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EDITORIALS

NOT TOO HIGH AND NOT TOO LOW: THE GOLDILOCKS APPROACH TO PREHOSPITAL TREATMENT OF SEVERE HYPERTENSION WITH STROKE

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Today more than ever, prehospital blood pressure (BP) lowering for stroke patients remains a hot topic, with many unanswered questions. First, how can we optimally lower BP before hospital arrival to help acute ischemic stroke (AIS) patients qualify for thrombolytics or mechanical thrombectomy? Secondly, how can we optimally lower BP before hospital arrival to prevent hematoma expansion for intracranial hemorrhage (ICH) patients? Thirdly, why are ambulances currently not lowering prehospital BP in stroke patients routinely and consistently already?

In an attempt to fill in some of these blanks, investigators from the Intensive Ambulance-Delivered Blood-Pressure Reduction in Hyperacute Stroke (INTERACT-4) trial published their findings in May 2024 in *The New England Journal of Medicine*. (Li, et al, 2024) Their study, conducted in China, utilized the anti-hypertensive drug urapidil, an α_1-receptor blocker unavailable in the United States, during the ambulance phase of care for patients with "undifferentiated stroke." This term refers to patients with stroke-like symptoms without neuroradiographic confirmation yet – before computed tomography (CT) reveals ICH or AIS. The urapidil dose was titrated to achieve a target prehospital systolic BP (SBP) range of 130-140 mmHg but participants in this study only reached an average of 159 mmHg. Investigators found improved outcomes for ICH but worsening for AIS. Specifically, the odds of a poor functional outcome for ICH decreased by about 25% (common odds ratio, 0.75; 95% CI, 0.60–0.92) but increased by about 30% for AIS (common odds ratio, 1.30; 95% CI, 1.06–1.60).

From our perspectives as a vascular neurologist (DZR) and as an EMS quality improvement expert (MRG), we are concerned that overinterpretation of this data may lead some clinicians to refrain from appropriate prehospital antihypertensive therapy for severely hypertensive stroke patients. We suspect that INTERACT-4 may magnify the preexisting fear of neurologic worsening or exam decline from treatment with antihypertensives in the prehospital setting. This fear applies mostly to patients with known carotid disease or large-vessel atherosclerosis, because persistent hypotension can lead to decreased cerebral perfusion pressure and watershed infarction. While this is a valid risk, and potentially played a role in the worsened outcomes for AIS in INTERACT-4, it must be counterbalanced by the current treatment guidelines from the American Heart Association, American Stroke Association, and the European Stroke Organization, which require BP to be <185 systolic and <110 diastolic before treatment with thrombolytics or thrombectomy (Powers et al, 2019), for which we know exists significant benefit. Failure to reach these BP thresholds within guideline-directed time limits (4.5-hours for thrombolytics and 24-hours for thrombectomy, from last known well) may result in "throwing out the baby with the bathwater" as some patients may not receive thrombolytics or thrombectomy because BP could not be controlled fast enough prior to or even after arrival to the hospital. Prehospital adjustment of SBP to pre-specified "Goldilocks" levels that are not too high and not too low may make all the difference.

Feasibly, for undifferentiated stroke patients to receive guideline-compliant care, ambulance crews may indeed be able to attempt to lower the BP to <185 systolic and <110 diastolic during the treatment time window (which needs to occur anyway before thrombolysis or thrombectomy can proceed). Achieving this in the ambulance before ED arrival avoids a preventable delay after hospital arrival. Every minute a stroke goes untreated, a patient loses 1.9 million neurons, each hour results in a 120 million neuron loss (Saver, 2006)

Practically speaking, INTERACT-4 tried to address two problems with one solution: it succeeded with ICH but failed for AIS because, in our opinion, the SBP levels were not (on average) high enough to require acute antihypertensive therapy anyway and may have been clinically unnecessary. Practically and realistically, we find no need to reduce SBP from 185 mmHg to 159 mmHg in AIS; we only need to lower SBP to <185 mmHg in AIS patients. If SBP is <185 mmHg upon presentation to clinicians in the field, then it would be reasonable to simply maintain it at that level to qualify for thrombolytic or thrombectomy upon arrival to the hospital, and not drop it further which could expose the AIS patient to further risk. INTERACT-4 authors found that lowering SBP to below thrombolytic/thrombectomy-required levels may worsen outcomes and hence it may be unwise to use antihypertensives to go below those levels in the field. However, many AIS patients present with SBP >185, often >200 mmHg, some much higher at 220 mmHg, occasionally 250 mmHg, and rarely some unfortunate soul breaks the sphygmomanometer at 300 mmHg. Therefore, what we urgently need is this high systolic data (which INTERACT-4 did not provide) showing the effect of lowering SBP from these levels to a 160-185 mmHg range. Because this data remains unknown, we cannot discard the possibility that this may be ultimate answer to the AIS-BP question.

We therefore believe that since suspected stroke cases are 'undifferentiated' in conventional ground ambulances, getting the patient into a tight SBP goal of 160-185 mmHg

(lowered only if SBP were >185 mmHg) would enable immediate administration of thrombolytic after CT-scan confirms no ICH upon arrival to the emergency department (ED). This would save valuable "time-is-brain" minutes otherwise wasted bringing SBP down after ED arrival.

For ICH, data from INTERACT-4 and the Intensive Blood-Pressure Lowering in Patients with Acute Cerebral Hemorrhage (ATACH-2) study (Qureshi et al, 2016) is somewhat more clear: lower is safe, and probably is better. The 2022 Guideline for the Management of Patients With Spontaneous Intracerebral Hemorrhage from the American Heart Association/American Stroke Association recommends a SBP range of 130-150 mmHg. (Greenberg et al, 2022) If EMS has already reduced the SBP to the 160-185 mmHg range and ICH is confirmed on CT in the ED, physicians can lower the SBP even further to that 130-150 mmHg goal in a stepwise fashion. This is far more preferable to precipitously dropping it from >200 mmHg (if untreated in prehospital setting) to that 130-150 mmHg goal quickly and dangerously in the ED. In essence, by lowering the SBP to 160-185 mmHg prehospital, the ICH patient is halfway there upon ED arrival. Hence, extreme BP plummeting (which could be detrimental even in ICH patients) is averted.

Fast-acting intravenous antihypertensives, like clevidipine or labetalol, are decent candidates for prehospital use. Transdermal nitroglycerin use in the ambulance for presumed stroke has been studied in randomized fashion (4), but it was not used to acutely manage severe hypertension. Moreover, because of their potent vasodilatory effects, nitrates are well-known to increase intracranial pressure, which could be harmful for ICH and also harmful for AIS with cerebral edema.

While clevidipine and labetalol are often administered after ED arrival, the next logical step in optimization of the sequence of care for stroke patients would be to implement a protocol for administering them safely before ED arrival in ambulances with infusion pumps designed for field use. Ultimately, for undifferentiated stroke, the "Goldilocks Approach," with SBPs just in the ideal range, not too high and not too low, needs to be evaluated in a prehospital trial.

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POSITION STATEMENTS

JOINT POSITION STATEMENT ON EMS PERFORMANCE MEASURES BEYOND RESPONSE TIMES

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Emergency Medical Services (EMS) exist to provide safe and effective out-of-hospital medical care to communities. Historically, response time has been the primary measure used to assess the performance of an emergency medical services (EMS) system/agency. Public policymakers have adopted response time because it is objective, quantifiable, and easily understood, however, this standard is derived from the need to respond quickly to cardiac arrest and time-sensitive conditions. While it is essential to continue to monitor and promote effective response, the majority of 911 EMS responses do not require a response time under ten minutes (Murray & Kue, 2017). Reliance solely on response time performance increases the cost of EMS and the risk of EMS vehicle crashes. It also prevents communities from evaluating other EMS system quality measures that demonstrate system effectiveness for patient care, experience, and outcomes.

This joint statement encourages EMS systems and community leaders to implement an approach to EMS system performance that prioritizes patient-centered care and uses a broad, balanced set of clinical, safety, experiential, equity, operational, and financial measures to evaluate the effectiveness of EMS systems.

This statement is endorsed by the Academy of International Mobile Healthcare Integration, American Ambulance Association, American College of Emergency Physicians, American Paramedic Association, International Academies of Emergency Dispatch, International Association of EMS Chiefs, International City/County Management Association, National Association of EMS Physicians, National Association of Emergency Medical Technicians, National Association of State EMS Officials, National EMS Management Association, National EMS Quality Alliance, National Volunteer Fire Council and Paramedic Chiefs of Canada. These associations recommend that local communities and governments modernize the assessment of the performance of their EMS systems/agencies by evaluating a broad array of domains with key performance indicators (KPIs) that can be measured and trended over time, and whenever possible, benchmarked with comparable EMS systems, or other national data, and published to local community stakeholders on a regular basis. The domains that communities should consider when evaluating an EMS system/agency are:

- *Effective*: Is the health care provided clinically appropriate and high quality?
- *Safe*: Are services being provided in a way that is clinically and operationally safe for patients, responders, and the community?
- *Satisfying*: How do patients and EMS clinicians feel about the service being provided?
- *Equitable*: Is the system providing care that is equitable based on patient demographics and service area geography?
- *Efficient*: Is this service being provided in a way that maximizes the use of economic and operational resources?

Whenever feasible, evidence-based performance measures should be used that are associated with improved patient outcomes and system performance. Resources are cited in the attached table that can help to guide selection.

It is also essential for government and community leaders and decision-makers to consider all elements of the EMS system from the moment a 9-1-1 call is made to the conclusion of care by the EMS system/agency.

Innovative programs such as mobile integrated healthcare/community paramedicine, alternative response models and response dispositions to enable a broader array of services to patients and communities should be considered.

By considering these additional performance measures, local communities can gain a more comprehensive understanding of the effectiveness of their EMS system/agency, identify areas for improvement in patient care, system efficiency, and overall emergency response capabilities.

Domain	Potential Type of Measure for Consideration	Source/Benchmark
Clinical	• Out-of-Hospital Cardiac Arrest • STEMI • Stroke • Trauma • Hypoglycemia • Asthma/COPD • Seizures/Status Epilepticus • Invasive Airway Management • Special Mental Health Crisis Management	• Internal agency data trended over time. • Benchmarked to comparable EMS systems/agencies. • National EMS Quality Alliance (NEMSQA) published measures. • NEMSIS Public Dashboards. • Cardiac Arrest Registry to Enhance Survival (CARES) • AHA Mission Lifeline • Other state, regional, provincial, or other community clinical indicators
Safety	• % of responses and transports using lights and siren (L&S). • Crash rate/100,000 miles. • Job-related injuries/100,000 hours worked. • Job-related illness/100,000 hours worked. • Reviews of all dispatch priority assignments. • EMS recall rate after a non-transport response.	• Internal agency data trended over time. • Benchmarked to comparable EMS systems/agencies. • National EMS Quality Alliance (NEMSQA) published measures. • NEMSIS Public Dashboards.
Operational	• The number of produced unit hours compared to scheduled unit hours. • Mission failure rate/100,000 miles. • Response time, for high acuity clinical responses, measured from the time the call is placed to a communication center, to the time of patient contact. • QA assessments to insure reliability of prioritization of responses.	• Internal agency data trended over time. • Benchmarked to comparable EMS systems/agencies.

Experiential	• Patient experience surveys
	• Hospital experience surveys
	• First Response Organization (FRO) experience surveys
	• Personnel engagement surveys
	• Employee turnover/retention
	• Emergency dispatcher engagement surveys
		• Validated, externally conducted patient and provider experience surveys, such as:
		  • EMS Survey Team
		  • Malcolm Baldrige
		  • Press Ganey
		• Alternatively, internal surveys could be conducted by the agency or local jurisdiction.

Financial	EMS system costs and revenues, reported per: • Staffed Unit Hour • Response • Patient Contact • Transport • Dispatch staffing deficits vs. fully staffed periods.	• Internal agency data trended over time. • Benchmarked to the Academy of International Mobile Healthcare Integration (AIMHI) survey of EMS systems, or other national data sources.
*These examples are not meant to be all-inclusive; communities should establish patient-centric and evidence-based performance measures based on value to their local stakeholders.		

Table 1. Examples of EMS System Performance Domains and Potential Measures for Consideration

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Murray, B. & Kue, R. (2019). The Use of Emergency Lights and Sirens by Ambulances and Their Effect on Patient Outcomes and Public Safety: A Comprehensive Review of the Literature – ADDENDUM. *Prehospital and Disaster Medicine, 34*(03), 345. https://doi.org/10.1017/s1049023x19000062

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RESEARCH REPORT

AN INTERNATIONAL COMMUNITY PARAMEDIC CAREER STRUCTURE: A SYNTHESIS OF THE LITERATURE, REGULATORY FRAMEWORKS, AND COMMUNITY PARAMEDICINE EXPERT ADVICE

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ABSTRACT

Introduction: Internationally, prehospital workers practice in a variety of community paramedicine roles. It can be unclear where community paramedics fit within existing paramedicine career structures and their professional capabilities are sometimes ill-defined or misunderstood. This study aimed to clarify some of these questions through the development of a community paramedic career structure and descriptions of their professional capabilities at different levels of practice.

Methods: The career structure was developed on the premise that paramedicine is an evolving autonomous health discipline. It was designed through the synthesis of the paramedicine literature, key regulatory frameworks, and advice from two panels of international community paramedicine experts. These purposively recruited panelists comprised practicing community paramedics, students, educators, professional leaders, and subject matter experts. Thematic analysis was undertaken of their open-text on-line questionnaire responses. After feedback from the first panel, a paramedic system modernization continuum was used to fashion community paramedic career structures to meet the needs of paramedic systems at different stages of development. These structures were tested with members of the second panel.

Findings: A five-step career structure was designed and conceptually separated into two distinct but related pathways to facilitate international comparability across paramedic systems in terms of professional autonomy and levels of education. Structural and cultural characteristics are represented through professional capability statements and indicative education levels that are incorporated into a paramedic system continuum ranging from directive to professionally autonomous paramedic systems.

Discussion: Although this study was conducted through the lens of community paramedicine, it might further international discussion of how attractive career structures could improve paramedic retention more broadly. Successful implementation of this career structure requires the support of key stakeholders in the face of strong structural and cultural barriers that continue to challenge innovations designed to respond to changing opportunities and needs in paramedicine.

INTRODUCTION

Community paramedicine programs have emerged that provide services to diverse and often under-served communities and individuals with a diversity of social and chronic disease characteristics. The associated role changes require paramedics to evolve into more than emergency health responders, through the adoption of knowledge, skills and behaviors that are more consistent with primary health professionals than those of public safety responders (Misner, 2005; O'Meara, 2014).

One of the challenges associated with these changes in roles and capabilities has been determining a definition of a community paramedic. To meet this challenge, an international research team developed the following consensus definition.

> *A community paramedic provides person-centered care in a diverse range of settings that address the needs of the community. Their practice may include provision of primary health care, health promotion, disease management, clinical assessment and needs based interventions. They should be integrated with interdisciplinary health care teams which aim to improve patient outcomes through education, advocacy, and health system navigation (Shannon, Baldry et al., 2023).*

Prehospital workers increasingly participate in a wide range of community paramedicine or paramedic primary care roles irrespective of their paramedicine model of care, variations in governance and leadership structures, nor the model of paramedic education and training that is available. While jurisdictions and agencies generally have their own paramedic career structures of varying complexity and clarity, it is often unclear where community paramedics fit, nor how these roles and associated capabilities can be compared across countries and regions (Long, Devenish et al., 2018; Eaton, Tierney et al., 2022).

At one end of the spectrum, emergency medical technicians with certificate-level education work as adjuncts to health professionals (American College of Emergency Physicians, 2015), while elsewhere advanced paramedic practitioners and consultant paramedics in primary care hold advanced postgraduate qualifications and work autonomously alongside other health professionals (Health Education England, 2019; Pre-hospital Emergency Care Council, 2022; Monash University, 2023). The emerging higher education expectations of community paramedics or primary care paramedics in the United Kingdom (U.K.), Australia, and Ireland are built on the back of bachelor's degree education for entry-to-practice paramedics. North American systems have been slower to adopt this approach (Caffrey, Barnes et al., 2018; Jensen, 2020; Sirr 2024) and have fallen back on short courses to fill educational gaps that have emerged as a result of changing demographics and epidemiological pressures, such as the COVID-19 pandemic (Wood, Ashton et al., 2017; Boehringer, O'Meara et al., 2021).

With prehospital workers across the world demonstrating a willingness to undertake additional education and training in the principles of community paramedicine (Steeps, Wilfong et al., 2017), it is important to recognise the variations in the availability of community paramedic or primary care education and the professional levels at which it is pitched (Ulintz, Gage et al., 2023). Arguably, one reason for these variations is that community paramedics' professional capabilities have not always been well described beyond the relatively recent generic definition of a community paramedic cited above.

This study sought to better describe the roles and professional capabilities of commu-

nity paramedics from an international perspective as part of a broader research project seeking to harmonize a community paramedic curriculum framework across selected countries and regions that are moving toward the implementation of community paramedicine models of care. During the scoping stage of this curriculum harmonization project, it became evident that community paramedicine curricula need to be matched to a wide range of different community paramedicine roles and their associated professional capabilities.

A community paramedic career structure has previously been developed in the U.S., however, the associated descriptors are limited and have minimal relevance beyond their local stakeholder groups (Paramedic Health Solutions, 2016). They were developed in an environment where there is limited agreement about emergency medical service (EMS) career pathways across the sector (Kirkwood, 2021). This situation contrasts with that found in some other countries; most prominently in the U.K., where the College of Paramedics has developed a long-standing and evolving postgraduate career pathway that is consistent with other allied health professions and articulated with the higher education system (College of Paramedics, 2023). Similar developments are underway in Australia and New Zealand through their combined paramedicine college (Australasian College of Paramedicine, 2022). These career pathways are also consistent with the rationale of the existing and evolving paramedic registration requirements in these and some other countries (Moritz, 2018). In 2024, the Paramedic Association of Canada promulgated a paramedic career structure that is consistent with the U.K. career pathway (Cameron & Batt, 2024). As a result of this ambiguity, the authors of this U.S. community paramedicine curriculum (Paramedic Health Solutions, 2021) battled to make a clear connection between their curriculum and career pathways based on the capability expectations of graduates moving into community paramedic roles.

Education providers need a clear set of educational outcome expectations to work toward when developing paramedic programs (including community paramedicine) at all levels of practice (Weber, Devenish et al., 2024). More broadly, a transparent career structure has been shown to help paramedics navigate their career progression and provide more opportunities for increased remuneration, as well as being associated with improved retention rates amongst paramedics in several countries (Rivard, Cash et al., 2020; Edwards, Csontos et al., 2022).

This study aimed to develop a community paramedic career structure and describe their professional capabilities at each level of practice in a manner that guides the development of international community paramedic curriculum frameworks.

METHODS

The harmonization of this community paramedicine curriculum project was built on a patient-centered ethnographic approach to professional practice associated with the provision of services that are socially and culturally sensitive to the needs of communities. In addition, the project incorporated the principles of evidence-based practice, the provision of appropriate and accessible education programs, and the development of sustainable career paths for community paramedics. The career structure was developed on the underlying philosophy that paramedicine is an evolving autonomous health discipline, rather than a public safety or paramilitary occupation (Williams, Beovich et al., 2021).

It was designed through the synthesis of the relevant paramedicine literature, key regulatory frameworks, and open-text questionnaire responses from two expert panels of paramedicine professionals drawn from six countries where community paramedicine is established or emerging. These purposively recruited panelists comprised practicing community paramedics, students and educators, professional leaders, and subject matter experts who were purposively recruited for the curriculum harmonization project through an approved process of informed consent. [Monash University Human Research Ethics Committee, Project ID: 36288]

Study data were collected and managed using REDCap electronic data capture tools hosted at Monash University (Harris, Taylor et al., 2009; Harris, Taylor et al., 2019). REDCap (Research Electronic Data Capture) is a secure, web-based software platform designed to support data capture for research studies, providing 1) an intuitive interface for validated data capture; 2) audit trails for tracking data manipulation and export procedures; 3) automated export procedures for seamless data downloads to common statistical packages; and 4) procedures for data integration and interoperability with external sources.

In the first round of consultation, Panel 1 members were invited to complete an on-line questionnaire that asked them to assess and make comments on the relevance of each topic in the existing Paramedic Health Solutions community paramedicine curriculum (Paramedic Health Solutions, 2021). It became evident from this initial feedback that a curriculum framework could not be effectively harmonized without a clearer community paramedic career structure and accompanying professional capability statements for each level of community paramedic practice.

In a second round of consultation, modified curriculum content and educational frameworks were presented to the Panel 1 members for assessment and further comment along with a specific question pertaining to a modified version of the Paramedic Health Solutions community paramedicine career structure that had been used to structure the curriculum. (Table 1) This five-level draft career structure was modified from the original six-level structure before distribution to incorporate international trends in paramedic career pathways. Panel 1 members were asked to complete a multiple-choice questionnaire (5-point Likert scale) to ascertain their overall support for the suggested structure and given an opportunity to provide open-text commentary on the career structure and the associated capability statements.

Thematic analysis of the responses was undertaken to identify and categorize common or disparate views and suggestions. To reconcile competing perspectives across different paramedic systems, Makrides' conceptual framework (Figure 1) that describes two prehospital sub-models or systems within the Anglo-American model, was used to fashion two community paramedic career structures tailored to meet the needs of paramedic systems at different stages of modernization (Makrides, Ross et al., 2022). In most cases, those countries that have implemented community paramedicine programs operate versions of the Anglo-American model.

Following this analysis, a two-stage community paramedic career structure was designed for directive and professionally autonomous paramedic systems. This approach sought to resolve fundamental differences of opinion between Panel 1 members who

Generic Titles	Capability Statements (not scope of practice)
Primary Care Technician	A Primary Care Technician (Community Paramedic) expands the role of the primary care paramedic (emergency medical technician) to provide health services where access to physicians, clinics, and/or hospitals is difficult or may not exist. This involves the application of knowledge and skills to connect underutilized resources to underserved populations through collaboration with local stakeholders. They have the capacity to follow a pre-existing care plan under the guidance of an appropriately qualified health care professional.
Community Paramedic Clinician	Community Paramedic Clinicians operate as the entry level community paramedics in some countries. They have the competencies and capabilities to practice as clinicians in a wide range of primary and urgent care settings. Community paramedic clinicians bring their core paramedic knowledge, skills, and behaviours together with additional community paramedicine related education and training to the health and social needs of their patients and communities.
Community Paramedic Practitioner	Community Paramedic Practitioners practice as paramedicine specialists across a wide range of primary and urgent care settings. They have acquired, and continue to demonstrate, an enhanced knowledge base, complex decision-making skills, competence, and judgement in community paramedic practice.
Community Paramedic Advanced Practitioner	Community Paramedic Advanced Practitioners bring high-level decision-making skills to patient care. Their skills and competencies are grounded in a thorough understanding of the pathophysiology of and therapeutic approaches to common illness and injury, in addition to models of primary, acute, and integrated care across the entirety of the healthcare system. The application of non-technical skills, complex reasoning, relationship building, communication and flexibility is of critical importance.
Community Paramedic Consultant	Community Paramedic Consultants carry out innovation and leadership roles in one or more of the academic, professional, or organisational leadership domains of community paramedic practice.

Table 1. Draft Community Paramedic Career Structure and Capability Statements

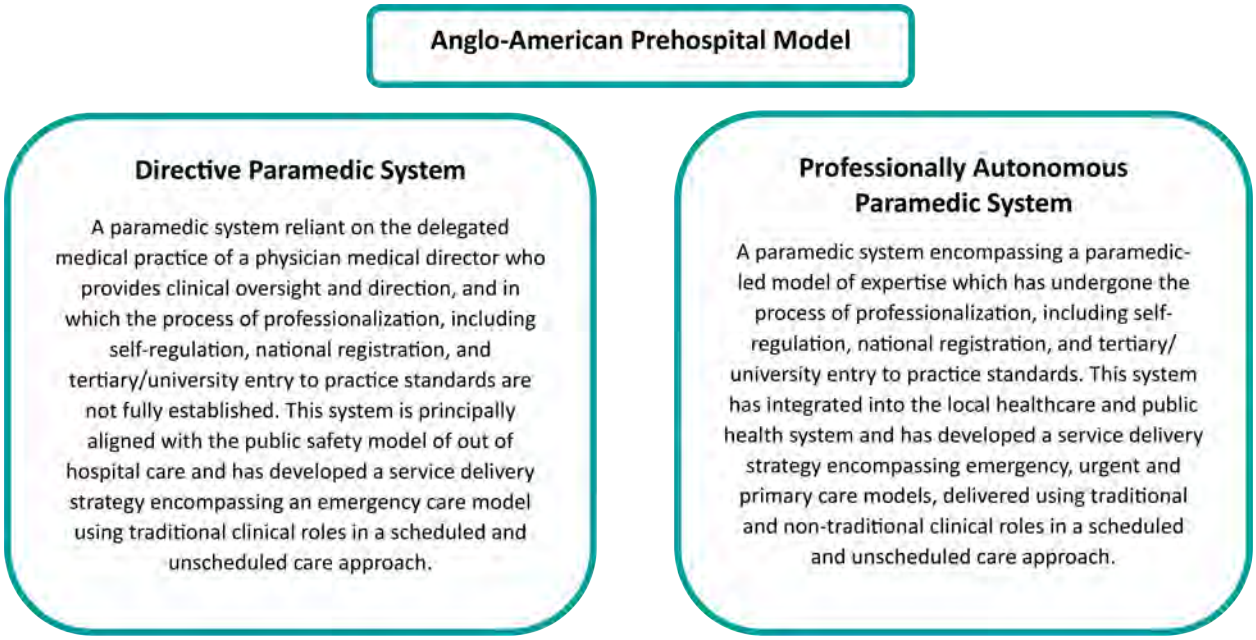

Figure 1. Definitions of Directive and Professionally Autonomous Paramedic Systems (Makrides, Ross et al., 2022)

were drawn from paramedic systems along this modernization continuum (Makrides, Ross et al., 2022). The next iteration of the career structure and capability statements were then sent to Panel 2, a second group of purposively recruited expert informants from the U.S., U.K. and Canada, to validate the final community paramedic career structure and accompanying professional capability statements. Where possible, the these panelists' suggestions were incorporated into the final community paramedic career structure that forms one section of the International Community Paramedic Curriculum: A Guide for Educators (O'Meara, Ahlers et al., 2024).

FINDINGS

The SQUIRE-EDU extension of the SQUIRE guidelines was used to report the findings of the community paramedicine curriculum harmonization project including those that address the development of a community paramedic career structure. This approach increased the completeness, transparency, and replicability of this effort to improve education of community paramedics (Ogrinc, Armstrong et al., 2019).

Of the 34 questionnaires distributed in the second round of the research to members of Panel 1, 17 were returned, with 14 (U.S. – 4; Australia – 8; Canada – 2) providing expert advice on the draft career structure and associated capability statements (Table 1). While overall support for a career structure was positive, six panelists held neutral or negative opinions about aspects of the career structure as presented.

The commentaries varied from one or two sentences to extensive expressions of expert opinion in relation to the draft community paramedic career structures and capability statements. These views varied according to their professional expertise and roles, as well as their perception of paramedic roles in their respective systems. Some saw paramedics as sub-professional health workers who follow protocols and work under the direction of health professionals, while others were more accustomed to paramedics working relatively independently and autonomously as health professionals alongside other health professionals in clinical and leadership roles. These findings were broadly consistent with Makrides' research that distinguishes between directive and professionally autonomous paramedic systems (Makrides, Ross et al., 2022).

Following thematic analysis, the responses were categorised into four themes: (1) policy and system issues; (2) career structure inclusions; (3) advanced practitioner/speciality and consultant roles; and (4) capability statements. Figure 2 illustrates the factors that

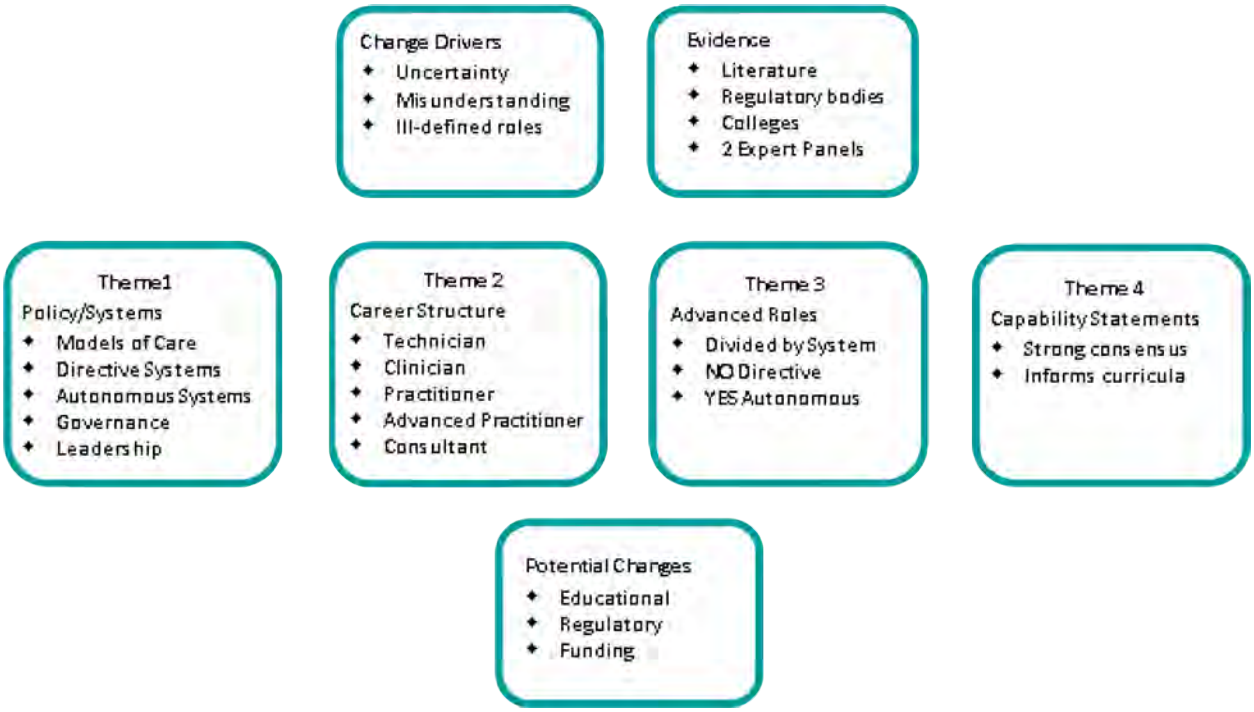

Figure 2. Community Paramedic Career Structure Themes

drove the research, the four themes identified, and changes that might flow from the findings.

With the identification of international and local variations in policy context and specific system issues, the career structure needed to acknowledge the diversity of cultural values and system needs. Most Panel 1 members suggested the adoption of two or three community paramedic levels, either through the elimination of the technician/clinician levels or the advanced paramedic practitioner/consultant levels. This dichotomy of views was difficult to reconcile within a single career structure and demanded a more nuanced approach. At the same time, there was strong support for all the suggested professional capability statements from panelist's individual perspectives.

Theme 1 - Policy and System Issues

Several members of Panel 1 argued that a community paramedic career structure could not operate in a vacuum, with associated policy and system changes required to strengthen the career structure for paramedics in general.

> *1996 EMS Agenda for the Future called for EMS in the United States to change and expand to better serve the patient. We have been slow to do that. This career structure will benefit both the profession and also the patient. This structure will improve the Paramedic education and profession by making Paramedicine more accepted in healthcare. It will create a better structure for education and a better structure for providing care. I support this concept and structure design. I believe that we need a better career structure for Paramedicine in general, not just Community Paramedicine. I am not sure we can or should have one without the other. (U.S. panelist)*

> *As a clinician from a country that utilises a Bachelor's degree as a base qualification, I feel that the EMT level position does not fit with community paramedicine as a separate specialty. Equally however I acknowledge that not all community paramedic programs will require a higher clinical level. (Australian panelist)*

Others appreciated efforts to scaffold the career structure and make linkages between role complexity and higher education requirements that were feasible irrespective of the country in which community paramedics practice.

> *I really like the scaffolding of the career structure. I'm not sure that every type of health system across the world would make use of each of them simply because of the ability to integrate into the health systems. Whether they do or they do not, having an opportunity to obtain each level would be optimal, regardless of the country. (U.S. panelist)*

> *The career structure is sound and the CP role advances as additional higher education is undertaken. (Australian panelist)*

One panel member argued that community paramedicine was already, or should be, integrated into general paramedic practice with paramedics moving between roles incorporating community paramedicine. Therefore, arguing that additional nomenclature is not required.

> *I understand the requirement to look to harmonize but I worry with the career structure we are adding further terminology that just isn't required. Ideally, we should be paramedics, its the model of service delivery that they work in that defines the role which will chop and change over time. (Australian panelist)*

Theme 2 - Career structure inclusions

Some panelists had general reservations or caveats related to the context in which community paramedics practice. Two panelists expressed concern about Primary Care or Emergency Medical Technicians (EMTs) being included in a community paramedic career structure because of their limited professional autonomy and limited educational preparation as recognized through their exclusion from national registration schemes in professionally autonomous paramedic systems.

> *Whilst I could make these fit and work, there are aspects that I don't fully endorse. The Primary Care Technician (or a technician level by any name) is not required in a structure - this level of provider is following protocols, working with and for other clinicians, and has no independence of thought or action. (Australian panelist)*

> *Structure appears to make sense - will be interesting where different jurisdictions will think these levels can be applied (in relation to education). I also appreciate that some jurisdictions will not adopt the generic titles even at the equivalency level of practice, especially those where paramedic is a protected title that has been appropriately fought for (ie: technician is no longer a term used in many paramedic services where paramedics are self-regulated, the title of paramedic is protected and thus should be used for members of the profession). (Canadian panelist)*

> *Looks good. The increasing levels make it clear that greater complexity and autonomy are required by the clinicians. (Australian panelist)*

The number of levels in the draft career structure was a challenging issue, with many panel members arguing that less would be preferred. Suggestions were made to reduce the number of levels and clarify their respective capabilities.

> *While I like the approach of building on skills, I would say there are too many levels. Is it necessary to keep applying different levels to a CP? I think for most jurisdictions and regions it would be more fiscally responsible to streamline learning and perhaps just create two levels. (Canadian panelist)*

> *While I agree with the concept, the introduction of five unique levels may be more than many agencies would want to introduce when other paramedic pathways may only have two or three promotion levels. (U.S. panelist)*

> *There appears to be many levels within this career structure, some of which appear to replicate others. (Australian panelist)*

> *It may be a little confusing to external stakeholders differentiating between a Community Paramedic Practitioner, and a Community Paramedic Advanced Practitioner. Why not use the term Community Paramedic Specialist as outlined in the capability statement, so that these two roles are clearly distinguishable. (Australian panelist)*

Theme 3 - Advanced Practitioner/Speciality and Consultant roles

The question of advanced practitioners, speciality and consultant community paramedic designations was contested with a strong divide between panel members from 'directive paramedic systems' and those from 'professionally autonomous paramedic systems' where advanced practitioner, specialist and consultant roles already exist or are under development. Others suggested more clarity between the higher-level roles.

My other concern is the use of the word "consultant" which has a very "physician" connotation to it. First, I'm not sure it is the right sentiment to attach to that level of CP and secondly, I think push back (or at least mockery) will come from the physician community. (US panelist)

The easiest way to integrate community paramedicine is to mimic the emergency stream that is already implemented in most countries. The advanced practitioner and consultant roles are going to be difficult to attain in the US system, due to the education requirements, standardization and work completed in UK. (Australian panelist)

The inclusion of two levels of practitioner is also confusing. I feel that a practitioner is considered as an independent clinician and that any level above that is a specialist in that field and not an advanced practitioner. (Australian panelist)

The Community Paramedic Advanced Practitioner aligns more to my understanding of a big 'P' practitioner, and I suggest that its title could be simplified to just Community Paramedic practitioner. The Community Paramedic Consultant is a level of defined expertise that I appreciate being included as part of the career structure. (Australian panelist)

Theme 4 - Capability statements

There was strong support for the capability statements, with one panelist finding them to be a "Good clear delineation of each role and the competencies and practice." (Australian panelist), although some felt that some of the wording could be out of step with recent international community paramedicine definitions that could potentially lead to confusion across borders.

I have some concerns about the wording of titles being inconsistent with international frameworks. The term consultant is related to Masters in this framework where internationally this term is utilised alongside a PhD completion. The term practitioner is also wordy at the end of community paramedic and also goes against recent consensus study of what a community paramedic is and reducing nomenclature confusion internationally. (Australian panelist)

The Community Paramedic clinician and Community Paramedic practitioners could be integrated (my preferred title would be Community Paramedic) ... They are not a big 'P' practitioner as I understand the term with some autonomy but largely still working under guidelines from an employer as opposed to a true practitioner who has wider scope to establish their own plans and implement these (including with prescribing in many cases). (Australian panelist)

The only thing I might add here for clarity is what level of experience and/or education is associated with each level, either as a prerequisite or as the result of earning a degree. Maybe even include EMT as the first rung of the ladder, although that might not be true in all countries. What I'm getting at is connecting Certificates, Diplomas, Associates, Bachelors, Masters, etc. to the titles/capabilities, if that is useful at a global level (in addition to preparation for the certification exam. (U.S. panelist)

Panel 2 members were independently presented with a modified career structure based on the feedback of Panel 1. Even though the number of panelists was low (n=3), support for the career structure was strong across three countries, with the descriptive figures used to describe the career structure appreciated. One concern was that the terminology used at the advanced or specialist level might be confusing in more mature systems.

This maps well to existing Advanced Clinical Practice MSc's in the UK. My only comment in this section for clarity would be to remove the term Specialist Paramedic and use the terms, Advanced Paramedic, Paramedic working at an Advanced Level of Practice or Advanced Specialist Paramed-

ic. Including Specialist paramedic on its own could create confusion as if they have completed a Masters program, they have demonstrated mastery of their subject so are formatively working at an Advanced and not a Specialist level of practice. (U.K. panelist)

Community Paramedic Career Structure Development

While community paramedic models exist within the context of local patient and community needs, there is a shared understanding that viable community paramedic career paths are required for the sustainability of these models of care. One observation is that cultural nuances and differences in system design, financing and regulatory architecture make attempts to design career structures and the supporting educational frameworks across different countries challenging. In the U.K. there has been considerable progress made toward the creation of a tiered career structure, along with the creation of clinical governance systems (Health Education England, 2019; Health Education and Improvement Wales, 2023). Ireland and Australia are moving toward similar innovations that will allow paramedics to practice at levels that better align with their professional capabilities (Pre-hospital Emergency Care Council, 2022; Monash University, 2023).

After applying Makrides' conceptual framework to the findings, a revised career structure and professional capability statements were further developed to span countries, regions, and systems at different stages of modernization. The proposed five-step career structure was split into two distinct but related career structures that allow international comparability and consistency in terms of professional autonomy and levels of education. (Figure 3) The Advanced Paramedic Practitioner nomenclature was preferred to Specialist nomenclature in the interests of international consistency.

Using this systems approach, professional capability statements and indicative education levels are presented in Figure 4 for directive paramedic systems and in Figure 5 for professionally autonomous paramedic systems. The two career structures span paramedic systems at different stages of modernization while maintaining consistent capability statements and providing indicative education levels for community paramedics.

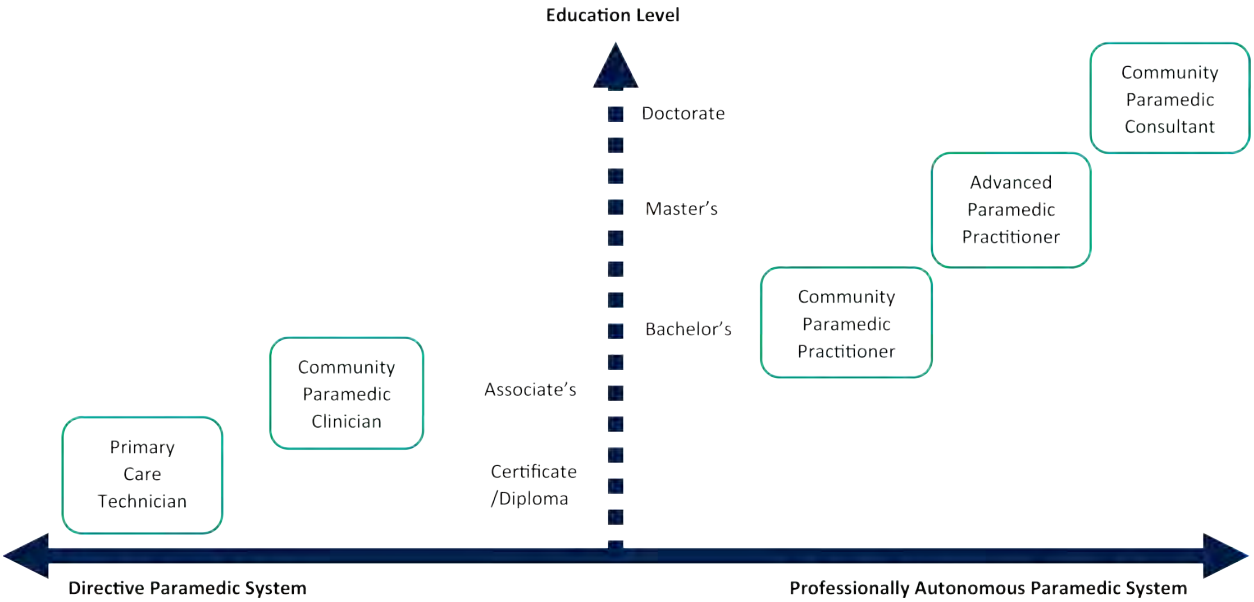

Figure 3. Community Paramedic Career Structure Across Systems

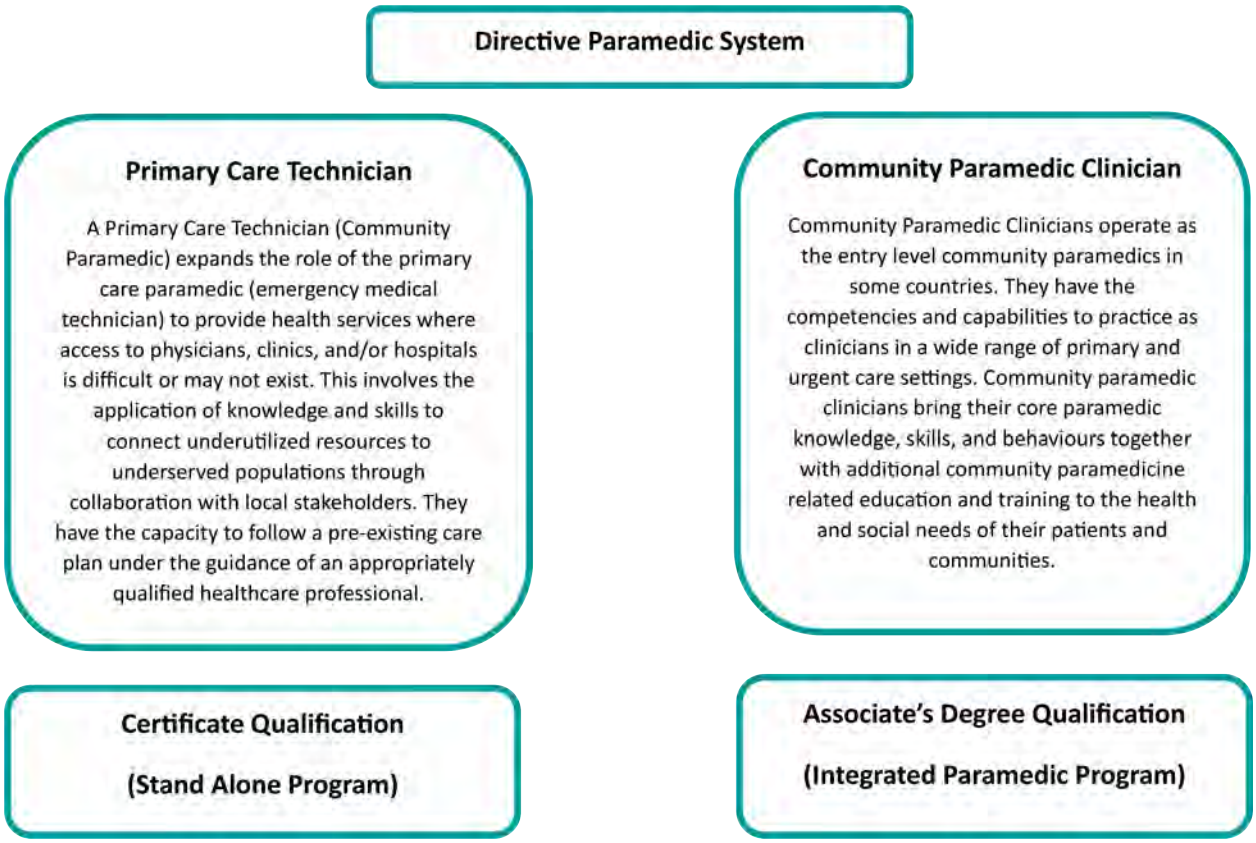

Figure 4. Directive Paramedic System Community Paramedic Career Structure and Capabilities

The suggested community paramedic career structure within autonomous professional paramedic systems (Figure 5) remains aspirational in settings where greater integration with health systems, improved access to higher education, and regulatory changes to facilitate paramedics fully utilizing their professional capabilities remain elusive (Makrides, Law et al., 2023). As some members of both expert panels commented, the acceptance of community paramedic practitioners, advanced paramedic practitioners and consultant paramedics will meet opposition from both internal and external stakeholders who might hold reservations about the professional capabilities of community paramedics at these levels of practice (O'Meara, 2024).

This combination of external skepticism and individual disconnection from the wider healthcare system is to be expected when innovations of practice are envisioned or implemented (Shannon, Shannon et al., 2022). On a positive note, advanced practice innovations in paramedicine are already being progressively implemented in several parts of the world with communities benefiting from community paramedics and other specialist paramedics making major contributions to improved health outcomes (Long, Devenish et al., 2018; Health Education England, 2019; Pre-hospital Emergency Care Council, 2022).

DISCUSSION

The underpinning premise of this research on community paramedic career structures was that paramedicine is a health profession transitioning toward professional recognition. Progress toward this vision can be observed through the presence or absence

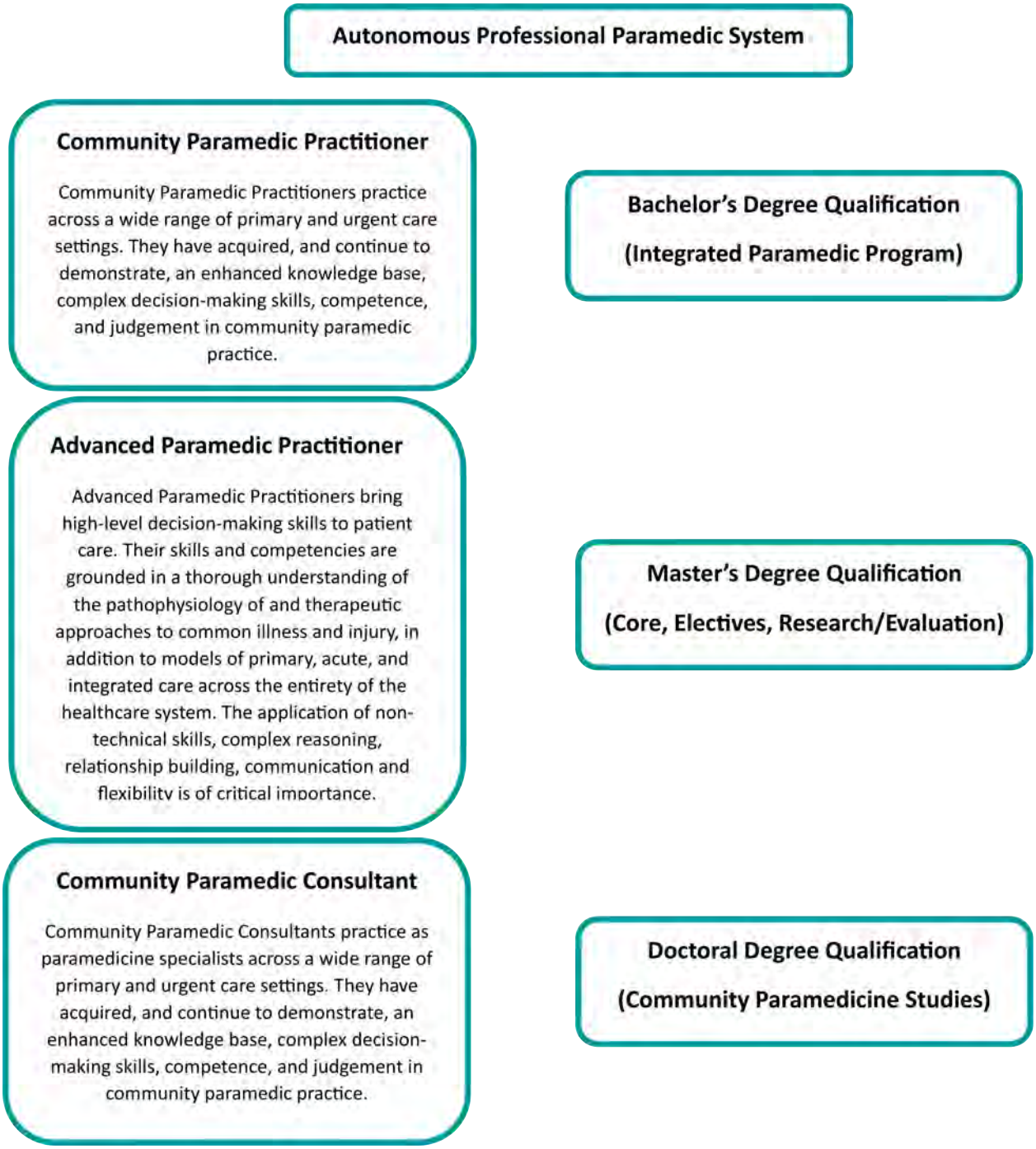

Figure 5. Autonomous Professional Paramedic System Community Paramedic Career Structure and Capabilities

of professionalization markers, such as higher education, creation of a unique body of knowledge, and self-regulation (Reed, Cowin et al., 2019). On this basis, paramedicine is already an emerging and well-respected health profession in most high-income countries employing the Anglo-American prehospital model (Makrides, Ross et al., 2020).

An outlier is the United States (U.S.), where paramedics and emergency medical technicians (EMTs) battle to achieve tangible professional esteem, are often poorly remunerated in uncertain employment, and have minimal control over their own occupation (Pozner,

Zane et al., 2004; Wang, Mann et al., 2013; Crowe, Levine et al., 2016; Newton-Riner, 2020; Rivard, Cash et al., 2020; O'Meara 2024). The fragmentation of the U.S. system presents challenges to the establishment of strong national professional associations and consistent regulatory structures that encourage the emergence of autonomous practice and self-regulation (O'Meara, Wingrove et al., 2017).

The U.K. post-registration career framework is the benchmark for paramedic career structures and is being broadly emulated in Australia and New Zealand through the work of their professional college, regulatory bodies and employers, as well as being used as an inspiration for Canadian efforts to transition their paramedicine system (Australasian College of Paramedicine 2022, Tavares W. et al. 2023, Cameron and Batt, 2024). Ireland is making progress along similar lines in regard to community paramedicine (Pre-hospital Emergency Care Council, 2022). The responses from the panelists highlighted a dichotomy between directive and professionally autonomous paramedic systems and this underpinned the rationale for presenting the community paramedic career structure across the paramedic system modernization continuum.

LIMITATIONS

This study did not explicitly explore barriers that stakeholders are likely to face as paramedics undertake novel roles, responsibilities, and accountabilities in response to community needs. Despite a considerable number of invitations and reminders to potential panelists, the number of panel members were limited to those who responded in a timely manner. A broader and more diverse group of stakeholders would need to be recruited to respond more directly to these questions about the future shape of paramedicine.

CONCLUSION

There is evidence that a career structure that provides opportunities for career progression, access to advanced and continuing education, and higher remuneration within the profession is an important factor driving greater professionalization and personnel retention (Edwards, Csontos et al., 2022). This career structure and associated capability statements are designed to further international discussion about the future sustainability of paramedicine through the lens of community paramedicine. This career structure will inform a more extensive discussion about the importance and value of attractive paramedic career structures amongst paramedics, regulators and employing agencies.

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RESEARCH REPORTS

SHEDDING LIGHT ON MOBILE STROKE UNIT DISPATCH PROTOCOLS: A GLOBAL SURVEY ANALYSIS

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ABSTRACT

Background: Treatment on Mobile Stroke Units (MSU) improves outcomes for patients with acute ischemic stroke, but MSU effectiveness relies on accurate field dispatch. This study aimed to collect data on dispatch infrastructure, methods of dispatching, operational rules, and the accuracy of dispatcher impressions relevant to MSU operations worldwide.

Methods: In 2020, the PREhospital Stroke Treatment Organization (PRESTO) surveyed all operational MSUs, with 20 of 23 MSUs (87%) on four continents responding. The survey investigated dispatch patterns of these resources, hypothesizing that inaccurate dispatch rates far exceed treatment admission rates. We assessed dispatch modes, dispatcher training levels, numbers and dispatch types, en route cancellations, and patient diagnoses.

Results: All 20 MSU services reported dispatching from emergency medical system (EMS) dispatch centers, with 14 sites also responding to requests from EMS personnel based on on-scene evaluations. Aside from 2 programs, all participated in initial dispatcher stroke training, but only 6 (30%) continued regularly. The median number of dispatches per year was 325, ranging from 119 to 2174. In addition to suspected stroke, 8 (40%) regularly dispatched for 'cardiac arrest alarms' and 13 (65%) for altered levels of consciousness. One also responded to calls for seizures, syncope, headaches, and other dispatches suggesting possible stroke. A median of 41% of deployments were cancelled en route by on-scene EMS for presumed non-stroke impressions or readiness to transport before MSU arrival. Of patients evaluated on scene by MSUs, stroke was excluded in 48%. Eighteen percent of assessed patients (~11% of all dispatches) were diagnosed with cerebral ischemia within 4.5 hours and were potentially eligible for intravenous thrombolysis.

Conclusions: Allocating MSUs to the most clinically appropriate dispatches is crucial for efficacy and benefit. Enhancing dispatcher recognition of stroke through education, feedback, and advanced technologies like AI algorithms can improve dispatch accuracy.

INTRODUCTION

Stroke is a “golden hour” emergency in which the timing of diagnosis and treatment are critical. In ischemic stroke, medical and endovascular therapies for vascular reperfusion, such as intravenous thrombolysis (IVT) and mechanical thrombectomy (MT), are highly time sensitive with better functional outcomes the earlier they are initiated (Lees et al., 2010; Saver et al., 2016). Mobile Stroke Units (MSU) are specialized ambulances equipped with CT-scanners, point-of-care laboratories (Walter et al., 2012) and a specialized stroke team, allowing for definitive prehospital diagnosis, initiation of thrombolytic therapy, reversal of hemorrhage in patients on anticoagulation, the initiation of antiepileptics and other brain and lifesaving treatments. The conclusive diagnosis offered in the prehospital setting on these specialized ambulances through image based evidence as well as neurologist expert examination allow for pre-arrival notification of MT teams at receiving hospitals aimed at expediting in-hospital endovascular reperfusion. Treatment on MSUs reduces time to IVT by ~ 30 minutes and results in more patients treated earlier as compared to treatment in the emergency department after standard EMS transport (Ebinger et al., 2014; Walter et al., 2012). Recent pivotal clinical studies have shown that MSUs improve 3-months outcome of acute ischemic stroke patients who are suitable for IVT (Ebinger et al., 2021; Grotta et al., 2021). However, the net benefit to the healthcare system and communities of MSUs is directly related to the number of appropriate patients who can access this resource. In order to optimize efficiency, MSUs must be dispatched simultaneously with first responding EMS units for calls with suspected stroke. This highlights the critical role played by the emergency call takers and dispatchers in identifying potential candidates for MSU management. Given that globally & locally, dispatchers use a variety of dispatch algorithms, the sensitivity, specificity and positive predictive value of stroke dispatches vary widely. We conducted a survey focused on MSU dispatch protocols in existing MSU programs worldwide in order to understand best practice models and provide the basis for the future development of a robust dispatch mechanism for these specialized resources.

METHODS

A dispatch survey was compiled by the dispatch committee of the PREhospital Stroke Organization (Audebert et al., 2017) investigating different aspects of MSU operations with regards to MSU deployment and interactions with local dispatch centers. A survey email was sent to MSU sites in 2020 requesting 2019 data. If a MSU was not operating during the entirety of 2019, an extrapolation of numbers for the 12-month period was allowed. The data collected included the questions detailed in Table 1 and provided in detail in the supplement. Using descriptive analyses with SPSS statistics software (IBM, US), we provide proportions expressed in percentages as well as continuous variables expressed as medians and ranges (minimum to maximum) and interquartile ranges (IQR) unless otherwise indicated for the responses provided by the MSU programs.

General Survey Elements
Dispatch Center Infrastructure and Education • Use of specific stroke identification protocol • Dispatcher training for stroke recognition (including frequency of training) • Feedback to dispatchers
Stroke Identification • Use of prehospital stroke scale • Focal neurological symptoms aside from strength and speech alterations • Dispatching to non-focal symptoms • Percentage of non-stroke diagnosis upon field assessment • Evaluation of accuracy in stroke identification
Dispatch Rules/Algorithms • Dispatching to all vs. some dispatcher impressions of stroke (based on time from symptom onset) • Dispatching to other dispatcher impression of non-stroke • Dispatching based on request of first responders following initial patient evaluation • Dispatch to suspected stroke with unknown time of onset
EMS/MSU Organization • Percentage of en route response cancelations • Cancelation secondary to delay in on scene arrival • Frequency of training of paramedics • Number of dispatches per year • Typical time from dispatch to on scene arrival • Number of CT and CTA scans performed per year • Operational days and hours of clinical service
Diagnoses of Stroke Dispatches • Percentage of diagnoses related to the following: ischemic stroke/TIA within 4.5 hours of onset, ischemic stroke/TIA beyond 4.5 hours of onset, hemorrhagic stroke • Median NIHSS for stroke patients • Percentage of other neurological diagnoses including epileptic seizures, headache, syncope, peripheral vertigo, movement disorder, delirium, transient global amnesia, tumor • Percentage of other non-neurological diagnoses including: psychiatric disorder, infection, metabolic disorders, hypo/hypertension, primary cardiac disorder • Source of diagnosis (MSU diagnosis vs. final hospital diagnosis)

Table 1. MSU Dispatch Survey Elements

RESULTS

Amongst 23 MSUs operational in 2019, we received 20 responses (87%) with 13 from North America, 5 from Europe, 1 from Asia and 1 from Australia. As of October 2021, the average (mean) operational time of the MSU programs who participated was 4.5 years and ranged between 1 and 12 years (SD 2.8y). The median time on clinical service was 12 hours per day (8 to 24 hours, IQR 9-15h). Eight MSUs had restricted operations on

weekdays, excluding weekends. The total numbers of dispatches per year ranged from 119 to 2174 (median: 325, IQR 260-1158) and the volume of thrombolysis correlated with volume of dispatches (Figure 1). All MSU services reported dispatching directly through emergency medical system (EMS) dispatch centers or fire departments, of whom 14 (70%) also reported responding to alerts from on-scene first responders based on initial patient evaluation on scene.

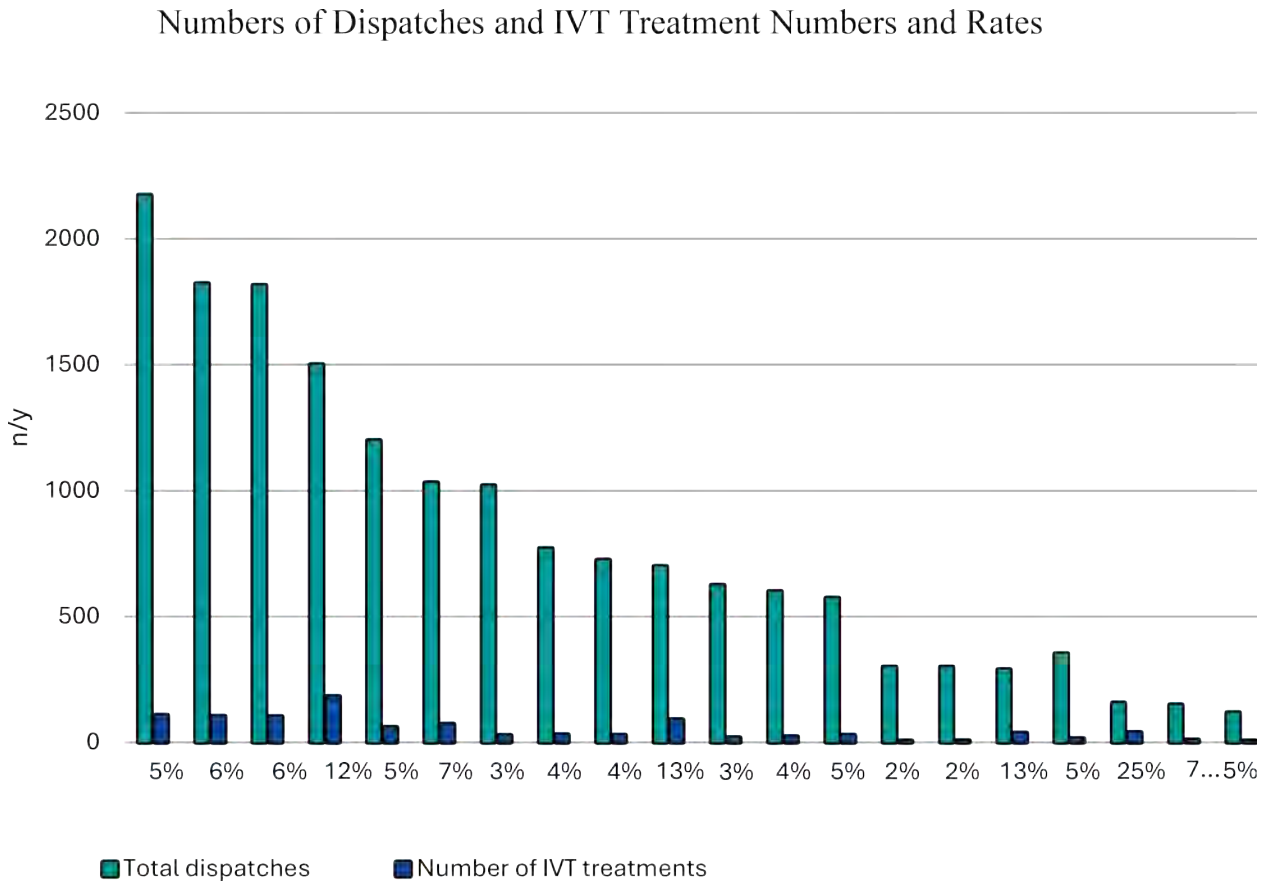

Figure 1: Number of Dispatches and tPA Treatments Numbers and Rates in 2019. Total numbers of dispatches at different MSU sites and respective numbers of intravenous thrombolytic (IVT) treatments per year. Proportion (%) of dispatches leading to prehospital IVT from all dispatches

Stroke Identification At Dispatch Level

Seventeen of 20 (85%) dispatch centers used specific stroke identification protocols/algorithms while the remaining 3 (15) relied on stroke identification by experienced dispatchers. A wide variety of dispatch systems were used, with 5 (25%) MSUs using the Medical Priority Dispatch System (MPDS, International Academies of Emergency Dispatch), others using a variety of commercial programs, dispatch algorithms made locally by their medical directors, or a combination thereof. With the exception of 2 (10%) programs, all reported participating in initial stroke identification/recognition training for EMS dispatchers in their system of care, however, only 6 (30%) programs followed that with routine (1 training/year).

Dispatch Regulations for MSUs

In the majority of MSUs, deployments were restricted by symptoms time since onset or patient last-seen-well time ranging from 4 to 24 hours, while 7 (35%) programs did not restrict their attachment to calls by a knowledge of the patient last known well time ahead of dispatch. Apart from dispatches for suspected stroke, 8 (40%) MSUs also attached to calls of 'cardiac arrest alarms' and 13 (65%) deployed to altered level of consciousness dispatches. One (5%) US-based MSU program responded to other call types including 'seizure', 'syncope', 'headache', 'sick person' if thought to be suspicious for stroke.

MSU Operational Rules, Number of Stroke Evaluations and Treatments

With the exception of 5 (25%) MSUs, all programs operated under a protocol of concurrent dispatch with first responding units. A median of 41% (IQR 25-61%) of MSU deployments were cancelled en-route by the first responders on-scene due either to a provider impression of non-stroke or much less frequently to readiness to transport ahead of MSU arrival. Fourteen (70%) MSU programs operated within a maximum (calculated) distance-to–scene time with a median of 20 (IQR 15-25) minutes, ranging from 10 to 160 minutes, the latter in a rural area.

The median number of CT scans was 171, ranging from 23 to 402 (IQR 20-91). Eight (40%) MSUs did not use CT-angiography (CTA) on board while the remaining MSUs performed on average (median) 42 CTAs per year (range: 12 to 402, IQR 20-91). After large vessel occlusion (LVO) diagnosis, pre-notification of in-hospital neurointerventional teams responsible for mechanical thrombectomy and delivery to the angiography suite was the preferred route. The median number of IVT treatments was 29 times per year ranging from 6 to 184 times (IQR 17-70).

Prehospital Diagnoses

For the evaluation of the patient diagnoses, 9 MSU programs participating in the survey reported final in-hospital diagnoses, 9 reported MSU-based diagnoses and 2 provided likely diagnoses. The proportions of most frequent diagnoses encountered are provided in Table 2. At on scene evaluation, the MSU teams excluded a diagnosis of stroke, or had a provider impression of non-stroke, 48% of the time (range: 3%-79%). Eighteen percent of all patients assessed (~11% of dispatches) had a likely diagnosis of cerebral ischemia and were within 4.5 hours of onset and therefore potential candidates for IV thrombolytic treatment.

DISCUSSION

Our survey from existing MSU operating in 2019 demonstrates that these novel specialty ambulances are dispatched in a heterogeneous fashion with differing dispatch algorithms. Hence, they vary in the number of dispatches, MSU admissions and therefore the number of patients treated by IV thrombolysis. Seen with each of their systems of care, the accuracy of EMS call taker of stroke is low worldwide and remains a barrier for a more efficient use of MSUs and the access of patients to this life and brain-saving resource. These results correspond to findings of a systematic review of stroke recognition tools at a dispatcher level with sensitivities ranging between 41%-83% and positive

predictive values between 41%-68% (Oostema, Carle, Talia, & Reeves, 2016). For EMS call takers, a limited amount of time and a limited breath of information available remain critical barriers for precise stroke dispatching. Additionally, current dispatch systems such as MPDS only use common stroke symptoms such as weakness, neglecting other subtle signs of stroke including gaze preference, neglect, visual field loss and aphasia. A targeted approach to the improvement in the sensitivity, specificity and positive predictive value for stroke dispatches is therefore critical to the successful deployment of highly specialized ambulance treatment units such as MSU.

Diagnosis	Median Proportion
Ischemic stroke or TIA within 4.5 hours of onset/LSW	18.3%
Ischemic stroke or TIA beyond 4.5 hours of onset/LSW	17.5%
Hemorrhagic stroke	4.5%
Non-stroke intracranial hematoma	0.5%
Epileptic seizures	5.0%
Non-stroke related headache	2.0%
Syncope	1.3%
Non-stroke related vertigo	0.9%
Delirium	1.3%
Movement disorders	0.7%
Tumor diseases	1.0%
Psychiatric diseases	1.4%
Infectious diseases	4.5%
Metabolic diseases	2.0%
Arterial hyper-/hypotension	2.1%
Dehydration	1.1%
Cardiac diseases	1.2%

Table 2. Most Frequent Diagnoses of Patients with Prehospital Stroke Dispatch

Future efforts for improvement may focus on the improvement of dispatch algorithms, routine training and education provided for EMS call takers and dispatchers as well as the incorporation of novel AI algorithms which may aid in diagnosis by phone. In Berlin, the proportion of acute ischemic stroke patients was highest after the joint derivation and validation of a stroke identification algorithm with the MSU team and the Dispatch Center in 2010 (Krebes et al., 2012). In the PHANTOM-S pilot period in early 2011 and only a few months after completing the aforementioned stroke dispatch project, 58% of evaluated patients with stroke dispatch had ischemic brain events (ischemic stroke or TIA) and 15% of all dispatches led to IVT(Weber et al., 2013). In the subsequent PHANTOM-S trial (2011-2013), 44% of the dispatches resulted in the diagnoses of ischemic brain events and IVT was given in 10% of dispatches (Ebinger et al., 2014). After several years without systematic training for various reasons, corresponding numbers were 32% for ischemic brain events and 5% for IVT during 2019. As there are no other obvious reasons for the worsened stroke dispatch accuracy, this experience argues for a need training of dispatchers and continuous quality management in dispatch centers.

Our survey carries limitations including retrospective data reporting and a difference in data collection methodology by a limited number of programs currently operating. It also carries potential selection bias of sites which elected to participate in the survey.

This survey indicates that the accuracy of EMS call taking for identification of stroke is low worldwide. With clinical benefits of MSU care demonstrated in recent studies, MSU programs should actively collaborate with their local dispatch centers to improve the positive predictive value of stroke dispatches, particularly for MSU deployment. Based on current evidence-based practice, MSUs are most effective in offering hyperacute treatment of ischemic stroke eligible for IV thrombolysis. Future studies are needed to understand the effects of quality improvement measures on the accuracy of stroke identification at a dispatcher level.

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RESEARCH REPORTS

THE ASSOCIATION BETWEEN PANDEMIC-RELATED INSTRUCTIONAL DELIVERY MODIFICATIONS AND EMERGENCY MEDICAL TECHNICIAN (EMT) FIRST ATTEMPT PASS RATES: A SINGLE CENTER RETROSPECTIVE STUDY

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Keywords: EMT education, NREMT exam, virtual learning, COVID-19, alternative instructional methods, competency outcomes, emergency remote learning, hybrid distance learning, healthcare education, EMS certification, emergency medical services, EMS, paramedicine

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ABSTRACT

Background: The COVID-19 pandemic represents a sentinel healthcare education event. Mandatory shutdowns of educational institutions, combined with increased demand for skilled healthcare personnel, highlighted obstacles to maintaining a stable workforce. To ensure continuity, many emergency medical services (EMS) educational institutions emergently transitioned in-person learning to digital formats, resulting in concerns regarding learning outcomes. This study investigated the impact of alternative instructional methods used during the COVID-19 pandemic.

Methods: The study is a retrospective review of prospectively collected data for EMT candidates from a single community college-based program who completed a first attempt of the didactic component of the National Registry EMT Certification examination from course sections ending between January 1, 2019, and December 31, 2020. Pre-COVID-19 first-attempt exam outcomes (115 students) were compared to first-attempt outcomes of Emergency Remote (ER) (48 students) and COVID Distance Learning Hybrid (DL) (94 students). Descriptive statistics were calculated, and multivariable-adjusted odds ratios (aOR) with 95% confidence intervals (CI) were computed to explore outcome differences.

Results: Didactic outcomes of 257 EMT students were evaluated. First-pass rates for ER and DL models compared to the traditional pre-COVID learning format (control group, 81.73%, ER group, 87.5%, DL group, 89.6%). There was no significant difference in first-attempt pass rates between students in the pre-COVID model (aOR = 1.00), the ER EMT model (aOR = 1.56, 95% CI [0.588 - 4.156]), and the DL EMT model (aOR = 1.88, 95% CI [0.836 - 4.212]). Retest rates and pre-/post-COVID-19 restrictions were not evaluated.

Conclusions: This study suggests alternative instructional formats are at least as effective as the traditional pre-COVID format in preparing students for the NREMT examination and therefore viable options for EMT education. Further research is needed to identify best practices for implementing virtual learning modalities in EMS education and to assess impacts on competency and workforce readiness.

INTRODUCTION

The COVID-19 pandemic represents a significant sentinel event in modern society. While the long-term effects of the pandemic

are still unclear, considerable short-term impacts across healthcare and education sectors have already been acknowledged. Mandatory shutdowns of educational institutions and increased demand for skilled healthcare personnel highlighted pre-existing challenges surrounding how to maintain a stable workforce. Cash et al. (2021) pointed out that although concerns regarding staff recruitment and retention were a primary focus, ensuring that educational programs were accessible during full-scale shutdowns represented another major challenge during pandemic protocols.

Compared to other developed countries, EMS education in the United States still straddles the line between vocational training and higher education, with 90% of American EMS programs issuing certificates rather than degrees (Ball et al., 2021). Although many institutions of higher education have actively embraced digitization as a means to reduce educational barriers, supplement existing in-person learning, and stabilize the workforce (Haffar et al., 2023; Mintz et al., 2020), the pandemic tested the implementation readiness of all educational programs (Al-Yateem et al., 2021). In order to mitigate disruptions due to emergency closures, virtual learning was adopted as the primary mode of education at an unprecedented speed and scope (Mintz et al., 2020).

Before COVID-19, many American EMS educational programs needed the pre-existing infrastructure, including financial and staffing resources, to implement virtual learning effectively (March et al., 2021). To prevent destabilizing the EMS workforce during the pandemic, educational stakeholders rapidly adapted traditional, in-person instructional methods to virtual platforms (Cash et al., 2021; Powell et al., 2022; Whitfield et al., 2021). Successful implementation of virtual learning depends upon four critical factors: the attitudes and IT competencies of instructors; students' discipline and time management skills; information technology reliability and infrastructure; and institutional support (Aini et al., 2020).

Access to reliable high-speed internet was one of the primary limiting factors to the success of virtual learning implementation initiatives (Dahiya et al., 2021). In 2019, the Federal Communications Commission (FCC) estimated that approximately 21 million Americans could not access reliable home internet service. The digital divide was most evident in low-income, rural, and tribal communities (Sanders & Scanlon, 2021), populations that historically struggled with achieving educational and healthcare equity and were especially vulnerable during the pandemic (Alvidrez et al., 2019; Wiemers et al., 2020).

Like many other healthcare educational programs, EMS faced additional challenges adapting to virtual learning (Gardanova et al., 2023). Significant portions of curricular content, such as hands-on skills training and experiential clinical rotations, only sometimes effectively translate to remote platforms (Allred et al., 2021; Gardanova et al., 2023). Beyond disrupting classroom access and altering the standard integration of traditional lab skills sessions into the didactic curriculum, pandemic protocols limited the availability of field and clinical learning opportunities due to site restrictions (Cash et al., 2021; Perkins et al., 2020). These interruptions to the pedagogical structure potentially impacted students' ability to synthesize didactic, psychomotor, and clinical knowledge while reducing or eliminating opportunities to develop professional affective skills, mentor-mentee relationships, and experience humanistic patient interactions (Mintz et al., 2020). The forced transition to digital learning formats unearthed concerns regarding alternative

learning methods' impacts on entry-level EMS providers' learning outcomes and overall competency levels (Allred et al., 2021; Perkins et al., 2020).

The study uniquely delved into the impact of alternative instructional methods used for EMT education during the COVID-19 pandemic. To date, a limited body of literature addresses the efficacy of virtual learning in EMS education (Cash et al., 2021), and an even smaller body of research investigates COVID-19's impact on EMS education and workforce availability (March et al., 2021). The goal was to determine the efficacy of a virtual learning didactic format regarding students' academic outcomes. This would provide insight for future EMS educational research and allow educational leaders to make sound, evidence-based decisions.

METHODS

Study Design and Setting

The IRB reviewed this research and determined to meet the criteria for exemption under protocol #20210304C. The study is a retrospective review of prospectively collected data for a single community college-based EMT program. It explores the impact of two alternative instructional methods –Emergency Remote (ER) and COVID Distance Learning Hybrid (DL)-- on students' performance on the National Registry of Emergency Medical Technicians (NREMT) certification compared to a historical control of traditional instruction. Inclusion criteria consisted of students who completed a first attempt of the National Registry EMS Certification examination for EMT candidates from course sections ending between January 1, 2019, and December 31, 2020.

Intervention

Before the pandemic, the traditional EMT course consisted of 132 synchronous, face-to-face learning hours (70 hours of didactic lecture, 62 hours of integrated lab), and 50 hours of asynchronous supplemental lecture content. The historical control consists of a 115-student cohort from course sections ending between January 1, 2019, and December 31, 2019.

Emergency Remote is defined as learning that took place during the immediate shutdown phase of the COVID-19 pandemic. Students signed up for the traditional course with no expected change to the format prior to the commencement of classes. 50% of instruction was delivered as planned before shutdowns forced a rapid change to instructional strategies, resulting in the final 50% of didactic instruction delivered via synchronous Zoom sessions. The remaining labs and tests were delayed until the end of the course (June 1-23, 2020) and administered on campus in a traditionally proctored environment with COVID-19 safety precautions in place.

Students who participated in the COVID Distance Learning Hybrid registered for a class with the complete understanding that the class's instructional format did not adhere to the traditional learning format. All lectures were delivered via synchronous Zoom sessions, and labs and tests were administered in person, on campus, and in the traditional sequence rather than at the end of the program.

All cohorts were required to pass the course's psychomotor component and a cumulative simulation scenario exam before they were eligible to schedule the National Registry didactic exam.

Measures/Outcomes

The National Registry EMT exam is a computer adaptive test that evaluates a candidate's ability to apply the knowledge expected of an entry-level provider. Candidates have two hours to complete the exam, designed to automatically calibrate each exam item's difficulty level based on the individual's performance on earlier questions. The exam continues until the allotted time is met or the candidate has answered the minimum number of questions necessary to determine with a 95% CI that the passing standard has been achieved or is impossible to attain (National Registry of Emergency Medical Technicians, n.d.). According to the National Registry Data Dashboard, the EMT exam has a 68% first-attempt success rate.

Data regarding students' first-attempt outcomes were collected from a single EMT program's National Registry completion report. Students were considered to have a successful outcome if they passed the EMT certification on their first recorded attempt. This study compared initial EMT certification exam outcome rates from class sections impacted by COVID-19, Emergency Remote (ER), and COVID Distance Learning Hybrid (DL) learning modifications to initial EMT certification exam outcomes from the control, pre-COVID, traditional learning format.

Statistical Analysis

Data were analyzed using descriptive methods and logistic regression. Mean first-attempt pass rates were calculated and compared. Multivariable logistic regression was used to determine the adjusted odds ratio (aOR) of achieving the outcome variable of passing the NREMT exam on the first attempt for each independent variable (instructional method: either ER or DL). The control was historical first-attempt pass rates of students from the same program who participated in original EMT classes before the COVID-19 pandemic, with traditional learning methods.

RESULTS

This study evaluated the outcomes of 257 EMT students who met the inclusion criteria. Inclusion criteria consisted of students who completed a first attempt of the National Registry EMS Certification examination for EMT candidates from course sections ending between January 1, 2019, and December 31, 2020. Successful completion outcomes were evaluated according to which educational method was implemented. These outcomes were compared to successful completion outcomes for traditional learning. Table 1 shows students' mean first-attempt pass rates overall and by the instructional method.

Instructional Method	n	Mean First Attempt Pass Rate
Traditional	115	81.73%
Emergency Remote	48	87.50%
Distance Learning Hybrid	94	89.36%
Overall	257	85.60%

Table 1. Instructional methods and mean first attempt pass rate.

This study holds significant implications for EMS education. It examined the likelihood of students passing the National Registry of Emergency Medical Technicians (NRE-

MT) exam on their first attempt in the Emergency Remote and COVID Hybrid DL models compared to the traditional pre-COVID learning format. The results, which are crucial for EMS education stakeholders, indicated that students who participated in the Emergency Remote model had a 1.56 adjusted odds ratio (aOR) of passing the exam on their first attempt, with a 95% confidence interval (CI) of 0.588-4.156. Similarly, students who participated in the COVID Hybrid DL model had a 1.88 adjusted odds ratio (aOR) of passing the exam on their first attempt, with a 95% confidence interval (CI) of 0.836-4.212 (Table 2).

Regressor	B	aOR	CI 95%
Traditional Hybrid EMT Pre-COVID (referent)		1.00	(1,1)
Emergency Remote EMT	0.37	1.56	(0.588-4.156)
Post COVID Hybrid DL EMT	0.63	1.88	(0.836-4.212)
Constant	1.50	4.48	(2.789, 7.184)
Number of Cases	257.00		
-2 log likelihood	-104.60		
Note: B = Logistic regression coefficient and OR = Odds ratio. * p<.05, ** p<.01, *** p</001			

Table 2. First attempt pass rate regressed on instructional method.

These findings suggest that students in the Emergency Remote and COVID Hybrid DL models are equally likely to pass the NREMT exam on their first attempt as students in the traditional pre-COVID learning format (Figure 1). However, it is important to note that while the results did not show a significant difference between the groups, this was a single program with more internal consistency than multi-center studies. While the instructional method varied, the same four instructors taught in all three conditions with frequent meetings to ensure section consistency.

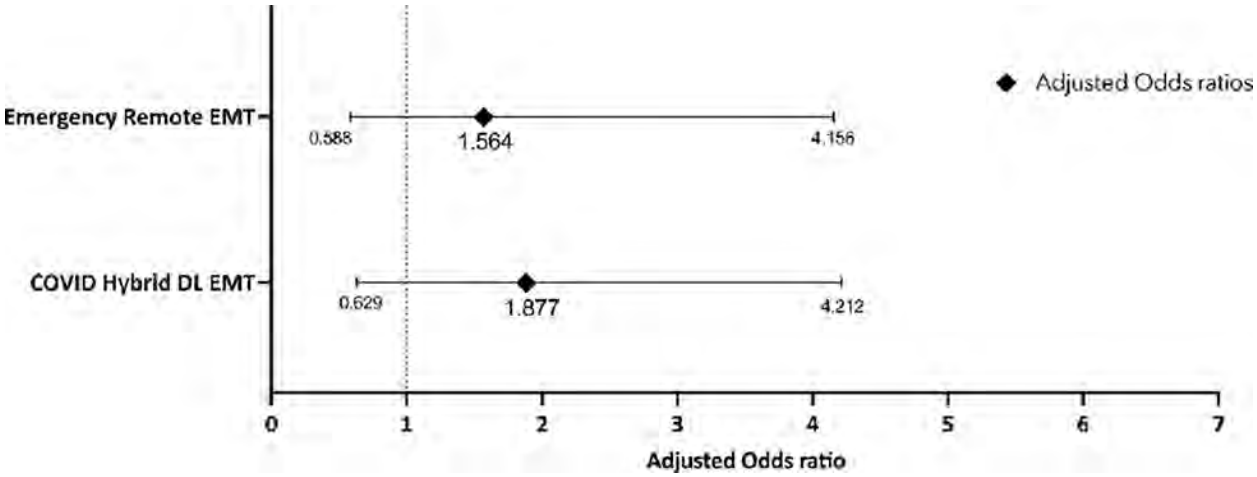

Figure 1. Association between instructional delivery modifications and EMT first attempt pass rates.

DISCUSSION

As vital healthcare system components, EMS professionals bridge the gap between the field and the hospital (Ball et al., 2021), bringing life-saving care directly to patients. The COVID-19 pandemic highlighted critical areas of strain within current practices, including existing barriers to obtaining EMS education and a realistic assessment of disaster preparedness undertaken by EMS education stakeholders. Given the ongoing healthcare shortage and the ever-looming possibility of another disruptive event, EMS education

stakeholders must investigate viable alternatives to traditional learning formats to guarantee a stable, uninterrupted workforce.

We determined that virtual remote learning methods prepared students for the NREMT examination just as effectively as traditional learning formats. Our finding is supported by Powell et al.'s 2022 national study of EMT and paramedic candidates, which found no statistically significant difference in NREMT first-pass rates for students participating in virtual learning versus traditional learning. Virtual learning is an effective instructional modality in other healthcare educational settings, including medical school, promoting consistent, successful outcomes in emergency remote and planned virtual learning settings (Allred et al., 2021; Anthony & Noel, 2020).

In the aftermath of the COVID-19 pandemic, Cash et al. (2021) identified EMS education program availability and accessibility as one of national EMS stakeholders' top eight research priorities. Geography is one of the main barriers to acquiring certification due to limited access to conveniently located EMS training programs (Cash et al., 2022). Approximately 22% of the United States population is greater than 30 miles from an available EMS program, with rural areas being the most underserved (Cash et al., 2022). Beyond reducing existing geographic limitations, virtual learning overcomes many constraints and challenges that prohibit adult learners from participating in EMS training programs, such as work schedules, family obligations, and other commitments (Osam et al., 2017). Expanding the EMS curriculum into digital learning applications is a practical and viable approach to help increase and stabilize the EMS workforce by offering adult learners flexible learning options that better suit their personal and professional lives (Bokolo, 2020).

In order to ensure the continuity of a stable, uninterrupted workforce, it is the responsibility of national EMS education stakeholders to guarantee that valid, reliable, and accessible methods for education are available. Although digital learning methods are effective in other medical education programs (Allred et al., 2021), EMS educational programs often lack the financial and personnel resources required to develop content, access digital materials, and participate in necessary professional development to ensure student engagement (Allred et al., 2021; Ball et al., 2021). Successful implementation requires thoughtful consideration to overcoming known challenges to virtual learning, including, but not limited to, access to a reliable internet connection, student engagement and motivation, limitations of instructors' digital literacy, and modification of curricular content for the virtual setting (Aini et al., 2020; Allred et al., 2021; Gardanova et al., 2023). This study underscores the need for further research in best practices for applying virtual learning modalities in EMS education, including cost and time-effective methods for professional, content, and resource development, inviting EMS education stakeholders to be part of this ongoing process.

LIMITATIONS

Study results are limited to students who participated in an EMT original course from a single program. Success rates from other EMS training programs that transitioned to virtual learning during COVID-19 restrictions, such as initial paramedic or refresher courses, were not evaluated. However, our results are supported by the results of studies exploring first-time NREMT exam pass rates for paramedics and EMTs (Powell et al.,

2022), studies investigating success rates of EMS refresher courses delivered via distance learning (March et al., 2021), and studies investigating the efficacy of virtual learning in other healthcare fields (Pei & Wu, 2019; Vallée et al., 2020). This study did not address potential confounding factors, such as COVID-19-related stress, test availability and administration procedure changes, and extended course completion time (Powell et al., 2022). Although Powell et al. (2022) noted a 14% decrease in NREMT examination administration during COVID-19, no significant differences in test administration were noted in the evaluated EMT program. One hundred fifteen students from this program took the NREMT EMT exam in 2019 compared to 122 in 2020. Forty-seven students participated in the Emergency Remote Teaching in early 2020, and 75 students enrolled in the planned DL hybrid in the fall of 2020. It is essential to note that during the remote teaching condition, the program experienced much higher attrition in the EMT program. Due to a radical shift in special COVID-19-related policies, students were granted a longer window for withdrawal with a full tuition refund. Typically, this withdrawal and refund period is limited to the first week of the semester. However, COVID-19-related policies extended this grace period to May 2020, 14 weeks into the 16-week semester.

Additionally, student success rates may have been impacted by alterations in work and life obligations, such as remote work or furloughs, or unspecified shifts in the demographics of students enrolling in healthcare-related programs during COVID-19.

CONCLUSION

This study was designed to explore the potential impact of Emergency Remote and Distance Learning Hybrid instructional methods relative to traditional EMT outcomes on the National Registry of Emergency Medical Technicians (NREMT) first-attempt pass rate. The analysis revealed no significant association between the two methods, suggesting that virtual learning is at least as effective as traditional formats in preparing students for the NREMT examination.

The similarity in the first attempt pass rates between the two learning formats presents a notable opportunity to transform the current Emergency Medical Services (EMS) education landscape. This transformation could entail increasing the accessibility and availability of EMS education, particularly to students from rural or underserved areas. By leveraging virtual learning platforms, it may be possible to overcome some logistical barriers, such as geographic and resource limitations, that often hinder students' access to traditional EMS education.

It is important to note that the present study's findings are limited to the specific context of NREMT first-attempt pass rates and may not be generalizable to other EMS education outcomes, including, but not limited to, skills competencies, affective competencies, cumulative pass rates, and student satisfaction. Therefore, further research is essential to comprehensively assess the effectiveness of virtual learning in EMS education, particularly regarding its impact on students' knowledge and practical skills. Nonetheless, the present study's results provide valuable insights into the potential benefits of virtual learning in EMS education, which could guide the development of more inclusive and innovative EMS education models.

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RESEARCH REPORTS

CROSS-SECTIONAL ANALYSIS OF KETAMINE USE IN A LARGE URBAN/SUBURBAN AREA

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ABSTRACT

Objective: Ketamine use is increasing across the US with 33% of EMS protocols authorizing use in 2018. This study evaluates the ketamine use in a single large urban/suburban fire-based EMS system.

Methods: Prehospital electronic medical records from 1/2021 to 12/2021 were queried for ketamine use. Data included: date, time, unit number, dose, route, and primary impression. Patients were grouped as low-dose or high-dose ketamine. Low-dose ketamine was defined as 0.2mg/kg intravenous (IV), intramuscular (IM), or intraosseous (IO) for adjunct pain control or severe respiratory distress. High-dose ketamine was defined as 2mg/kg IV/IO/IM for severe pain, severe burns, hyperactive delirium, post-intubation sedation, or presumed asthma-induced cardiac arrest. Since patient weights were unavailable, we considered 60mg or less of ketamine as low-dose, and over 60mg as high-dose. Descriptive and temporal statistics, chi-square, and t-test were used.

Results: 711 total records of ketamine use were obtained. 19 were excluded due to missing dosage. 576 patients received 692 doses of ketamine (108 patients received 2 doses and 8 patients 3 doses). Low-dose ketamine was administered to 102 patients (23 IM, 79 Vascular). High-dose ketamine was administered to 474 patients (343 IM, 129 Vascular, 2 Other). Average first dose for low-dose ketamine was 27.57mg +/- 12.57mg with median 25mg (IQR 20mg-30mg, abnormal distribution). Average first dose for high-dose ketamine was 223.03mg +/- 91.98 mg with median 200mg (IQR 200mg-300mg). Ketamine was re-dosed 19% of the time. Ketamine use was not statistically different during the dayshift of the week. Peak daily ketamine use was from 1600-2000 hrs. and lowest use was 0600-0800 hrs.

Conclusions: The majority of patients were given high-dose ketamine for severe pain and/or sedation. Low-dose ketamine was mainly IV while high-dose ketamine was predominantly IM. Patients required a second dose almost one-fifth of administrations, regardless of initial route of administration or dose but only 1% required a third dose.

INTRODUCTION

Ketamine is an N-methyl-D-aspartate (NMDA) receptor antagonist that causes dissociative sedation and analgesia (Sih et al., 2011). Because of its analgesic and amnestic properties, ketamine can be used as an induction agent for intubation, procedural se-

dation, pain management, bronchospasm, seizure, and rapid sedation of agitated patients (Balzer et al., 2021; Mankowitz et al., 2018; Rosenbaum et al., 2022; Sih et al., 2011; Sullivan et al., 2020). Ketamine is increasingly being used in the prehospital setting. In a 2018 survey, only 33% of paramedics were authorized by their Emergency Medical Services (EMS) protocols to use ketamine (Buckland et al., 2018).

The effect desired is dependent on the dosing. At lower levels, sub-dissociative doses, ketamine can be used for analgesia. Ketamine has been shown to safely and adequately manage pain in the range of 0.1-0.3 milligrams per kilogram (mg/kg) when given intravenously (IV) (Ahern et al., 2013; Balzer et al., 2021; Beaudoin et al., 2014; de Rocquigny et al., 2020; Kiavialaitis et al., 2020; Lee & Lee, 2016). At higher, dissociative doses, ketamine can be used for sedation in the range of 1-2 mg/kg when given IV and 3-5 mg/kg when given intramuscularly (IM) (Cole et al., 2016; Li et al., 2020; Lin et al., 2021; Mankowitz et al., 2018; Scaggs et al., 2016; Scheppke et al., 2014; Sullivan et al., 2020).

Ketamine administration has some complications and side effects to consider including vomiting, emergence reaction, hypersalivation, laryngospasm, need for additional sedation, and intubation (Mankowitz et al., 2018). The most concerning complication often cited is intubation. A systematic review found that approximately 30.5% of the patients who received ketamine for sedation ended up being intubated (Mankowitz et al., 2018). Not all the intubations were the result of the ketamine though. Some patients who received ketamine were undergoing cardiac arrest, head injury, or massive trauma (Mankowitz et al., 2018). Individual studies for prehospital administration of ketamine have intubation rates as high as 63% and as low as 3.8% (Burnett et al., 2015; Burnett et al., 2012; Cole et al., 2018; Cole et al., 2016; Gangathimmaiah et al., 2017; Hollis et al., 2017; Keseg et al., 2015; O'Connor et al., 2019; Olives et al., 2016; Scheppke et al., 2014). In several studies, the patients were not intubated by Emergency Medical Services, but rather by the emergency department (ED) provider once they got to the ED (Cole et al., 2018; Hollis et al., 2017; Keseg et al., 2015; O'Connor et al., 2019; Olives et al., 2016). These intubations frequently occurred overnight and often one individual provider had a large number of the intubations (Cole et al., 2018; O'Connor et al., 2019; Olives et al., 2016).

Ketamine has increasingly been in the news over the past few years, often stemming from high-profile incidents (Ho et al., 2019; Smith et al., 2021). Some of the negative media coverage was due to concerns that the medication was used for law enforcement purposes and not for acute medical emergencies and would involve false or misrepresented information (Klein & Cole, 2021). As a response, a study using data from the ESO Data Collaborative (Austin, TX) was published that found that in 15,204 ketamine administrations in 2019, there were 120 in-hospital deaths and 8 on-scene deaths (Fernandez et al., 2021). Of these deaths, ketamine was excluded in all but 8 deaths, 0.07% of those receiving ketamine, but was not proven to have contributed to their death. Of these 8 deaths, only three were given sedation-level dosing (Fernandez et al., 2021).

The goal of this study was to evaluate ketamine use in our large urban/suburban fire-based EMS system. The focus was on how often ketamine was being administered, whether ketamine was being given for high-dose or low-dose needs, whether ketamine administration needed to be repeated, and the most common routes given. The secondary goals were to determine if the agency was using ketamine per protocol and if there were any variations in ketamine administration by day of the week or time of day.

METHODS

Study Design

This was a cross-sectional analysis of all patients who received prehospital ketamine from a single EMS agency in a large urban/suburban area. Ketamine usage was identified from 1 January 2021 through 31 December 2021 using a quality assurance dataset obtained from the prehospital service's electronic prehospital care reports (ePCR) ("Rescuenet WebPCR" ZOLL Data Systems, Broomfield, CO, USA). The software allowed researchers to pull all documented administration of ketamine for the agency.

The Office of the Institutional Review Board at the University of Texas Health San Antonio (San Antonio, TX, USA; where the EMS system is based) determined that the project did not require IRB approval as the study was not human research as defined by DHHS regulation 45 CFR 46 and FDA regulation 21 CFR 56.

Study Setting and Population

Prehospital data were obtained from a quality assurance dataset that is used for the purpose of monitoring ketamine use by the San Antonio Fire Department (SAFD). SAFD is a fire-based EMS system that is the sole 911 provider and answers over 180,000 calls annually with an urban and suburban population of almost 1,500,000 residents distributed over 500 square miles. EMS ambulances are Advanced Life Support certified and staffed by two paramedics, and most calls also have first responder crews typically made up of a 2-person Squad crew or 4-person fire company. The area's race/ethnicity demographic makeup is approximately 64% Hispanic or Latin American of any race, 23% non-Hispanic white, 6.5% Black or African American, 3.2% Asian, and 3.5% multiracial or some other race (United States Census Bureau, 2021).

Agency Protocol

At the time of the study, local protocol authorizes ketamine use at the following doses 0.2mg/kg Intramuscular (IM)/intravenous (IV)/intraosseous (IO), 2mg/kg IV/IO, and 4mg/kg IM. The 0.2mg/kg IV/IO/IM dose is authorized for adjunct pain control and severe respiratory distress due to asthma and/or chronic obstructive pulmonary disease (COPD) in pediatrics over age 8 and adults. The 2mg/kg IV/IO dose is authorized for rapid sequence intubation (RSI), post-intubation sedation, severe pain, severe burns, seizures, or cardiac arrest due to asthma exacerbation in both pediatrics over age 1 and adults. The 4mg/kg IM dose is also authorized for hyperactive delirium with severe agitation, seizures, severe pain, and severe burns in both pediatrics and adults. If sedation is being given for severe agitation, medics must first radio or call the on-call medical director to discuss using ketamine vs midazolam and correct dosing. Handtevy (Pediatric Emergency Standards, Inc., Davie, FL, USA) is available to medics for pediatric dosing.

Measures

Data elements of interest included: date, time, unit number, dose, route, and primary impression. Other relevant data elements of interest: patient weight, complications, and vital signs were not available in the dataset available to the authors. The route was broken down into IM, Vascular (IV or IO), or Other (endotracheal or intranasal). Patients were grouped as low-dose or high-dose ketamine. Low-dose Ketamine was defined as

0.2mg/kg IV, IM, or IO for adjunct pain control or severe respiratory distress. High-dose ketamine was defined as 2mg/kg IV/IO/IM for severe pain, severe burns, hyperactive delirium with severe agitation, post-intubation sedation, or presumed asthma-induced cardiac arrest. Since the patient's weight was not available, 60mg or less of ketamine was considered low-dose, and over 60mg was high-dose. The 60mg cut-off was calculated using a 300 kg (661 lb) weight at 0.2mg/kg. The assumption was that the majority of the local population would be less than 300kg. The 300kg weight also coincided with the maximum weight that the largest CT Scanner in the region can accommodate.

The Primary Impression was placed in the ePCR by the treating paramedic or his paramedic partner. The paramedics documenting the primary impression were limited to the choices in the ePCR. Primary Impressions were consolidated into overall groups. For example, "Injury – Hand" was simplified to "Injury." Similarly, "Pain – Knee" was simplified to "Pain." Similar consolidations were also done for cardiac, Psychiatric, Respiratory, and Toxic ingestions. If there were fewer than 5 total of a primary impression, they were relabeled as "Other."

Statistical Analysis

Data from the ePCR was extracted into Microsoft Excel software (Microsoft Corp, Redmond, VA, USA), and descriptive and comparative statistics were calculated. A p value of <0.05 was considered statistically significant. Chi-squared and t-tests were used.

RESULTS

In 2021, there were 711 documented usages of ketamine, see Figure 1. Of these, 19 were instances when the medication was drawn up but not administered to the patient, i.e. discarded or wasted. These were excluded from the study. This resulted in 692 independent dosages for 576 individual patients. 108 patients (19%) received a 2nd dose of ketamine, and 8 patients (7% of 2nd dose patients and 1% of patients overall) received a 3rd dose of ketamine.

Of the 576 individual patients, 102 patients (18%) first dose was considered a low dose, and 474 (82%) were considered a high dose, see Figure 2. Of the 102 patients whose first dose was low, 83 (81%) had a single dose and 19 (19%) had two or more doses. Of the 19 low-dose patients who had a second dose, only 1 (5%) required a third dose. All repeat dosing of initial low-dose patients remained low.

Of the 474 patients whose first dose was considered high, 385 (81%) received only one dose

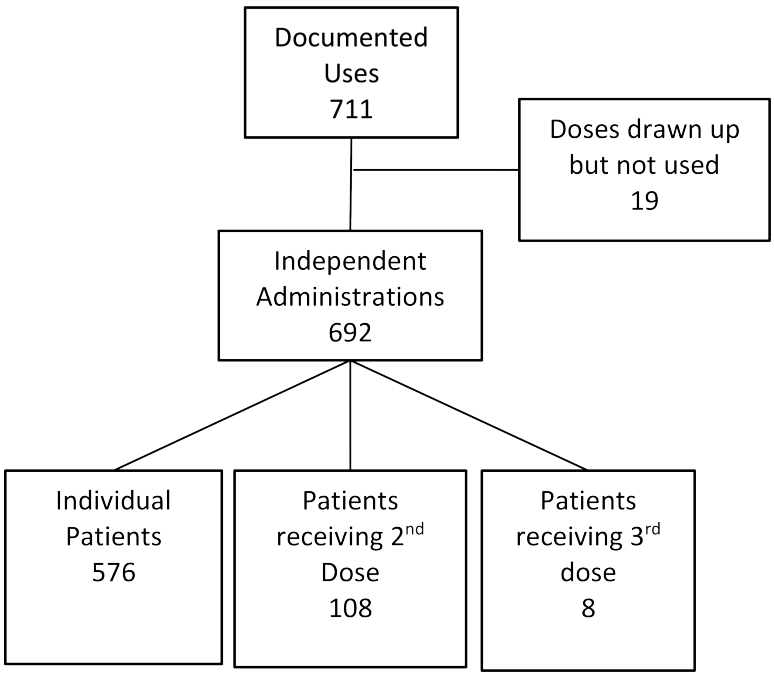

Figure 1. Ketamine administrations.

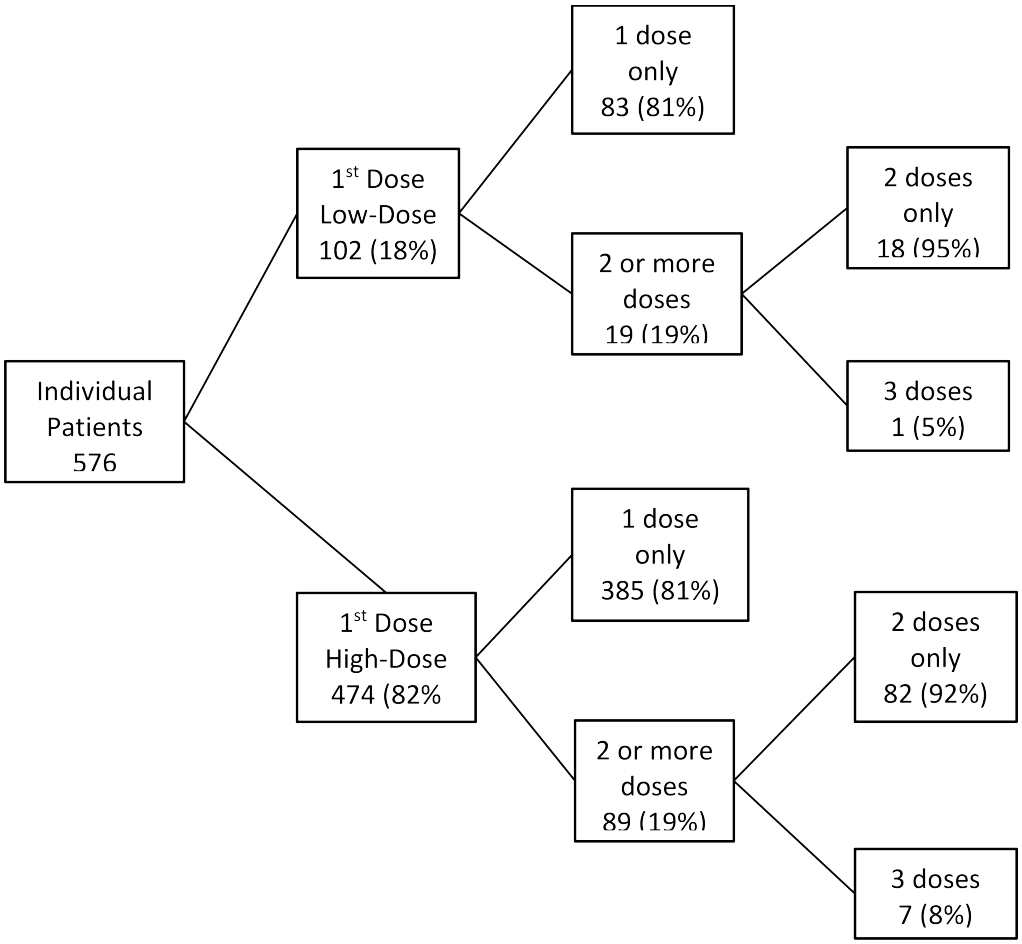

Figure 2. Ketamine administrations.

and 89 (19%) received two or more dosages. Of the 89 second dosages, 81 (91%) remained a high-dose, while 8 (9%) received low-dose. Seven of the 89 second doses (8%) received a third dose. For the third doses, 6 of them were high doses for all three doses. The remaining third dose was high for the first dose but low for the second and third doses.

Of the 102 patients whose first dose was low, 23 (23%) received a first dose of IM ketamine and 79 (77%) received a first dose of vascular ketamine, see Figure 3, 5. The first dose of patients initially receiving low-dose ketamine had a mean of 27.57 mg (SD=12.57 mg) and a median of 25 mg (IQR 20-30mg). The second dose of patients initially receiving low-dose ketamine had a mean of 26.58 mg (SD=14.15 mg) and a median of 25 mg (IQR 17.5-32.5mg). The only third dose of a patient initially receiving low-dose ketamine was 15 mg. This is represented in Table 1 and is further broken out between IM and vascular.

Of the 79 patients who received low-dose vascular ketamine 14 (18%) required a second dose. All 14 of these second doses were again a vascular route. None required a third dose. Of the 23 patients who received low-dose IM ketamine 5 (22%) received a second dose. Three of these (13%) were IM and 2 (9%) were vascular. One of the IM to vascular second doses required a third dose.

Of the 474 whose first dose was high, 343 (72%) received a first dose of IM ketamine, 129 (27%) received a first dose of Vascular ketamine, and 2 (<1%) received a dose of ketamine

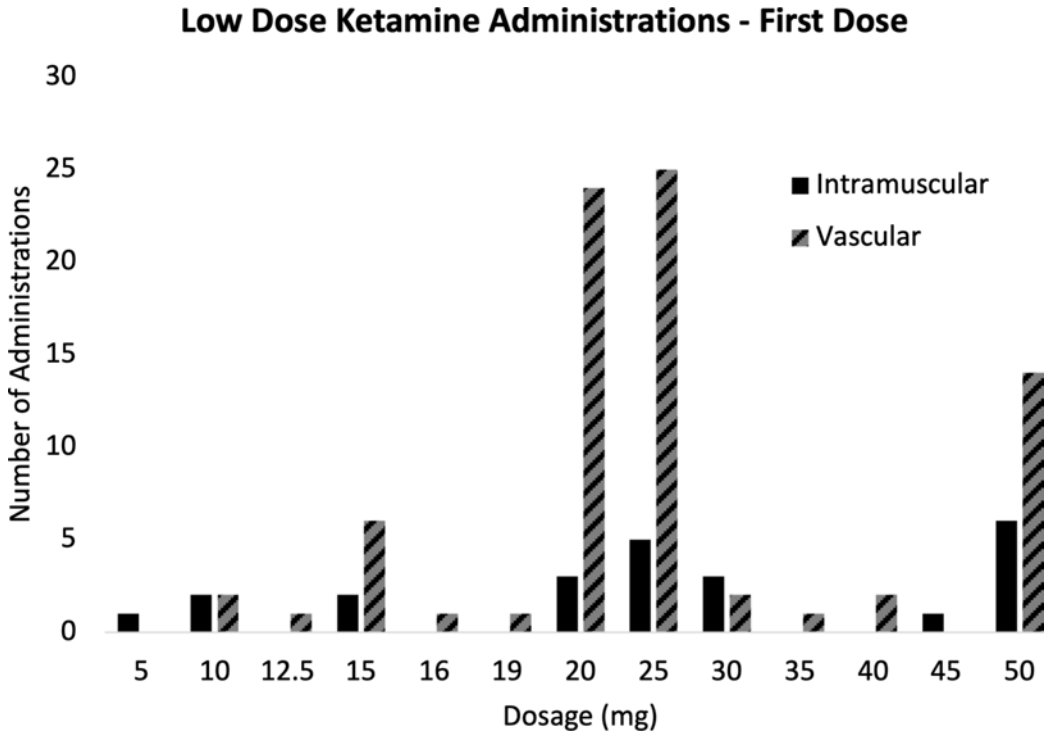

Figure 3. First dose of low-dose ketamine administrations by dosage.

in the Other route, see Figure 4, 5. The first dose of patients initially receiving high-dose ketamine had a mean of 223.03 mg (SD=91.98 mg) and a median of 200 mg (IQR 200-300mg). The second dose of patients initially receiving high-dose ketamine had a mean of 152.30 mg (SD=66.96 mg) and a median of 150 mg (IQR 100-200 mg). The third dose of patients initially receiving high-dose ketamine had a mean of 135.71 mg (SD=85.22 mg) and a median of 100 mg (IQR 100-150 mg). This is represented in Table 2 and is further broken out between IM and vascular.

Of the 129 patients who received high-dose vascular ketamine 23 (18%) required a second dose. 22 received a second dose via vascular access and one received a second dose via IM. None required a third dose. Of the 343 patients who received high-dose IM ketamine 66 (19%) received a second dose. 52 (79%) of the second doses were IM and 14 (21%) were vascular. Three of the 14 receiving first dose high-dose IM and second dose IV (21%) received a third does of vascular ketamine. Four of the 52 receiving first dose high-dose IM and second dose IM (8%) received a third dose of IM ketamine.

Dose and Route	Mean	SD	Median	IQR	Mode	Count (%)
Low-Dose, all routes						
1st dose	27.57	12.57	25	20-30	25	102
2nd dose	26.58	14.15	25	17.5-32.5	25	19
3rd dose	15	N/A	15	N/A	15	1
Low-Dose, IM						
1st Dose	29.35	14.95	25	20-47.5	50	23 (23%)
2nd Dose	33.33	15.28	30	25-40	40	3
3rd Dose	N/A	N/A	N/A	N/A	N/A	0
Low-Dose, Vascular						
1st dose	27.06	11.84	25	20-25	25	79 (77%)
2nd dose	25.31	14.08	22.5	15-27.5	25	16*
3rd dose	15	N/A	15	N/A	15	1^
* Two of these 16 second dose vascular route ^ First dose was IM but second dose was low-dose vascular ketamine						

Table 1. Low-dose statistics.

Overall, Injury was the most common primary impression for the 576 patients receiving ketamine, 105 patients (18%), see Table 3. This was followed by Psychiatric Issues (79 [14%]), Toxic Ingestion (69 [12%]), Altered mental status (69 [12%]), Pain (60 [10%]), and Delirium (47[8%]). For the 474 High-dose ketamine patients, the rankings for primary impression were similar to the total results: Injury (92 [19%]), Psychiatric Issues (77[16%]),

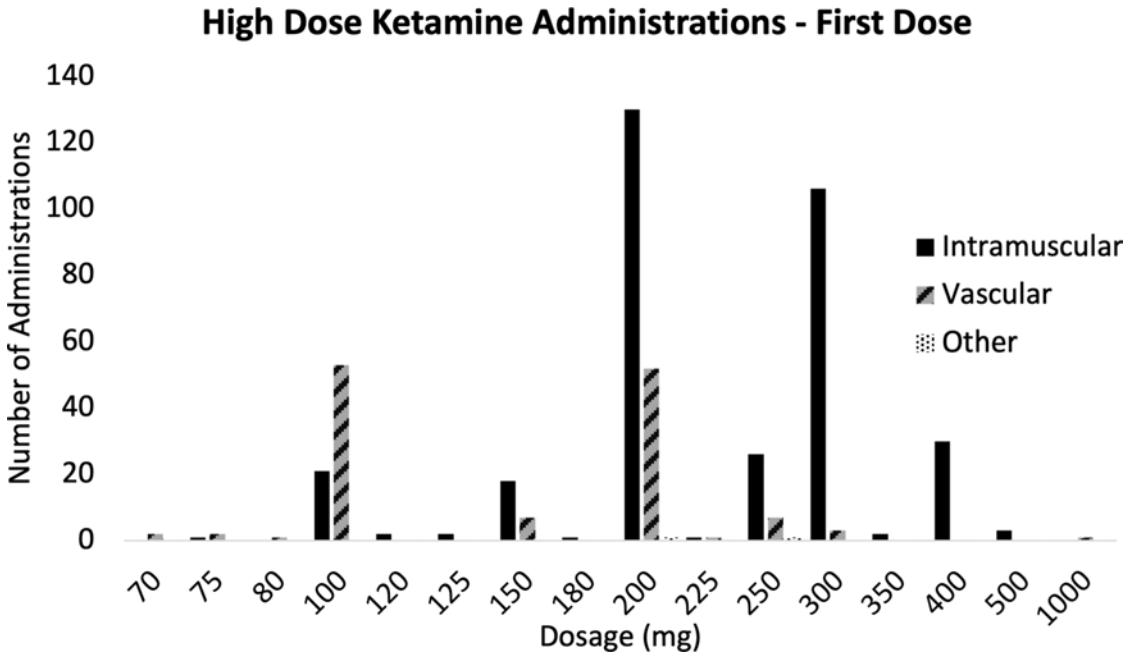

Figure 4. First dose of high-dose ketamine administrations by dosage.

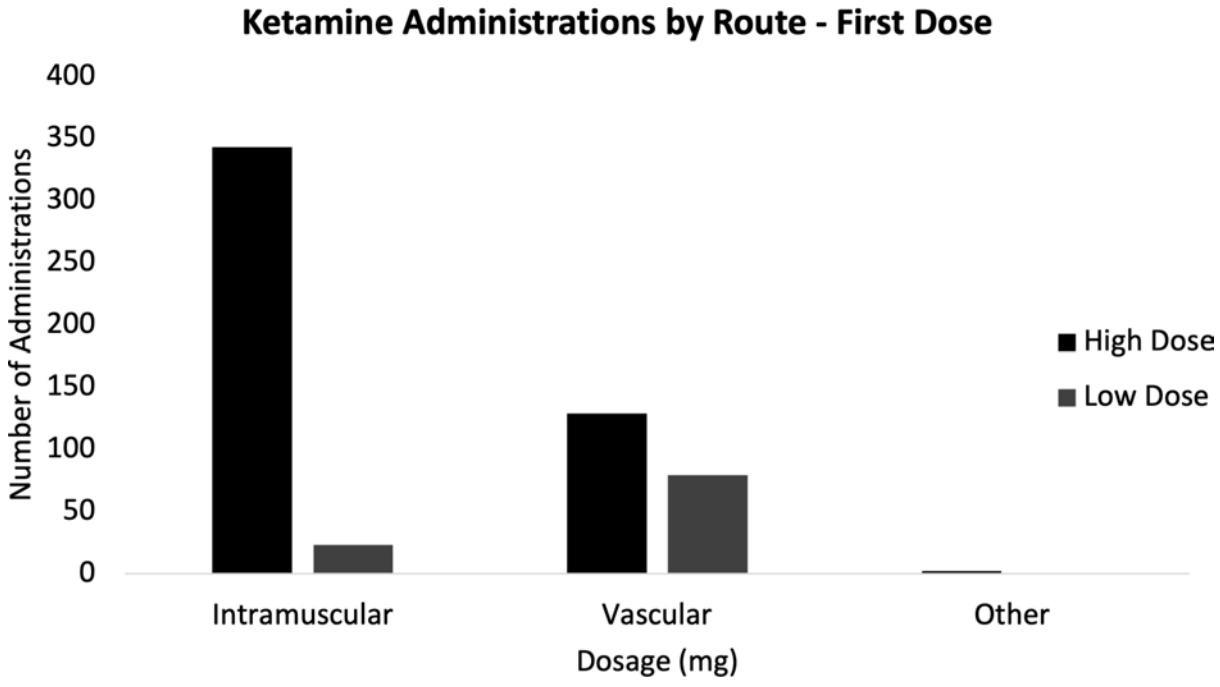

Figure 5. First dose ketamine administrations by route.

Toxic Ingestion (69 [15%]), Altered mental status (66 [14%]), Delirium (46 [10%]), Pain (25 [5%]). For 102 low-dose ketamine patients, the most primary impression was Pain (35 [34%]). Next was Respiratory Distress (21 [21%]), followed by Injury (13 [13%], and then Burn (7 [7%]).

The second dose and third dose were also considered in evaluating the primary impression. 89 patients (19%) of those who received a first dose of high-dose ketamine required a second dose. The most common primary impression for repeated doses of those receiving high-dose was Injury (21 [24%]), Psychiatric Issues (15[17%]), Delirium (13 [15%]), Toxic Ingestion (12 [13%]), Altered mental status (10 [11%]). 19 patients (19%) of those who received a first dose of low-dose ketamine required a second dose. The most common primary impression for repeated doses of those receiving low-dose was Pain (8 [42%]), Injury (5[26%]), Burn (3 [16%]), and Altered mental status (2 [11%]). The only third dose with initial dose low-dose IM was for knee pain. There were 7 third doses for initial dose high-dose ketamine. All 7 were initially an IM dose. Three were IM first, vascular second, and vascular third. These were for one episode of lower leg pain, and two psychiatric. Four were IM for the first, second, and third doses. These were for primary impressions of seizures/convulsions, toxic ingestion, burn, and psychiatric issues.

Dose and Route	Mean	SD	Median	IQR	Mode	Count (%)
High-Dose, all routes						
1st dose	223.03	91.98	200	200-300	200	474
2nd dose	152.30	66.96	150	100-200	100	89
3rd dose	135.71	85.22	100	100-150	100	7
High-Dose, IM						
1st Dose	245.69	80.56	200	200-300	200	343 (72%)
2nd Dose	171.70	56.76	200	100-200	200	53*
3rd Dose	175	95.74	150	100-200	100	4
High-Dose, Vascular						
1st dose	162.75	94.21	150	100-200	100	129 (27%)
2nd dose	123.75	71.26	100	100-162.5	100	36^
3rd dose	83.33	28.87	100	75-100	100	3~

* One of the 53 was first dose vascular ketamine

^ 22 had first dose vascular ketamine and 14 had first dose IM ketamine

~ All three had first dose IM ketamine followed by 2nd and 3rd dose vascular ketamine

Table 2. High-dose statistics.

Primary Impression	All (%)	High (%)	Low (%)
Altered Mental Status	69 (12)	66 (14)	3 (3)
Asthma	6 (1)	0 (0)	6 (6)
Burn	22 (4)	15 (3)	7 (7)
Cardiac	8 (1)	5 (1)	3 (3)
Cardiac Arrest	21 (4)	19 (4)	2 (2)
Delirium	47 (8)	46 (10)	1 (1)
Hypotension	5 (1)	3 (1)	2 (2)
Injury	105 (18)	92 (19)	13 (13)
Pain	60 (10)	25 (5)	35 (34)
Psychiatric Issues	79 (14)	77 (16)	2 (2)
Respiratory Distress	36 (6)	15 (3)	21 (21)
Seizures/Convulsions	16 (3)	14 (3)	2 (2)
Sick Person	12 (2)	10 (2)	2 (2)
Toxic Ingestion	69 (12)	69 (15)	0 (0)
Other	21 (4)	18 (4)	3 (3)
Total	576	474	102

Table 3. Primary impression.

In a secondary analysis, the day of the week ketamine was administered was evaluated, see Figure 6. Sunday had 109 (16%) administrations, Monday 96 (14%), Tuesday 108 (16%), Wednesday 105 (15%), Thursday 70 (10%), Friday 102 (15%), and Saturday 102 (15%), p=0.09. The time ketamine was administered was grouped into two-hour time buckets starting at midnight, see Figure 7. The 0600 to 0759 bucket had the least administrations (26 [4%]) while 1600 to 1759 had the most (77 [11%]), p<0.05.

DISCUSSION

A study evaluating battlefield use of ketamine for pain found that 69%-100% of the time ketamine was administered via an IV (de Rocquigny et al., 2020). In our study, the first dose of low-dose ketamine was administered via an IV 77% of the time. The battlefield study did not differentiate between low-dose adjunct pain control and high-dose for severe pain as our protocol does. The study found a median total IV dose of 50mg (de Rocquigny et al., 2020). This is significantly higher than our first dose of low-dose vascular ketamine which had a median of 25mg. This is probably due to the local EMS pro-

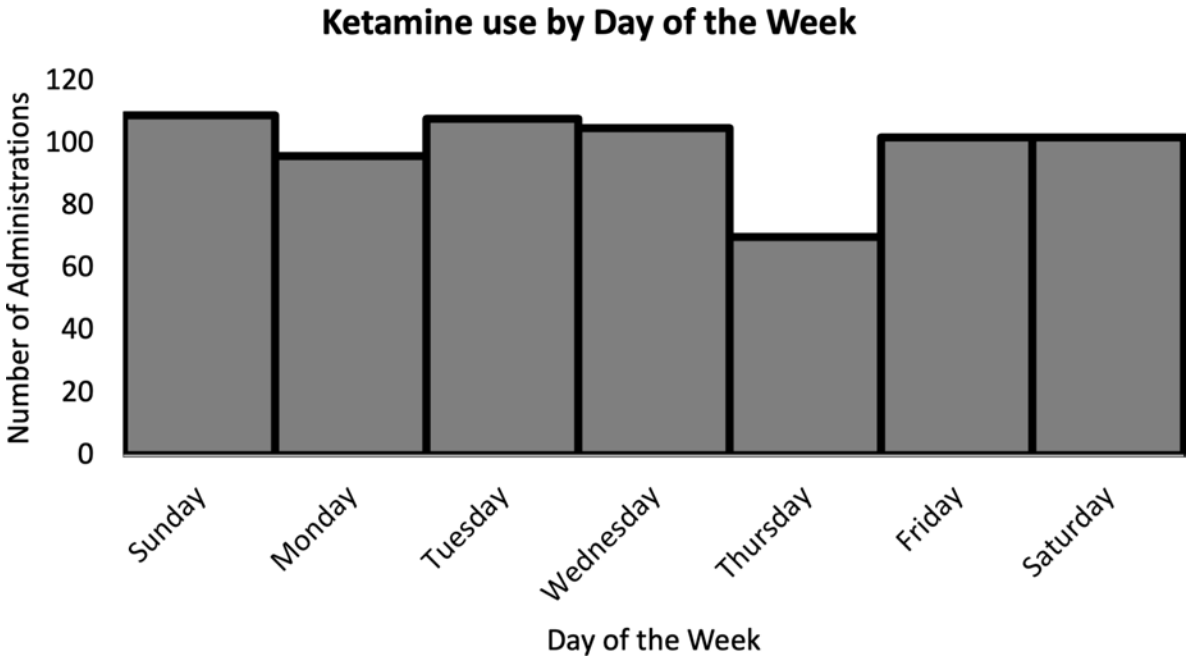

Figure 6. Ketamine administrations by day of the week

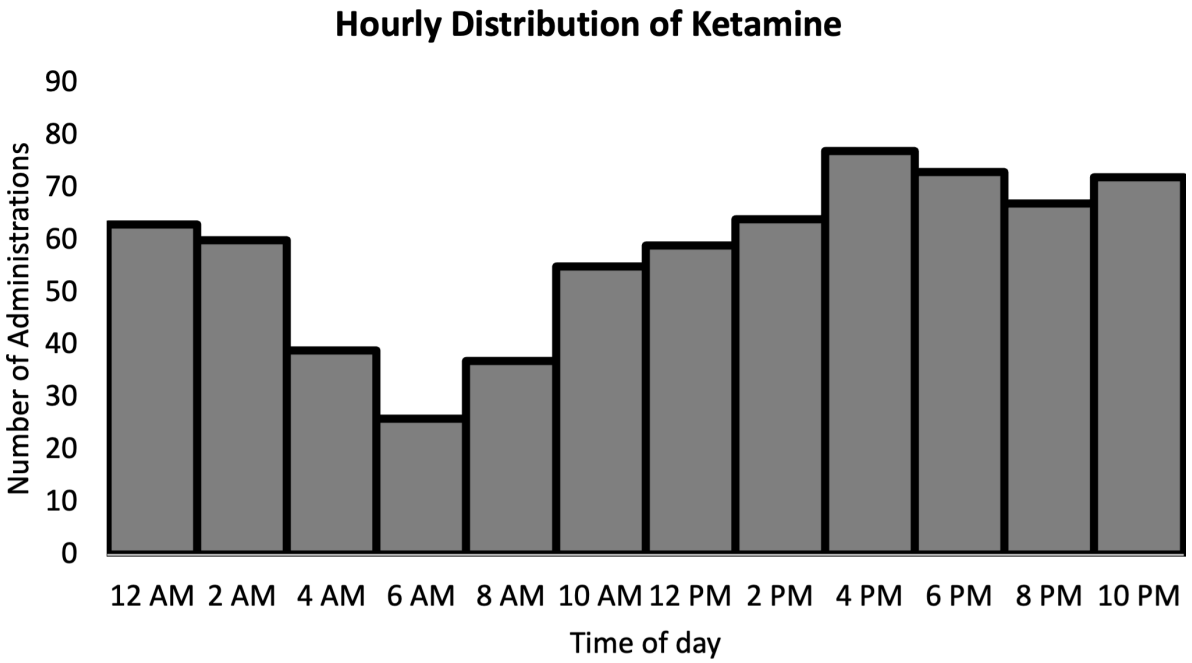

Figure 7. Distribution of Ketamine administration by two-hour time bucket

tocol splitting between low- and high-dose ketamine for pain and the battlefield study just looking at all doses. Unfortunately, most other studies evaluate low-dose ketamine in mg/kg or fixed mg dosing and are limited for comparison due to our lack of patient weight (Lee & Lee, 2016).

Our mean high-dose ketamine was lower than in other studies. A 2018 meta-analysis of ketamine for sedation found a mean dose of 315 mg IM ketamine and a mean IV dosing of 150mg (Mankowitz et al., 2018). Their IM dose was higher than our first dose of high-dose IM ketamine (246mg) but their IV dose was similar to ours (163mg). If we look at our first dose of high-dose ketamine, they don't necessarily match our protocols. An average 163mg dose at 2mg /kg IV by protocol would mean the patient is approximately 81.5kg or 180 lbs. This would be reasonable since the mean body mass of a person in North America is 80.7 kg (Walpole et al., 2012).

Looking at IM dosing, our mean high-dose of 246mg at 4mg/kg IM would result in a 61.5 kg person or 136 lbs. In 2014, 71% of YYY County, the county containing [City], [State], was considered overweight (39%) or obese (31%) based on body mass index (BMI) (Metropolitan Health District, 2017). This shows our agency was probably underdosing IM ketamine as per protocol. In 2021, the agency was required to call the Office of the Medical Director (OMD) for authorization and dosing of sedatives like midazolam or ketamine. This underdosing may also be an indication of various practice patterns of the physicians in OMD. This also shows that the paramedics were comfortable giving various doses of ketamine for these indications and redosing if necessary. As a result of this study, the agency changed the protocol for agitation from 4mg/kg IM to 2-4mg/kg IM.

Overall, 19% of ketamine administrations required redosing. Broken down by dose, 19% of low-dose and 19% of high-dose ketamine required at least a second dose. Of those receiving low-dose ketamine, 18% who received vascular ketamine and 22% of those receiving IM ketamine required redosing. Of those receiving high-dose ketamine, 18% who received vascular ketamine and 19% of those receiving IM ketamine required redosing. This is similar to Cunningham et al who showed that 21% of patients who received 3.0 mg/kg IM ketamine for sedation required redosing (Cunningham et al., 2021).

Our study had 1% of patients requiring ketamine required three doses and no one required a fourth dose. Broken down by dose, 1% of low-dose and 1% of high-dose ketamine required a third dose. Of the 8 patients requiring 3 doses, 7 started as high-dose ketamine and one was low-dose. For the high-dose ketamine, 4 had all three doses as IM and 3 had the first dose as IM and the remaining two as IV. The most common reason for three doses was Psychiatric issues (3/8 patients). It is unknown if these were for continued agitation, continued pain, or if these patients were intubated and required additional sedation. Further research will be needed to better evaluate needs for redosing but our study shows that almost one-fifth of patients required a second dose regardless of the route or dose and 1% required a third.

For primary impressions, the results between high- and low-dose ketamine were different, as expected. High-dose ketamine was used for sedation so altered mental status, toxic ingestion, and psychiatric issues were common complaints. Low-dose ketamine per protocol is for pain or respiratory distress. The most common primary impressions were therefore Pain, Injury and Respiratory Distress for low-dose ketamine.

Our secondary outcomes evaluated the day of the week and time of administration. There were no significant differences in the day of the week ketamine was given. For the time of day, the least ketamine was given in the early morning. This is expected as most people are sleeping during those hours. The least given was from 0600 to 0759. The EMS crews shift change is at 0700 so it was expected to have fewer medications given during this time.

LIMITATIONS

The main limitations impacting generalizability in our study were the lack of relevant data and the retrospective nature of this study. The data set did not have the patient's weight, so we could not determine the dosage in mg/kg. Because of this, the 60mg cut-off was calculated using a 300 kg (661lb) weight at 0.2mg/kg. The data also did not have follow-up data to analyze outcomes. We were unable to evaluate any side effects or complications in our cross-sectional analysis.

Another limitation is that this study did not evaluate the demographics of patients receiving ketamine. Khatri et al showed that Black patients were 1.63 times more likely to be chemically sedated than non-Hispanic white patients (2022). Hispanic patients were also sedated more than non-Hispanic patients but this was not statistically significant (Khatri et al., 2022). Black patients are also under-treated with pain medication (Hoffman et al., 2016). Without demographic information, we are unable to make a comparison to our dataset.

Finally, we did not know the exact reason for the administration of the ketamine in our study. We had the "primary impression" but this may or may not have been the reason for administration. For example, burn patients may have been given ketamine for pain or they may have been given ketamine for RSI.

CONCLUSIONS

In our large urban/suburban Fire-based EMS systems, there were almost 700 administrations of ketamine. The majority of patients were given high-dose ketamine with the high-dose ketamine predominantly being given IM. Low-dose ketamine was mainly given IV. Almost 20% of patients required a second dose of ketamine regardless of initial route or dose and 1% required a third. There were no significant differences in ketamine dosage by day of the week. Ketamine was given less in the early morning and more in the afternoon/evening.

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RESEARCH REPORTS

FACTORS THAT INFLUENCE MEDICAL RETRIEVAL DECISIONS IN REMOTE CENTRAL AUSTRALIA: A QUALITATIVE STUDY

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ABSTRACT

Introduction: Medical retrieval services play a key role in the transportation of unwell patients from remote communities across Australia. Decision to retrieve a patient from a remote community is dependent on unique characteristics of remote locations and thus different to urban and rural retrievals. The study aims to explore various factors that affect medical practitioner decisions to retrieve patients from remote central Australian communities.

Methods: Semi-structured interviews were conducted with 36 staff involved in medical retrieval processes in central Australia. The data collection and analyses were part of a broader study evaluating a newly implemented medical retrieval model in central Australia. All interviews were recorded and transcribed. Transcripts were co-coded inductively by two researchers using NVivo software. Similar codes were grouped into themes, one of which related to the range of factors that affect decisions to retrieve a patient or request a retrieval, which is the focus of this paper.

Results: Decision-making about who, when, and how to retrieve patients was complex and involved trade-offs. The severity of patient illness, resource availability (e.g., transport infrastructure, remote area staff workload, and fatigue), the skills, experience, and relationships of primary health care and medical retrieval staff with the community, the strength of primary health care systems in remote communities, specific primary health care and retrieval policies, and innovations in disease prevention and management influenced medical retrieval decisions.

Conclusion: It is critical to understand that both general and contextual factors unique to remote communities affect medical retrieval decisions. Decisions are highly complex and necessitate trade-offs, frequently related to resource scarcity, which are somewhat different from those of urban retrieval services. Resource allocation in the context of providing retrieval services for remote populations must account for differences in burden of disease, cultural requirements, workforce characteristics, and overall access to health care compared to urban populations.

INTRODUCTION

Compared to their urban counterparts, remote residents in Australia have poorer health and limited access to many health services, which in part are a result of health workforce shortages and maldistribution, as well as geographical isolation (Humphreys et al., 2008; Hussain et al., 2015). Medical retrieval services play a key role in the transportation of acutely unwell patients from remote communities, patient repatriation back to their country following hospital admissions and inter-hospital transfer for those requiring a higher level of care. Retrieval decisions (who to retrieve, when to retrieve, and how to retrieve) have been linked to referrer factors (referrer's skill in diagnosis and resuscitation, and resources available within the referring facility); patient factors (urgency of transfer, socio-economic and cultural factors and willingness to be retrieved, weight and mobility of the patient); characteristics of the retrieval team (skilled human resources and equipment available); characteristics of the retrieving hospital (capacity to manage referral); aviation factors (distance, weather, terrain); and logistical factors (competing demand on resources, availability of fixed wing or rotary aircraft or ground transport, safe working hours for retrieval crew) (Danne, 2003; Ramadas et al., 2016). However, the geographical scope of this body of literature is general in nature, applying largely to rural and urban retrievals in Australia. The extant literature, therefore, lacks detail about how factors affecting decision-making in a remote retrieval context may differ from those in rural and urban areas.

Recent reviews have highlighted a dearth of literature describing the effectiveness of structures and processes of remote medical retrieval systems in producing desired outcomes (Edwards et al., 2021; Mathew et al., 2022). In this study, we hypothesize that the context from which remote patients are being retrieved will influence decisions about who, when, and how to retrieve these patients. We contend that remote central Australia presents a markedly different context for medical retrievals compared to rural and urban locations due to –

- its vast size, geographical remoteness, and sparsity of populations (only 2% of the Australian population reside in remote and very remote areas, with population densities of only 0.07 people per km2 in remote regions such as central Australia compared to 33,500 people per km2 in urban centers such as Melbourne CBD (Australian Bureau of Statistics, 2023));
- the proportionally large First Nations population (First Nations people represent more than 60% of the population that live in remote or very remote areas (Australian Institute of Health and Welfare, 2014)) and their high health needs (First Nations Australians experience a burden of disease that is 2.3 times the rate of non-Indigenous Australians (Australian Institute of Health and Welfare, 2016));
- extremely high health workforce turnover (Annual turnover rates of nurses working in remote clinics were found to be 148% (Wakerman et al., 2019)); and
- the importance and necessity of ensuring culturally safe health services (De Zilva et al., 2021). A lack of attention in the retrieval literature to the cultural factors can be inferred from the absence of staff cultural awareness training indicators amongst the entire body of literature reporting outcome measures related to the quality of air ambulance services. (Edwards et al., 2021) Affirming this gap is further evidenced by recent empirical research from central Australia exploring

> patients' retrieval journeys, which highlighted the need for improved patient satisfaction and cultural safety practices. (Lankin et al., 2023a)

In light of the stark differences between remote and urban/rural contexts for health service delivery, it is pertinent to address identified gaps in the available literature related to retrieval from remote First Nations settings, taking into account the unique circumstances of remote Australia that are likely to affect medical practitioners' decisions to retrieve patients. This paper aims to explore the key influences on medical retrieval decision-making (i.e. who to retrieve, when to retrieve, and how to retrieve) in remote central Australia.

METHODS

Setting

The Central Australian retrieval service provides emergency retrieval services to more than fifty remote communities covering a multi-jurisdictional region and a population of almost 50,000 people dispersed across an area of 1.4 million km2, roughly the size of France and Germany combined. The retrieval service undertakes around 2000 retrievals per year, the majority (>80%) of which are First Nations people (Johnson et al., 2022). The service retrieves patients largely from remote communities and cattle stations that are scattered around radii ranging from 10 to 500km from two regional hospitals. Inter-hospital transfers are also provided between regional and urban tertiary hospitals. Accessibility of some remote communities is difficult due to large sections of unsealed roads, seasonal road closures, limited transport services, and limited availability of telecommunication services (Infrastructure Partnerships Australia, 2022). Remote communities have primary health care (PHC) centers (remote clinics) usually managed by remote area nurses (RANs). Remote Health staff can seek real-time professional support via a telehealth support system that includes a medical retrieval and consultation center (MRaCC) for emergency calls (staffed around the clock by doctors with advanced critical care skills) and a remote outreach consultation center (ROCC) for PHC support (staffed by general practitioner's (GPs) during usual weekday business hours and after hours by MRaCC consultants) (Russell et al., 2023).

Recruitment of Participants

Most participants were recruited through an online survey conducted as part of a broader study evaluating the new MRaCC/ROCC retrieval service model implemented in central Australia in 2018 (Green et al., 2022). Electronic links to this survey were distributed via usual electronic communication channels used by the central Australian government and non-government health services. Survey participants who registered their interest for a follow-up interview were contacted by one of the research team members and invited to an interview. Additionally, four participants were recruited using a snowballing approach, whereby other participants recommended the study to them. Participants included - air and ground medical transport staff, specialists from the Central Australian hospitals, medical retrieval consultants, RANs, and GPs who provided PHC advice to RANs working in the remote clinics of Central Australia.

Data and Analysis

Semi-structured interviews were conducted between April and August 2020, during which period there was an Australia-wide lockdown to reduce COVID-19 transmission. All interviews, except three, were conducted via telephone. Of those three, two were completed via Zoom, and one was completed face-to-face. The average interview length was 45 minutes. Interviews (n=36) were conducted till data saturation was reached. With the permission of each participant, all interviews were audio recorded. Audio recordings of the interviews were professionally transcribed verbatim. All transcriptions were analyzed thematically, using reflective induction to identify themes and subthemes (Braun & Clarke, 2006). Coding was done using NVivo-12 software. Three co-authors coded three transcripts each and independently created an initial set of themes and sub-themes, which were then discussed to ensure agreement on the initial themes. The remaining interviews were co-coded by two researchers. Subsequent discussions among the two coding researchers clarified minor points of difference and allowed for agreement to be reached on the final labeling of themes and sub-themes. The interview protocol covered questions designed for the broader study evaluating the efficiency, timeliness, cost and cost-effectiveness of the new MRaCC/ROCC model implemented in central Australia compared to the previous retrieval model. Participants were asked to describe the new and previous retrieval models, how they worked, and differences between them, and instances where retrievals didn't go smoothly. In addition to the content related to the new retrieval model's effectiveness, timeliness, and benefits, which has been published elsewhere, (Fitts et al., 2024 forthcoming; Green et al., 2022; Russell et al., 2023) participant responses also included content related to the key factors that affect decisions to retrieve a patient or request a retrieval, which is the focus of this paper.

Ethics Approval

The project was approved by the Central Australian Human Research Ethics Committee (CA-19-3320).

RESULTS

Five themes emerged, which were related to the key factors that affect retrieval decision making in the remote Australian context (see thematic diagram Figure 1):

Physical Infrastructure Available

This theme refers to how the availability of transport infrastructure, telehealth facilities and capability, as well as patients' access to the necessary infrastructure to care for themselves in the community influences a retrieval consultant's decisions to retrieve a patient.

Transport Infrastructure

Retrieval staff perceived the allocation of transport infrastructure to be more challenging than in urban settings. For instance, staff highlighted that the central Australian medical retrieval service does not have a medical retrieval helicopter and a limited number of fixed wing assets. Staff often had to consider trade-offs between having aeromedical transport assets engaged in planned long distance tasks such as inter-hospital transfers and ensuring aeromedical transport assets were available to respond to new or existing emergencies arising in very remote communities.

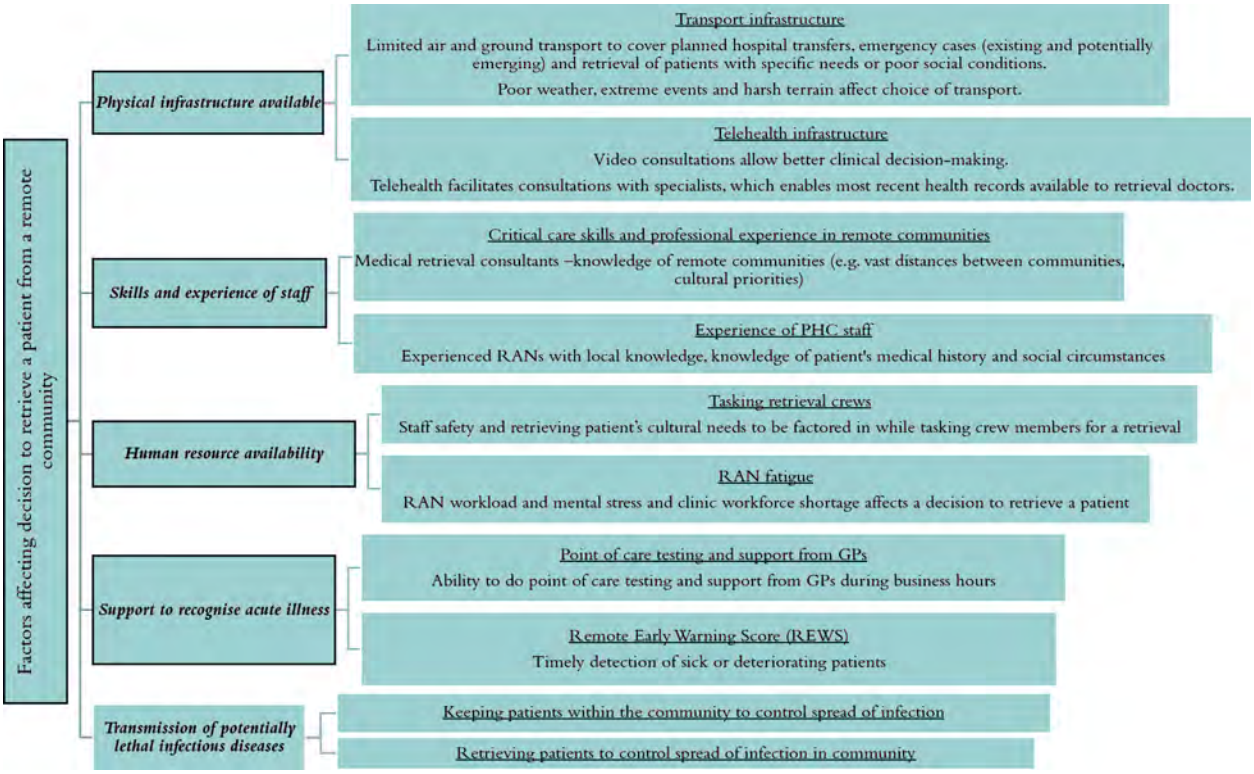

Figure 1. Diagram describing themes.

> *"For places …that are reasonably close [to a hospital]… tasking a plane … should try and avoid it, because I would rather keep the plane ... for somewhere more distant, too." (MRaCC/ROCC staff member)*

This included the need to monitor cases that could potentially worsen (e.g., potential cases of preterm labor reported by clinic staff) or to respond to anticipated emergencies (e.g., a major sporting or community event happening in a community).

> *"… [If I] know that something significant is going on, and I know that the plane is about to take off to do some sort of lower acuity task, I will ring comms (in charge of plane tasking) and say, hold the plane at the hangar, we may have something much more urgent coming through, just don't send it, just wait." (MRaCC/ROCC staff member)*

Other transport infrastructure considered important for influencing retrieval decision making included road accessibility (e.g. road surface and condition), availability of an airstrip in the community, and airstrip infrastructure such as airstrip lighting (e.g., suitability for nighttime landing).

Weather and environmental conditions were also perceived as important considerations in decisions about retrieving a patient. Poor weather and occurrences of extreme environmental events such as bushfires created hazards that often prevented plans for landing and successful retrieval. In these instances, decisions to retrieve patients either later or earlier would ideally be informed by weather or environmental warnings:

> *"There's been a situation about three or four months ago, when a night evacuation [was required], a plane flew out, circled around, visibility was too poor because of smoke and so they had to leave." (RAN)*

Telehealth Infrastructure

Many, though not all, remote PHC clinics in Central Australia have video cameras that MRaCC consultants use to visually examine patients during emergencies. Retrieval and remote clinic staff perceived telehealth (with video) as providing additional useful information to inform decisions about whether a patient needed to be retrieved. Cameras that could be controlled by MRaCC staff – for example, to zoom in on different parts of a patient's body – were considered especially useful. In specific examples mentioned, both retrieval and remote clinic staff perceived that the use of video cameras for pediatric consultations enabled MRaCC consultants to make a more informed clinical judgment about how sick a child was, and the additional clinical information influenced retrieval staff decisions regarding retrieval:

> *"You will be on the fence as to whether a child needs to be retrieved or not, and then from the description you're getting over the phone, and then you put the job on tele-health and you're like, oh wow, this kid's actually a lot ... like from what the ... you know, they're a lot different to how, either better or worse" (MRaCC/ROCC staff member)*

Retrieval decisions were also influenced by how recently patients had seen a health professional (face to face or via telehealth) and what level of information was available about patients' medical conditions and accessible in their medical records. The availability of high level, recent data informed the consultants' decision not to retrieve certain patients:

> *"It was really useful to know that they [patient referred for retrieval] had just had a specialist consult three days earlier. I feel like those are the sort of things that are enabling less retrievals to occur." (MRaCC/ROCC staff member)*

Human Resource Availability

This theme discusses how the availability of staff – PHC staff in remote clinics and retrieval crews – affects medical retrieval decisions regarding patients in remote areas.

RAN Fatigue

Staff who worked in both urban and remote retrieval services pointed out that decisions about retrieving remote patients were not only based on the severity of patients' illnesses but also needed to consider remote PHC human resourcing capacity and capability to care for unwell patients in their community. Participants, particularly those working in remote communities, described limitations in the capacity of staff working in remote PHC clinics to care for and monitor acutely unwell patients, especially overnight, including when awaiting a night retrieval:

> *"…if the nurses are exhausted and working short-staffed, you're risking patient care … you might be risking a community." (RAN)*

The necessity to limit 'RAN fatigue' was perceived as an important factor affecting retrieval consultants' decisions to retrieve patients from remote communities.

Tasking Retrieval Crews

Some retrievals from remote communities have specific crew requirements. For example, requiring crew members of a particular gender for cultural safety reasons. Accommodating such retrieval crew requirements could depend on the availability of a culturally

appropriate retrieval crew within an acceptable time frame relative to the patient's condition:

> *"… it might be a cultural issue where they only want to have a female crew. That's like, all right, cool, I'll get this crew back from their job and then you can have them to go see this patient." (MRaCC/ROCC staff member)*

Another factor to consider when tasking retrievals is ensuring that retrievals are completed within rostered shifts and in accordance with the aviation industry's safety protocols for air medical retrieval crews. Staff from road and air medical retrieval participant groups both provided specific examples of where low acuity retrievals were requested shortly before a retrieval team's shift ended. In such cases, low acuity retrievals were scheduled for the next shift with a fresh retrieval crew:

> *"…a case comes in for a low acuity retrieval at four in the morning, which is two hours before the end of a 12-hour shift for crew, so it's considered a moderate risk for us to go ahead and do that retrieval. So a conversation with the MRaCC would be to hold that off until six when a fresh crew starts and send them out on a retrieval." (Staff member from road/air retrieval service)*

Support to Recognize Acute Illness

This theme relates to how the tools used and processes followed in PHC settings support staff in recognizing when patients are acutely unwell and how these factors guide retrieval decision-making.

Point of Care Testing and Support From GPs

From a remote clinic staff member's perspective, the presence of a strong PHC delivery system with clear processes and guidelines for determining the severity of patient illnesses assists with communicating the severity of patient conditions to retrieval consultants. RANs acknowledged the importance of ongoing and strong support from GPs (face-to-face or via ROCC's telehealth unit) in subacute cases where staff weren't certain about a patient's health condition. GP support, particularly face-to-face consultations in the community was perceived as medical education opportunities, which contributed to improved medical skills of RANs, equipping them to decide when to seek medical retrieval support from MRaCC.

> *"There are educational opportunities, you know so while the GP's are out there [in the community], they are teaching the RANs, every person they see together is a teaching opportunity and a teachable moment." (Hospital staff)*

The use of point of care Testing (PoCT e.g., i-STAT testing) to test blood gases and cardiac troponin and having ready access to specific medical equipment (e.g., electrocardiogram machines) also informs diagnoses and means that better information is available to support decision-making about managing and retrieving patients. This may include confirming or excluding the presence of potentially life-threatening conditions:

> *"We've got the i-STAT machine and we can do troponins. So when someone has chest [pain] or high abdominal pain, we can exclude cardiac contributions." (RAN)*

Remote Early Warning Score (REWS)

The REW score, which is calculated by measuring temperature, pulse, respiratory rate, blood pressure, and oxygen saturation (Remote Primary Health Care Manuals, 2017) and used for the early detection of sick or deteriorating patients, supported remote clinic staff members to assess disease severity, and provided guidelines for the most appropriate referral pathway (emergency or PHC support) for further management according to the score. REW scores were described by both retrieval and remote PHC staff as being an important tool for informing timely decision-making about medical retrievals.

Skills and Experience of Staff

This theme describes the skills and experience levels of remote clinicians initiating emergency calls and the person/s receiving those calls.

Critical Care Skills snd Professional Experience in Remote Communities

Remote clinic staff and retrieval staff both emphasized that it was particularly important that the first point of contact during emergencies were experienced and had a high level of critical care skills as these facilitated timely and appropriate decisions about whether an air medical retrieval was necessary or whether a patient could be safely managed in the community.

> *"I think that having people with lots of emergency experience in MRaCC taking that initial call, where they're getting good initial management, so maybe they can be treated before they deteriorate. I think our comfort level – for a lot of us – in managing things in the community, at least giving them a try for a day or two before flying people in, is possibly higher than clinicians that don't have as much emergency care experience." (MRaCC/ROCC staff member)*

Participants considered it important that MRaCC consultants had good knowledge of the context in which health care is provided in remote communities to inform appropriate medical retrieval decision making. Important contextual knowledge included how remote clinics operate (e.g., operating hours and staffing profile), characteristics of patients (e.g., multiple chronic conditions), cultural requirements of patients and characteristics of specific remote locations (e.g. air strip availability). Retrieval staff who had professional experience working in remote communities were perceived to be better decision-makers than staff who weren't as familiar with remote communities.

> *"The MRaCC staff that struggle more, probably have spent less time in community." (MRaCC/ROCC staff member)*

> *"…we're not a 24-hour overnight service. You know that we can't sit in the clinic and wait eight hours for a plane." (RAN)*

Consistent with this, participants observed that locum staff who came from interstate to work in the medical retrieval center sometimes made sub-optimal retrieval decisions because they were unfamiliar with the remote context.

> *".. locums, particularly people who just arrived from interstate, weren't in a position that they knew how to do that, so very often they would make a call on people who probably didn't need to be admitted." (Hospital staff member)*

Experience of PHC Staff

Similarly, participants observed that the skills and experience of staff working in remote clinics also impacted retrieval decisions:

> *"The constant rotation of staff [remote area nurses] that may or may not have worked in community before and may or may not know the specifics of a certain community, sometimes that might cause some, or has caused some issues" (MRaCC/ROCC staff member)*

Factors such as limited remote health experience of some nursing agency staff (short-term staff sourced from recruitment agencies), perceptions about the strength of relationships between remote staff and their patients, presence of many new remote clinic staff, and retrieval staff member's confidence in the ability of remote clinic staff members to manage situations affect medical retrieval decisions. Retrieval and remote clinic staff particularly stressed the importance of established relationships between patients and remote clinicians because knowledge of patients' individual health histories and social circumstances (e.g., family support available, housing and overcrowding issues in the community) were often important factors in determining whether a patient needed to be retrieved.

> *"You could always get [more information] from a nurse that's been with the community for 15 years and who knows the patients and the families and the social challenges that exist in that community…. If something was to happen, they would just know the different strategies to greatly assist us, so easiest to deal with someone who knows the talk, rather than [from staff who are on their] first day." (MRaCC/ROCC staff member)*

Transmission of Potentially Lethal Infectious Diseases

Seasonal variations in disease epidemiology and the availability of innovative therapies or measures to prevent and manage disease were linked by participants to different medical retrieval decisions.

Keeping Patients Within the Community to Control the Spread of Infection

In the early phase of the COVID-19 pandemic, noting the high disease burden and poor socio-economic situations prevalent in remote Australia, health services and other service providers worked to keep remote Aboriginal populations safe from COVID-19. (Parliament of Australia, 2020) As illustrated by the quote below, most participants (pre-COVID-19 vaccine period) mentioned that there was an increased imperative to manage patients in remote communities where possible rather than evacuating them to hospitals, which increased the risk of hospital-acquired COVID-19 infection:

> *".. if we can manage someone in a remote community you shouldn't be bringing them to [town name] and exposing them to [COVID-19] risk." (MRaCC/ROCC staff member)*

Retrieving Patients to Control the Spread of Infection in the Community

Participants recollected specific policies or health initiatives introduced in relation to managing infectious diseases that also affected retrieval decisions. For example, following a 2017 meningococcal outbreak in central Australia (Department of Health, 2017), a policy was introduced requiring that all febrile children were retrieved during the

outbreak because of the seriousness of the condition for children and the overcrowding in the community and associated risks of rapid spread.

DISCUSSION

This is the first time to the authors' knowledge that the factors influencing medical retrieval decisions in the context of sparsely populated remote locations have been published in peer reviewed literature. These findings are, therefore, an important contribution to the extant retrieval literature, addressing significant gaps identified in two recently published literature reviews (Edwards et al., 2021; Mathew et al., 2022).

The study revealed that remote medical retrieval decisions are influenced by a range of referrer, patient, retrieval and transport factors, some of which they have in common with retrievals undertaken in other settings and others of which are likely to be different and may be most relevant for the remote Australian context of this study, as outlined in Table 1.

The study underscores the importance of having retrieval team members with high-level critical care skills (Russell et al., 2023), as well as contextual knowledge and experience in remote health service delivery. Remote Australia experiences extreme health professional shortages and turnover (Russell et al., 2017), which makes remote medical retrieval services dependent on interstate or international locums or agency nurses who may not have adequate contextual knowledge of specific remote communities, cultural and social circumstances of patients, the constrained environments in which remote clinics operate or the impacts of allocating specific retrieval infrastructure, all of which can affect appropriate medical retrieval decision-making. For example, a contextual factor influencing experienced remote consultants' retrieval decisions is whether the referring remote PHC centers have the human resources and skills to care for a patient within the community. Reliance on RANs employed in a short-term (temporary) capacity (Wakerman et al., 2019) is sometimes associated with sub-optimal clinical and cultural skills and low confidence in managing patients in the relative professional and geographic isolation in which they find themselves (Dunbar et al., 2019). For experienced RANs, heavy workloads limit their ability to care for seriously ill patients within a community while waiting for medical retrievals to occur. In these circumstances, some medical retrieval decisions may be completely different from what otherwise might occur in urban and rural contexts. Workforce instability and heavy workloads, including amongst MRaCC, ROCC, and remote health staff, can thus make a considerable contribution to the number of avoidable retrievals and also affect the appropriateness of retrievals in remote Australia. Strong professional relationships, developed over time between longer-term retrieval and remote PHC staff, provide opportunities for each health professional to better know each other's abilities and resource constraints (e.g., RAN fatigue), which can more readily be considered when making retrieval decisions. Solutions to remote PHC workforce instability, presented in more detail elsewhere, include strengthening remote health training pathways, ensuring a supportive and adequately resourced work experience, and providing appropriate personal and professional support (refs e.g. Wakerman et al. 2019; Russell et al. 2021).

Another key finding was that the decision to retrieve a patient at a particular time depended on the availability of scarce retrieval transport resources – these being retriev-

Type of factor	General factors	Important contextual factors in remote Central Australia	Relevant themes that describe contextual factors
Referrer factors	Referrers' skill and resources available	• Usually the referrer is a Remote Area Nurse (RAN) and a doctor is not physically present with the patient. • Emergency and PHC professional support for referrers are accessed via separate telehealth referral systems (MRaCC and ROCC, respectively). • Telehealth audiovisual infrastructure and connectivity is variable between clinics and often unreliable, especially across different jurisdictions. • Limited workforce capacity within PHC clinics to provide after-hours care for sick patients without compromising functioning of clinics during the day. • Access to advanced medical equipment and Point of Care Testing capability are limited in some remote communities. • Workforce instability is extremely high, which impact on referrer's relationships with community, relevant clinical skills and organizational knowledge.	• Experienced PHC staff • Point of care testing and support from GPs • Telehealth infrastructure • RAN fatigue • Remote Early Warning Score
Patient factors	Socio-economic & cultural factors	• Greater hesitancy to seek health care and hence greater need to develop trusting relationships between patients and health professionals. • Frequently high levels of poverty with limited access to basic personal health care infrastructure (eg. Smartphone, refrigerator, running water). • Cultural determinants of health including holistic view of health and wellbeing, preferences to be treated by same sex health professionals, role of family in decision making and meeting cultural obligations. • Overcrowding of houses and inadequate housing and implications for care.	• Critical care skills and professional experience in remote communities • Experience of PHC staff • Keeping patients within the community to control spread of infection • Retrieving patients to control spread of infection in community
Retrieval team	Skilled human resources	• Dependence on short term staff in remote clinics means staff may not have established relationships with a patient. • Retrieval team members require contextual knowledge of how remote clinics operate and cultural aspects of health service utilization. • Tasking of assets accounts for longer duration of tasks due to distances involved and duration of crew shifts.	• Experience of PHC staf
Retrieval hospital	Clinical capability	• Two regional hospitals with limited subspecialty services. Patients may require transfer to a tertiary hospital 1500km away for definitive care	• Transport infrastructure
Retrieval transport factors	Distance	• Distances impact on optimal transport mode. Communities are located 10-500km away from the regional hospitals.	• Transport infrastructure • Tasking retrieval crews
	Weather	• Extreme weather events eg. floods, dust storms, smoke affect mode of transport and timing of retrieval.	• Transport infrastructure
	Aviation infrastructure available	• Aviation and ground infrastructure (e.g. night landing strips, unsealed roads requiring 4WD ambulance). • No rotary assets available for medical retrieval in central Australia. • Small number of fixed wing assets which cover vast geographical areas and provide a range of different functions (emergency transport, repatriations, interhospital transfers).	• Transport infrastructure
	Road infrastructure	• Condition of roads including safety for night-time driving with wildlife and road surface	• Transport infrastructure

Table 1. General and contextual factors influencing medical retrieval.

al aircraft or ambulances (Danne, 2003) and appropriate human resources making up the retrieval teams. While resourcing can be a challenge for urban medical retrievals, it is particularly difficult and different in remote contexts as retrieval services need to balance the utilization of the limited resources with the acuity of cases that emerge in remote communities, inter hospital transfers and specific social and cultural needs of the patients. Because remote retrievals generally occur over large distances, once resources are allocated, it may be many hours before they are next available. Prioritization of emer-

gency cases by remote medical retrieval services will be at the expense of lower priority patients (Gardiner et al., 2020) who may be experiencing one or more chronic conditions and needing inter-hospital transfers for specialist consultations. Remote communities often experience poor living environments caused by housing crisis, overcrowding issues (Lowell et al., 2018), and energy poverty that restricts people from accessing thermally comfortable houses (Race et al., 2016). These circumstances can affect people's capacity to care for themselves within the community. While a doctor, nurse, or paramedic may be part of a retrieval crew depending on the acuity of the patient (Kennedy et al., 2017), the gender of crew members needs to be factored in some remote retrievals. The social and cultural circumstances of a patient are thus considered in a decision to medically retrieve a patient. The deployment of a dedicated medical helicopter could address additional demand caused by the contextual factors that affect optimal retrieval decision-making for remote communities within a 200 km radius of Alice Springs (Loyd et al., 2023).

In this study, the decision not to retrieve a patient was positively linked to adequate PHC tools, well-staffed remote clinics, and dedicated PHC support for remote area nurses. There is mixed evidence on the impact of access to PHC services, effective chronic disease management, and preventive programs on the need to retrieve patients (Haren et al., 2015; Hussain et al., 2014; Lavoie et al., 2010; Moore & Kirby, 2015; Wieland & Abernethy, 2023; Zhao et al., 2013). Point of Care Testing, availability of medical equipment, and sustained supply of medicines were important in this study. This is consistent with studies that have found that using PoCT devices by RANs changed the triage decision for 41% of patients (Spaeth et al., 2019; Spaeth et al., 2018). In terms of medical retrieval processes, the routine use of REWS allowed the early recognition of sick or deteriorating patients and thus also guided medical retrieval decisions (Remote Primary Health Care Manuals, 2017). Clinical information that was available in real time via video consultation also assisted with retrieval decisions. The effectiveness of video consultations has been linked to the quality and availability of telehealth infrastructure (including appropriate internet speeds) in remote clinics, staff confidence in using the technology, and patient preferences (Mathew et al., 2023), so more telehealth related investments could enable improved retrieval decisions.

The views of a range of staff involved in all aspects of a remote medical retrieval process have been included in this paper. Feedback from remote community members - users of the retrieval services has not been sought. A recent study on patient journeys found that the physical health needs, social, and cultural care needs of health service users in central Australia are often overlooked during medical retrievals (Lankin et al., 2023a). From a provider point of view, it is thus important to provide adequate training for new to remote staff to ensure retrieval decisions do not overburden remote PHC staff, and captures the social and cultural health care requirements of First Nations patients. In terms of future research, this study highlights the need to work with retrieval service users, retrieval staff, and medical professionals to design contextual indicators to monitor and evaluate the effectiveness and efficiency of remote medical retrieval services.

CONCLUSION

A range of workforce and infrastructure characteristics of the remote healthcare system and social and cultural circumstances of remote community patients impact the decisions made by medical retrieval consultants to evacuate patients from remote Australia.

The rationale behind retrieval decisions for remote community patients may not always match that for urban patients. The adequacy of medical retrieval services for remote communities should consider the high burden of disease, cultural requirements, workforce characteristics, and poorer access to health care and social circumstances compared to urban populations. The study highlights the need for dedicated investments and adequate workforce training to ensure medical retrieval decisions are acceptable for remote patients and appropriate in remote circumstances. The learnings of this study are potentially translatable to other remote retrieval systems elsewhere in Australia and internationally, which may be servicing culturally and linguistically diverse populations.

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RESEARCH REPORTS

A CROSS-SECTIONAL ANALYSIS OF ALS/BLS CARE IN LOW ACUITY 9-1-1 RESPONSE BY GEOGRAPHY AND INSURANCE STATUS UTILIZING THE 2019 NEMSIS DATASET

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ABSTRACT

Purpose: The objective of this study was to examine the relationship between patient acuity and level of EMS care (ALS/BLS) adjusting for rurality and insurance.

Methods: Data were obtained from the National Emergency Medical Services Information System (NEMSIS) dataset for 2019. EMS responses (n = 4,375,568) were analyzed comparing patient acuity and CMS service level, advanced life support (ALS) vs basic life support (BLS), to assess for associations in acuity and CMS service level using logistic regression.

Results: Overall, there was a decreased odds of advanced life support service use at low acuity EMS responses (aOR = 0.457, 95% CI [0.454, 0.460]). Analysis exploring the interaction between CMS service level and rurality demonstrates an overall trend of decreasing odds of low acuity EMS responses among rural areas and BLS care (aOR = 0.492, 95% CI [0.486, 0.498]) and ALS care (aOR = 0.208, 95% CI [0.206, 0.210]). When analyzing trends among public versus all other insurance and rural versus urban settings, there were decreases in low acuity ALS care in the rural setting; ALS and public insurance (aOR = 0.469, 95% CI [0.465-0.472], $p < 0.001$), ALS and rural (aOR = 0.208, 95% CI [0.206, 0.210], $p < 0.001$) among low acuity responses. The results indicate that acuity and service level vary according to insurance and rurality. In the low acuity call type, we see decreased odds of ALS use compared to BLS use in those with public insurance compared to other insurance. There is also a geographic component to these results where the use of advance life support services declined with decreases in urbanicity.

Discussion: These results potentially highlight that rural areas utilize less emergency medical response resources in low acuity responses. As such, EMS programs like community paramedicine, could be potentially effective interventions to close gaps in access to care for rural residents.

INTRODUCTION

Emergency medical care has a critical role in providing access to health care. Historically, emergency medical services (EMS) in the United States were created to transport ill or injured pa-

tients to the nearest hospital facility and were poorly organized, unregulated, and rooted in businesses such as the funeral industry (West Virginia Department of Education, n.d. However, over time their role developed, and by the late 19th century, EMS were equipped with compact medical equipment to provide prehospital care and improve patient outcomes (Shah, 2006). In the 1960s, legislative action oversaw the standardization of emergency medical services by geography, resulting in the development of the first statewide EMS program in Maryland (Shah, 2006). EMS responses now consist of six main areas, which are early detection, early reporting, early response, on scene care, care in transit, and transfer to definitive care (PFEMS, 2022). Taken together, these actions are meant to provide critically ill or injured patients with immediate medical care to prolong life.

Patient acuity in EMS response is as diverse as it is complex, representing the perceived severity measured subjectively by the responder (Shekhar & Blumen, 2021). The National EMS Core Content provides a framework of the knowledge and skills required for EMS clinicians to assess, diagnose, and manage patients (National Highway Traffic Safety Administration, 2005). Its guidelines divide severity of patient scenarios into three categories, based on the Model of Clinical Practice of Emergency Medicine: Critical, Emergent, and Lower Acuity (Beeson et al., 2020; NHTSA, 2005). Acuity is determined by the responder based upon signs and symptoms of the illness or injury at the time of assessment. Critical patients, according to this framework, have a high probability of mortality if immediate lifesaving intervention is not initiated, while those categorized as emergent have conditions which could progress with further complications without treatment, whereas lower acuity have a low probability of progression to more serious disease or complications (Beeson et al., 2020). While some conditions are easy to categorize as critical, for instance, an unresponsive patient, others are more subjective to responder biases and experience, and while acuity can dictate level of care, this relationship is not exclusive (Shekhar & Blumen, 2021).

Importantly, not all EMS are equally credentialed to provide the same level of life support to communities. The differentiation of BLS and ALS services is vital, as access to these resources differs, even within the United States (McLaughlin et al., 2021). This is of serious public health concern, as an EMS response involving ALS services may permit use of tools or medications to improve patient-centered outcomes or care not available to BLS services. It is important to note that some states' EMS agencies are required to license at the highest level of care they can guarantee to provide, which may understate the actual care able to be provided. Consequently, whether ALS services are used at a response or not does not accurately reflect on their availability (National Association of State EMS Officials, 2020).

In comparing settings, geographic differences typically result in urban EMS having shorter response, on scene, and transport times, higher survival rates, decreased morbidity, and more clinicians and resources (Alanazy et al., 2019; Lerner & Moscati, 2001; Newgard et al., 2017). Disparity in the availability of resources could result in critically ill or injured patients within rural areas being transported to a hospital by EMS with only BLS credentialing, while EMS with ALS certification may respond in urban areas to low acuity situations. Previous research has examined disparities in the use of EMS in low acuity situations and found increasing use in vulnerable populations (Durant & Fahimi, 2012). However, they did not examine level of EMS support utilized within low acuity re-

sponses. There is a scarcity in the literature regarding disparities in frequency of basic or advanced life support services by EMS within differing levels of response acuity. Gaps in available research are further exacerbated when attempting to locate geographic differences in inequities in BLS and ALS services.

Previous studies have utilized prehospital databases such as the National Hospital Ambulatory Care Survey (NHAMCS) or the National Emergency Medical Services Information System (NEMSIS) to better understand emergency department visits for low acuity EMS responses, reimbursement for low acuity EMS response, and disparities in use of EMS services among older adults (Alpert et al., 2017; Duong et al., 2017; Durant & Fahimi, 2012). However, no study to our knowledge has described disparities in level of support provided during low versus all other acuity calls, or attempted to understand how they differ by rurality. This study has the potential to better inform policy and resource allocation for placement of EMS services within differing regions of the U.S. The purpose of this study is to fill the gap in research surrounding use of ALS versus BLS services during EMS response at low acuity versus emergent and critical acuity responses.

METHODS

Data Source and Management

Data were obtained from the National Emergency Medical Services Information System (NEMSIS) 2019 data files. Briefly, NEMSIS is sponsored by the National Highway Traffic Safety Administration's (NHTSA) Office of EMS which collects EMS data from 48 states and three U.S. territories to improve standardization, aggregation, and utilization of EMS events (National Emergency Medical Services Information System, 2020). In the 2019 data set, these data are de-identified, contain no protected health information, and are made up of reports from 34,302,737 EMS activations.

Study inclusion criteria consisted of 9-1-1 response to scenes from patients who were treated and/or transported as well as those who refused treatment and/or transport. Exclusion criteria comprised responses for interfacility, routine transfer, mutual aid, standby events, and public assistance. Exclusion criteria also included incidents which did not have a patient, for example "no patient found" entries and responses where the CMS service level (ALS/BLS), insurance, or initial acuity indicators were missing. CMS service level was used to elucidate level of care provided by EMS responders (ALS/BLS) and is defined in the NEMSIS extended data definitions as the service level provided for the encounter (NASEMSO, 2016). Lastly, a response was excluded if initial acuity was categorized as dead without resuscitation efforts, as they were inherently different and likely did not have a treatment or transport component.

The outcome for the study was the odds of a low acuity response compared to all other initial acuities among our study sample. Initial acuity is indicative of the severity of the EMS encounter and is defined by the Model of Clinical Practice of Emergency Medicine and reported in the National EMS Core Content (NHTSA, 2005). Initial acuity is stratified into four categories (low, emergent, critical, and dead without resuscitation efforts). Low acuity calls have a low probability of progression to more serious disease, emergent may progress in severity or complication with a high probability for mortality, and critical involves life threatening illness or injury with a high probability of mortality if

immediate intervention is not begun (NHTSA, 2005). Initial acuity was dichotomized as low initial acuity and all other acuities.

Covariates included CMS service level (level of treatment ALS or BLS), unit level (license level of responding unit ALS or BLS) age, sex at birth, insurance coverage, and urbanicity. Age was colinear with insurance and so was excluded from the analysis. Insurance coverage was dichotomized to patients with or without public insurance. Race was not included in our analysis given it was missing in greater than 50% of the EMS responses in our analytic sample. Urbanicity of EMS response was captured to characterize geographic differences between acuity of calls and CMS services provided. Urbanicity in the NEMSIS dataset is based on the 2013 United States Department of Agriculture (USDA) influence codes which are divided into four categories: urban, suburban, rural, and wilderness (U.S. Department of Agriculture Economic Research Service, n.d.). These four categories were further dichotomized in our study to rural and non-rural.

Statistical Analysis

Logistic regression was conducted to identify differences in the odds of a low acuity call by CMS service level, adjusting for covariates in the model. Regression analyses were also conducted to investigate effect modification in CMS service level by rurality, patient insurance coverage by rurality, and CMS service by patient insurance coverage. Statistical significance was evaluated using 95% confidence intervals around estimated odds ratios. All data management and statistical analyses were conducted in R Studio (Version 1.3.959).

RESULTS

Overall, there were 2,821,072 low acuity events and 1,434,956 emergent and critical events within our NEMSIS study sample. Among low acuity events, 72% received ALS care while 28% received a BLS level of care. Among low acuity events the responding unit's license level was BLS in 9% of responses and ALS in 91% of responses.

	Low Acuity N=2,812,072	Emergency and Critical Acuities N=1,434,956
Sex		
Female	1502075 (53.4%)	730831 (50.9%)
Male	1309997 (46.6%)	704125 (49.1%)
Unit Level		
BLS	395458 (14.1%)	131851 (9.2%)
ALS	2416614 (85.9%)	1303105 (90.8%)
Level of Care		
BLS	782323 (27.8%)	216578 (15.1%)
ALS	2029749 (72.2%)	1218378 (84.9%)
Insurance		
Non-Public Insurance	1927049 (68.5%)	972191 (67.8%)
Public Insurance	885023 (31.5%)	462765 (32.2%)
Rural		
Non-Rural	2577529 (91.7%)	1216835 (84.8%)
Rural	234543 (8.3%)	218121 (15.2%)
Rural and Insurance		
Non-Rural & Non-Public Insurance	1792869 (63.8%)	855353 (59.6%)
Non-Rural & Public Insurance	784660 (27.9%)	361482 (25.2%)
Rural & Non-Public Insurance	134180 (4.8%)	116838 (8.1%)
Rural & Public Insurance	100363 (3.6%)	101283 (7.1%)
Level of Care and Rural		
BLS & Non-Rural	684857 (24.4%)	168008 (11.7%)
BLS & Rural	97466 (3.5%)	48570 (3.4%)
ALS & Non-Rural	1892672 (67.3%)	1048827 (73.1%)
ALS & Rural	137077 (4.9%)	169551 (11.8%)
Level of Care and Insurance		
BLS & Non-Public Insurance	540944 (19.2%)	148989 (10.4%)
BLS & Public Insurance	241379 (8.6%)	67589 (4.7%)
ALS & Non-Public Insurance	1386105 (49.3%)	823202 (57.4%)
ALS & Public Insurance	643644 (22.9%)	395176 (27.5%)

Table 1. Characteristics of study population (NEMSIS, 2019).

Among low acuity events, 32% involved patients with public insurance classifications (n = 885,023), 53% were female (n = 1,502,075), and 92% were among urban geographic localities (n = 2,577,529). Low acuity complaints were identified to have statistically different distributions of insurance, service level, gender, and urbanicity compared to emergent and critical acuity complaints. A comprehensive breakdown is presented in Table 1.

Covariate	Odds Ratios	CI	p
Sex			
Female	1		
Male	0.909 ***	[0.905, 0.912]	< 0.001
Service Level			
BLS	1		
ALS	0.457 ***	[0.454, 0.460]	< 0.001
Unit Level			
BLS	1		
ALS	0.819 ***	[0.813, 0.824]	< 0.001
Insurance			
Non-Public Insurance	1		
Public Insurance	1.015 ***	[1.010, 1.019]	< 0.001
Rural			
Not Rural	1		
Rural	0.459 ***	[0.457, 0.462]	< 0.001

Table 2. Multivariable logistic regression for all acuity calls. Results display the odds ratios for probability of Low Acuity responses within different subgroups within the analysis.

Multivariable logistic regression results are presented in Table 2. There was a significantly lower odds of involvement in low acuity events for ALS services compared to BLS services (aOR = 0.457, 95% CI [0.454, 0.460]). Low acuity events had a statistically lower odds of the responding unit being ALS licensed (aOR = 0.819, 95% CI [0.813, 0.824]) compared to those which were licensed BLS. Low acuity events had a statistically lower odds of occurring in rural areas compared to emergent and critical acuity events (aOR = 0.459, 95% CI [0.457, 0.462]). Males had a statistically lower odds involvement in low acuity events than females (aOR = 0.909, 95% CI [0.905, 0.912]). Lastly, there was a statistically higher odds of a low acuity event involving someone with public insurance compared to all other insurance types (aOR = 1.015, 95% CI = [1.010,1.019]).

Interaction specific model results are displayed in Table 3. All models included adjustment for patient sex at birth and responding unit level. There was a significantly lower odds of a low acuity event involving patients living in rural areas who had public insurance compared to those in non-rural areas without public insurance (aOR = 0.466, 95% CI [0.462, 0.471]). Similarly, there were statistically lower odds of a low acuity event involving patients living in rural areas without public insurance compared to those in non-rural areas without public insurance (aOR = 0.542, 95% CI [0.538, 0.547]). Alternatively, there was a statistically higher odds of a low acuity event involving a patient living in a non-rural area with public insurance compared to those in non-rural areas without public insurance (aOR = 1.029, 95% CI [1.025, 1.034]). When examining the interaction between CMS service level and insurance status, responses involving BLS care and patients with public insurance had statistically lower odds of involvement in low acuity events compared to those receiving BLS care without public insurance (aOR = 0.978, 95% CI [0.968, 0.988]). Similarly, responses involving ALS services had statistically lower odds of involvement in low acuity events for patients with public insurance (aOR = 0.469, 95% CI [0.465, 0.472]) and for those without public insurance (aOR = 0.488, 95% CI [0.484, 0.491]) compared to those receiving BLS care without public insurance. Lastly, for CMS service within rural versus non-rural areas, BLS service in rural areas had statistically lower odds of involvement in a low acuity event compared to BLS care in non-rural areas

(aOR = 0.492, 95% CI [0.486, 0.498]). Likewise, there was statistically lower odds of involvement in a low acuity event for ALS care among rural (aOR = 0.208, 95% CI [0.206, 0.210]) and non-rural (aOR = 0.464, 95% CI [0.461, 0.467]) compared to BLS care in non-rural areas.

Covariate	Odds Ratios	CI	p
Gender			
Female	1		
Male	0.901 ***	[0.897, 0.904]	< 0.001
Unit Level			
BLS	1		
ALS	0.611 ***	[0.606, 0.615]	< 0.001
Rural & Insurance			
Non-Rural & Non-Public Insurance	1		
Non-Rural & Public Insurance	1.029 ***	[1.025, 1.034]	< 0.001
Rural & Non-Public Insurance	0.542 ***	[0.538, 0.547]	< 0.001
Rural & Public Insurance	0.466 ***	[0.462, 0.471]	< 0.001
Gender			
Female	1		
Male	0.908 ***	[0.904, 0.912]	< 0.001
Unit Level			
BLS	1		
ALS	0.819 ***	[0.813, 0.825]	< 0.001
EMS & Rural			
BLS & Not Rural	1		
BLS & Rural	0.492 ***	[0.486, 0.498]	< 0.001
ALS & Not Rural	0.464 ***	[0.461, 0.467]	< 0.001
ALS & Rural	0.208 ***	[0.206, 0.210]	< 0.001
Gender			
Female	1		
Male	0.909 ***	[0.905, 0.913]	< 0.001
Unit Level			
Female	1		
Male	0.811 ***	[0.805, 0.817]	< 0.001
EMS & Public Insurance			
BLS & Not Pub Ins	1		
BLS & Pub Ins	0.978 ***	[0.968. 0.988]	< 0.001
ALS & Not Pub Ins	0.488 ***	[0.484, 0.491]	< 0.001
ALS & Pub Ins	0.469 ***	[0.465, 0.472]	< 0.001

Table 3. Interaction logistic regression model results for odds of low acuity event by insurance, EMS and rurality.

DISCUSSION

The results indicate that patient acuity level, low acuity versus emergent and critical acuities, varied across insurance status and geography. Importantly, odds of low acuity involvement were lower for rural areas, among patients with public insurance, and responses involving ALS services. This study also highlights key interactions between these covariates which complicates direct inferences which can be drawn from the main effects. Importantly, we found that regardless of insurance status, there was a lower odds of a low acuity event in rural areas. This was not true for non-rural areas, where non-rural areas with public insurance had higher odds of low acuity events. This may be due to variation in socio-economic status levels among non-rural versus rural areas. Previous studies have found differing impact of socio-economic status and vulnerability across rural and urban communities (Deziel et al., 2023; Eberhardt et al., 2002). This study highlights an important disparity among rural communities, who also experience longer than average travel times for primary care and limited access to medical specialties and hospitals (Iglehart, 2018).

Conversely, urban areas that likely have greater access to healthcare resources and public transportation, and probably have more ALS EMS resources available displayed increased odds of low acuity events. One potential explanation of our results is that with greater access to ALS care there could be over triage of care in the urban environment whereas in the rural environment there is less access to ALS services. Interestingly, in the urban setting those without public insurance exhibited a lower odds of low acuity response than those with public insurance whereas in the rural setting those with public insurance had a higher odds of low acuity events.

While the cross-sectional nature of these data prohibits a causal inference, the disparity in ALS vs BLS services and acuity of calls in rural areas could speak to the disparities in access to health care in rural versus urban settings. This is key as educational interventions or additional studies could be designed to better understand disparities in EMS utilization.

These findings, though not causative, provide contextual support for additional research to elucidate the mechanisms for the disparities across the geographic and socioeconomic spectrum. Studies aimed at evaluating resource availability, allocation, and potential alternatives would be appropriate. Potential outcomes include supporting programs aimed at reducing disparities in access to healthcare. These could include community paramedicine programs targeted to communities with reduced access to care and or assisting the reduction of EMS calls and hospital crowding in the urban environment. Finding ways to share resources in those areas with reduced access to care could also be a strategy to increase access to care and address rural disparities. One example may be for local hospitals to partner with EMS agencies to bridge gaps in care.

Several limitations to our approach exist. First, while NEMSIS is a nationally representative sample of EMS responses, not every EMS agency or state participates. This bias has the potential to influence relationships found by geography as EMS responses are not evenly distributed within space (NASEMSO, 2020). Next, responses did not include a unique identifier for individual patients, which could result in a single patient having more than one entry. However, we attempted to mitigate this through our inclusion/exclusion criteria. For example, exclusion of inter-facility transport reduces instances in which a patient is transported multiple times by EMS for the same encounter. It is important to keep in mind that NEMSIS is an encounter-based surveillance system and was not intended to be used for patient level analyses. Though defined in the National EMS Core Content, patient acuity is subjective to classification by the EMS practitioner which creates the potential of information bias such as over or under triage of patient acuity. This could also influence ALS versus BLS care where for example in an urban setting with only ALS providers, a low acuity response that may typically be completed with BLS resources was treated with ALS care. Though this is a limitation in our results, it also supports the possible disparity of EMS resources in these settings. Unit level is defined by the NEMSIS data dictionary as the level an EMS unit/crew can provide regardless of patient need (NASEMSO, 2016). There may be instances where a unit is licensed as ALS but staffed by a BLS crew providing BLS care; however this situation is not discernable within this data set. Despite these limitations our study had several strengths. With 4,247,028 EMS events our sample size was robust and is adequately powered. Our inclusion of unit level, though with limitations, does hint at the potential availability of ALS resources within a response area. Importantly, this is the first nationally representative analysis of patient insurance status, geography, and EMS service level involvement by acuity of event in EMS response data.

CONCLUSIONS

This research provides a national overview of the frequency of involvement for different insurance statuses, geographies, and patient demographics in low acuity events for 9-1-1 responses. While we are unable to examine local neighborhood context for the relationships we observed, our study does address major gaps in the current public health

literature concerning urban-rural disparities in prehospital health care. In particular, this study addresses uncertainties with regard to how EMS service level availability is distributed within different geographic contexts and for a variety of patient populations. Future research is warranted to focus specifically on how the relationships identified here vary in geographic space and to examine resource utilization in differing EMS models. Methods, such as those applied within spatial epidemiology, could be particularly useful in elucidating how these factors impact provision of care for patients across the United States rural-urban gradient.

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RESEARCH REPORTS

THE EXPERIENCES OF AND ATTITUDES TOWARDS CONTINUING PROFESSIONAL DEVELOPMENT: AN INTERPRETATIVE PHENOMENOLOGICAL ANALYSIS OF UK PARAMEDICS (EAT CPD)

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ABSTRACT

Background: Paramedics are Allied Health Professionals (AHPs), registered with the Health and Care Professions Council (HCPC). Part of this registration is the responsibility to conduct and record continuing professional development (CPD) with a sample of UK paramedics audited every two years as part of their reregistration process. Compared to other AHPs very little is known about paramedics' engagement with CPD and how it affects them professionally.

Methods: To understand the lived experiences of paramedics related to their CPD an Interpretative Phenomenological Analysis (IPA) was undertaken. Audio-recorded semi-structured interviews took place with registered paramedics working across healthcare. Interviews were professionally transcribed and analysed via thematic analysis related to IPA research.

Results: Seven interviews produced one overarching domain of Paramedics experiences of and attitudes towards CPD, developed from four themes created by a variety of subthemes. The four themes were: personal factors (individual motivations to conduct CPD), professional accountability (how CPD improves oneself and the profession), employer investment and support (how employers play their part in CPD facilitation), and Covid-19 (Covid-19s impact on CPD). Novel subthemes included CPD is a personal responsibility and Covid-19 factors.

Conclusions: Paramedics are faced with a plethora of factors impacting upon how and why they engage with CPD. Whilst many factors are shared the combination of factors are individual and personal to each paramedic. A more structured and integrated collaboration between paramedics, employers, regulators, and CPD providers could help promote facilitators and reduce barriers to CPD for paramedics, whilst also delivering focused CPD activities that improve the profession and registration requirements.

INTRODUCTION

Continuing Professional Development (CPD) is a mandatory requirement of registration for all healthcare professionals including paramedics in the United Kingdom (UK) (Karas et al., 2020), as well as paramedics across the globe includ-

ing Australia, New Zealand, and South Africa. The subject of CPD in relation to the paramedic profession has not been studied as in depth compared to other medical and Allied Health Professionals (AHPs) (Gould et al., 2007; Haywood et al., 2012; Hobbs et al., 2021; Vazquez-Calatayud et al., 2021; Walter & Terry, 2021). Some international literature exists, beginning to explore this subject (Adefuye et al., 2020; Bryant et al., 2023; Gent, 2016; Hobbs et al., 2021; Knox et al., 2014; Knox et al., 2015; Williams & Edlington, 2019), but no previous study specifically looking at the attitudes and experiences of paramedics regarding their CPD as part of a mature registration process has been conducted in the UK.

As of September 2021, there were 31,470 registered paramedics in the United Kingdom (UK) (Health and Care Professions Council [HCPC], 2021a). Paramedics reregister every two years, declaring their continuing abilities to meet a number of practice and personal competencies (HCPC, 2014a, 2016a, 2018, 2021a) though their CPD requirements are not as prescribed compared to other healthcare professions in the UK (Karas et al., 2020) or abroad (Paramedicine Board of Australia, 2018).

In the UK paramedics no longer work exclusively for ambulance trusts, having broadened their employability and scopes of practice, and can be found working across a plethora of healthcare and industry settings (College of Paramedics, 2019). It is unknown if this expansion of the profession has had a positive or negative effect on CPD engagement and how it relates to registration for the paramedic profession.

HCPC commissioned research (Illing et al., 2017; Silversides, 2015) into its CPD standards and audit processes have shown mixed understanding and feelings from AHPs regarding HCPC processes and expectations, causing anxiety. Despite this only a handful (5 out of 3161) of paramedics have had their registrations removed for failing a CPD audit since 2008 (HCPC, 2012, 2014b, 2016b; 2019, 2021b, 2023 Illing et al., 2017). The majority have occurred recently with no obvious reason(s) for this.

Further discourse surrounds CPD for healthcare professionals (Draper & Clark, 2007; Illing et al., 2017; Silversides, 2015), and extends to whether it is a professional responsibility to meet registration organisation requirements, employees beliefs concerning how employers can provide and support CPD (Alsop, 2013; HCPC 2017; Illing et al., 2017), and, specifically for paramedics, the subjective guidelines provided to them by the HCPC compared to other healthcare professionals (Karas et al., 2020). Paramedics in the UK via the HCPC are not provided with specific CPD requirements in terms of time or activities, rather these are 'suggested'. Compared to other healthcare professionals' registration bodies such as the Nursing and midwifery Council (NMC), who stipulate 35 hours of CPD over 3 years with 20 hours spent within group learning and additional reflection required (Karas, et al., 2020), and the Paramedicine Board of Australia (2018) who require paramedics to complete 30 hours of CPD annually with 8 of these in interactive settings with other practitioners.

Despite the lack of prescription in terms of required CPD time and activity the paramedic profession is meeting its requirements as a whole, but due to the limited focus on this area for the profession it would appear pertinent to understand in more depth the motivations of paramedics regarding how / why they engage in CPD.

METHODS

Aims

To better understand paramedics' lived experiences of conducting CPD, how they engage with it and the types of facilitators and barriers they encounter.

Objectives:

- What are paramedics experiences of engaging with CPD activities?
- What are the attitudes of paramedics towards CPD activities?
- What are the reasons paramedics engage with CPD?
- What do they like / dislike about CPD?

Design

This study was interpretive in nature and employed a phenomenological approach, specifically Interpretive Phenomenological Analysis (IPA) (Smith, 1996). The aim of phenomenology is to explore individuals, groups, and cultures' lived experiences of their day-to-day lives (Holloway & Galvin, 2017) with individuals seeking meaning from their experiences and their accounts conveying these meanings (Gill, 2020). This requires a sample that reflects the diverse range of employment opportunities undertaken by paramedics can be accounted for both in terms of similarities and differences. IPA sits within Heidegger's school of methodology which acknowledges that it is not possible for researchers to be completely free from presumptions during the research process and can therefore not 'bracket' these as expected within descriptive phenomenology (Gill, 2020),, pertinent for the researcher in this case who adopted a reflexive stance to acknowledge their position.

A hermeneutic approach was adopted, allowing for the researcher's interpretation of the participants' interpretations to occur while acknowledging their reflexivity due to their background, employment, and closeness to the research topic and participants, meaning they could not truly be detached from their assumptions, beliefs, and knowledge during data collection and analysis (Gill, 2020; Holloway & Galvin, 2017). Also, they continue to work as a paramedic based in the UK, first registered in 2008, working for their ambulance trust since 2004, and was audited by the HCPC for their CPD in 2017, passing successfully.

An interview topic guide was developed consisting of 13 questions where a pilot ensured appropriate editing of questions, content validity, improvements to the language used, and the questions were clinically and practice relevant (Howitt, 2020). In-depth semi-structured interviews were conducted, capturing interpersonal data related to lived and life-world experiences of conducting CPD rather than second hand knowledge (Brinkmann & Kvale, 2018; Matthews & Ross, 2010; Patton, 2021; Wheeldon & Ahlberg, 2012), beneficial for complex, sensitive, or poorly understood topics (Matthews and Ross, 2010), and for qualitative and phenomenological research (Brinkmann & Kvale, 2018).

Ensuring a reflexive stance, especially within the data analysis, was important. Doing so improved the transparency and trustworthiness of the research and reduced the biases of the researcher but ensured a greater understanding of the lifeworld and lived experiences being explored (Holloway & Galvin, 2017). To assist with reflexivity and triangu-

lation of the data, observational note taking during interviews took place alongside the production of a reflexive journal. Triangulating the data from these sources meant more comprehensive results (Flick, 2018) and the hermeneutic circle was adhered to with the hidden meanings (Rodriguez & Smith, 2108) extracted rather than generalisations.

Six of the seven interviews took place face to face and adhered to social distancing and personal protective equipment wearing protocols as required by the UK government due to the Covid-19 pandemic. The remaining interview was conducted using Microsoft Teams. Each participant received a Participant Information Sheet. Verbal and written consent were sought before interviews began.

IPA focuses on small numbers of participants (Gill, 2020), from homogeneous groups enabling detailed analysis of each participant's data (Smith et al., 2009). The sampling was purposive for individuals with relevant experience(s) and pertinent to the research (Gill, 2020; Peat et al., 2019; Smith & Osborn 2015). Fundamental to IPA is to articulate the commonalities across groups of individuals rather than making broader generalised comments (Smith & Osborn, 2015). To do this IPA employs a sampling strategy different from other interpretative phenomenological approaches, meaning thematic saturation is not required (Gill, 2020), with 3 – 6 participants recommended for student research (Smith et al., 2009).

Setting and Sampling Strategy

The research was aimed to specifically look at paramedics. Whilst it is acknowledged others such as employers, the HCPC and CPD providers have vested interest in this topic too, it was outside of the scope of this study to include them. Hopefully this can add to the research in this area and be a catalyst for wider discussion. Therefore, a purposive sample, promoting diversity of participants relating to their employment(s), length of registration and characteristics was undertaken. The Health Research Authority (HRA) at the time had suspended its approvals for student research (Health Research Authority [HRA], 2021) (more details in ethics section) due to the Covid-19 pandemic. Guidance on how to conduct research outside of the NHS which still involved NHS staff was followed (HRA, 2021).

Participants

Seven participants were interviewed (m=4, f=3). All were registered paramedics with the HCPC, working for a mid-sized National Health Service (NHS) ambulance trust in the UK. n=5 held substantive contracts with the trust in question, though with different clinical / organisational roles. n=2 held substantive contracts with other healthcare providers alongside bank contracts as paramedics at the same ambulance trust. All participants held registrations covering at least one full audit cycle. n=1 had been previously audited by the HCPC.

Data Collection and Analysis

Professional verbatim transcripts were produced by a third party, with all data handled in accordance with the Data Protection Act 2018. A step-by-step inductive thematic analysis for IPA research (Howitt, 2020; Smith, 2011; Smith & Osborn, 2015; Smith et al., 2009)

was undertaken. SRQR reporting guidelines (O'Brien et al., 2014) were utilised to ensure the comprehensiveness of this qualitative study.

RESULTS

The researcher noted several topics of discussion provided by the interviews and in the analysis were similar to their own experiences and refereed to at the start of the research in their reflexive journal.

One overarching domain of Paramedic's experiences of and attitudes towards CPD was developed from four themes: personal factors, professional accountability, employer investment and support, and Covid-19 as seen in figure 1. Each theme being developed from a number of subthemes as seen in table 1.

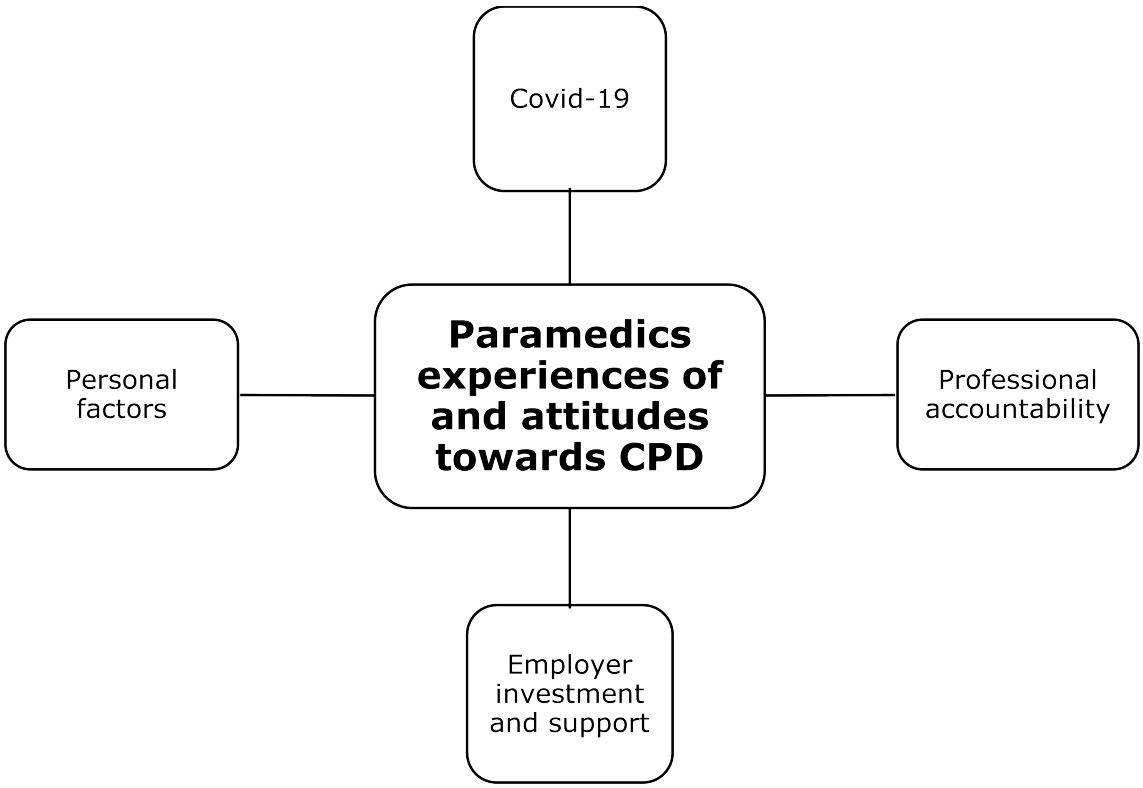

Figure 1. Thematic map of domain with associated themes.

Covid-19

Composed from the subtheme Covid-19 factors. Covid-19 was a prominent factor for all participants. Not just different working practices but the impact it had on CPD and how it could be engaged with,

> *Um, it's been more difficult over the past couple of years, obviously, because of, of COVID (P7).*

Though there were benefits through innovation,

> *I've noticed like webinars and those sorts of platforms have really sort of kicked up in volume through COVID, where really, they-they were few and far between before that. So, I think, yeah, there's a-there's a lean towards that method because, you know, people are – the kind of big ad-*

vantages; you don't have to worry about travelling, you don't have to worry about accommodation, um, actually, it's probably considerably cheaper for what you get, (P3).

Domain	
Paramedics experiences of and attitudes towards CPD	
Theme	**Subthemes**
Personal factors	• Activity preference • Additional opportunities • Enjoyment • Faculty • Personal responsibility • Work-life balance
Professional accountability	• Benefits patients • CPD standards, expectations, and audit • CPD within job role • Improve profession • Remain up to date • Role relevance • Self-reflection
Employer investment and support	• Culture • Employer provision/lack of • Funding • Time
Covid-19	• Covid-19 factors

Table 1. Overview of domain, themes, and subthemes.

Personal Factors

Comprised of pertinent individual reasons as to why CPD is conducted, it covered sub-themes of personal responsibility, activity preference(s), enjoyment, additional opportunities, faculty, and work-life balance.

Most prominent was a belief that CPD is a personal responsibility. Every participant referenced this and appeared proactive.

Me. Just me. Um, the reality is, is as a healthcare professional… it's up to me… to seek out the CPD that will benefit me, um, it'll benefit my – ultimately, then benefit my service users (P3).

Most participants alluded to activities needing to be varied with the majority preferring practical activities in small groups, alongside peers / stakeholders, offering challenge, whilst being contemporary and evidence based.

So, I look at a broad range of methods. So, I'll utilise courses, I'll utilise webinars, journal articles, I will have professional discussions, I will, um, listen to podcasts, I will watch YouTube videos, I will, um, participate in study days, I will look at, um, just even-even so much as something like a radio program (P3).

Activities where poor engagement could be seen were those of larger sizes such as conferences, passive activities such as e-learning which can lead to boredom, and the increased use of information and communication technology to deliver CPD was not universally liked.

Enjoyment in terms of improving engagement and developing motivation for CPD was important.

and the more I did, the more I enjoyed it, the more opportunities became available and yeah, it, it was very fruitful, very enjoyable (P1).

Some participants realised the benefit of CPD to further their careers and future diversification because it offers additional opportunities.

I feel like I've, I've learnt a lot from it, erm, and ultimately it's kind of resulted in me changing my job roles and now pursuing a slightly different angle, pre-hospital care (P1).

The faculty whilst not impacting on the participation of a CPD event, contributed towards the overall experience and memory of it.

> *different workshops of different skills that were very good because you had a higher level of, er, skilled people being able to run the skills workshops, er, and run scenarios which I found very useful (P2).*

The main area of discourse described by all participants was work-life balance. Paramedics appear keen to conduct CPD but are not prepared to over invest in terms of time and monetary resources.

> *unfortunately to get decent CPD now you do seem to have to pay quite a large sum to actually attend these days (P2).*

> *your days off don't become your days off and you need your days off. So, I suppose it's the work life balance which is affected (P1).*

Professional Accountability

This theme relates to having a strong professional foundation regarding CPD, its clinical and personal benefits but also issues around the professional expectations. It included subthemes of, benefit the service user, remain up to date, improve the profession, self-reflection, role relevant, CPD as job role, and CPD standards, expectations, and audit.

Fundamental to this was the importance of CPD improving the self and benefiting the service user.

> *So, I think it is taking any platform of information where you're benefiting your practice and subsequently benefiting um the - the service user or patient (P6).*

Paramedics appear to be invested in evidence-based practice to remain up to date more than ever and do this to ensure contemporary practice,

> *my obligation as a paramedic to, to stay current is first and foremost (P1).*

Paramedics have a strong sense of professional pride. The landscape of professionalism within the paramedic profession has changed over the last decade and paramedics feel at the forefront of being able to improve the profession.

> *people would then have these little areas of expertise which will then drive the profession forward (P1).*

Paramedics, when undertaking self-reflection regarding CPD activities, had three specific areas they wanted to focus on. These were areas of interest, areas of weakness, and clinical self-improvement.

> *I think the ones that you have an interest in are certainly more positive and I think that's just human nature. It's if you're doing something you've got an interest in, you're gonna take more from it, well, you're gonna enjoy it more, should I say, maybe take more from it (P1).*

Opposite to this are areas of practice that leave paramedics feeling anxious, vulnerable, and unprepared meaning CPD can be utilised in an attempt to reduce these feelings,

> *more the sort of trauma work. We don't seem to get that much, so trauma courses are quite decent things to be doing because of the lack of exposure that we seem to be getting. So, the more experience we have, obviously the more competent and confident you're going to be when you're – when you're attending (P2).*

All participants were keen that any CPD they participated in had role relevance.

> *I think if I can see the relevance, and if I can see - see that it's going to directly make me better at my job, then I'm all for it, (P4).*

Some participants picked up on the idea that CPD within the job role can occur naturally, but it is about realising this and making the most of it.

> *as far as my urgent care stuff, because I have to complete it with both, but hopefully there'll be - there's bits I can cross-reference with all three different areas of my work (P5).*

CPD standards, expectations, and audit encompassed negativity towards the requirements of CPD. This subtheme was comprised of areas including, lack of knowledge of CPD standards, fear of audit, unsure what counts as CPD and there being a vast amount to cover.

> *Sure. I'm aware there are standards. [Laughs]. Yeah. Um, so yes, I am aware of the fact that it is a requirement, I'm - I would say I'm vaguely aware of what they're looking for, um, but I'm not confident that, you know, if I - if I - if I - if I couldn't have a look, I wouldn't be confident that I'd know exactly what to document, how they want it, and what sorts of things they're after and how to kind of justify its position within my CPD portfolio. So, I'm aware of it, but not in the detail that I need in order to, you know, answer any audits that come my way (P4).*

Employer Investment and Support

Referring to paramedic's feelings and experiences about how their employers view and support CPD for individuals, it comprised sub-themes of culture, employer provision/lack of, funding, and time.

Paramedics believed employers who invest in their development more would reap the benefits in improved job satisfaction, patient care, and retention. Culture was key to this with a belief that investment leads to investment.

> *if you're not investing and you're kind of then creating an environment where, why do people want to invest in themselves, if that makes sense, and they might just do the bare minimum or maybe not much at all towards their CPD portfolio (P1).*

It was acknowledged there was both employer provision/lack of but overall employees want employers to do more,

> *Um, and, I guess, CPD is probably also training that you put on for work as well, um, either offered or mandatory training, er, courses, reading, that kind of thing (P4).*

> *I feel, there, there, there should be more opportunities from the employer. They should offer more opportunities (P1).*

Funding was seen as an area for improvement because costs can be prohibitive for individuals or funding is not available,

> *maybe I had to fund a few bits because, erm, funding was difficult to obtain for certain areas because it may have not been beneficial for the organisation to do it, or it just wasn't available at the time (P1).*

Time was key as CPD is generally conducted in personal time and there are no protected criteria for paramedics compared to other AHPs.

we're probably a little bit behind the curve in terms of professional development time (P3).

DISCUSSION

This is the first qualitative study in the UK exploring paramedics' experiences and attitudes towards CPD.

The majority of themes and subthemes have been identified within healthcare research previously (Bryant et al., 2023; Gould et al., 2007; Haywood et al., 2012; Hobbs et al., 2021; Knox et al., 2015; Vazquez-Calatayud et al., 2021; Walter & Terry, 2021; Williams & Edlington, 2019).

The Covid-19 pandemic did effect professionals' ability to engage with CPD activities but it was still their responsibility to engage and develop despite regulators relaxing their requirements (Mack & Filipe, 2021). The Covid-19 theme is likely due to its contemporary nature and time this research was conducted. It appears to have had an effect on how paramedics engaged with their CPD and has probably started or at least brought forward the increased use of technological innovation for CPD offerings (Mack & Filipe, 2021). Exactly what these are, the benefits and barriers (Knox et al., 2015), what could be considered the 'new norm', and the Covid-19 pandemic's overall influence and relationship to CPD requires studying now its impact has subsided. Though this research does not pertain to do that it does highlight that paramedics had to adapt their CPD practices and a quantifiable link between the effects of Covid-19 and paramedic CPD engagement has occurred. While CPD offerings have developed or changed because of the Covid-19 pandemic, providers still need to be aware of providing inclusive activities whilst acknowledging a blended approach between the use of technology and practical application has been seen as motivating and engaging, (Knox et al., 2015; Mack & Filipe, 2021) especially considering the practical nature of the paramedic role. Rowland et al (2021) summarises for individuals and CPD providers to learn from this period and develop how CPD is delivered in the future so as not to lose the insights gained.

The paramedic profession has historically attracted those who have preferences for physical and practical work (Wood, 2012). This study does not change that belief despite the recent increase in academic entry to the profession. As academic requirements grow it must be acknowledged the role of a paramedic is practical in nature and CPD must continually consider how it caters to different learning styles and preferences. Students within medical professions are multimodal in their approach to learning (Busan, 2014; Samarakoon et al., 2013), with practical elements encouraged due to their benefits and improved abilities to maintain attention spans (Campbell, 2014).

Paramedics generally wanted to be involved in group activities involving peers and stakeholders, ensuring activities cover a variety of learning styles to benefit the majority. This has already been seen (Knox et al., 2015; Williams & Edlington, 2019) and could be related to rarely working in solitude, being comfortable around peers and wanting to learn from others they work alongside. As healthcare becomes more collaborative in nature developing interprofessional CPD that changes the focus from individual profession learning to one of improved understanding and appreciation of different roles could prove beneficial for healthcare professionals and patients (Sargeant et al., 2018).

There was total agreement that CPD requirements are a personal responsibility of a paramedic. Hobbs et al (2021) found this linked to higher levels of professionalism but this was in contrast to another Australian study (Williams & Edlington, 2019) who found paramedics believed CPD provision and engagement was an employer responsibility. The later study was conducted prior to professional registration within Australia, whereas the former and this study reviewed a mature registration process in the UK, occurring since Australian registration has begun, which may account for the differences in attitudes seen.

Paramedics were overwhelming in their consensus that CPD was a personal responsibility, but support (especially from employers) as also reported by Hobbs et al (2021), was required to lessen the commitment. Historic ambulance education and CPD has had a negativity surrounding it; especially in terms of statutory and mandatory requirements over clinically relevant activities (Gent, 2016; Williams & Edlington, 2019) and the need to rely on more than clinical exposure alone (Gent, 2016). This has potentially led to an attitude of self-preservation within the profession to remain current in clinical practice and knowledge bases but also to guarantee the meeting of professional standards.

The relatively open guidelines for paramedics issued by the HCPC regarding CPD requirements may account for the proactive attitudes seen within this study. HCPC registrants have asked for specific minimum requirements to work towards to increase the rigor of the standards but also to reduce anxiety around them (Silversides, 2015). This is in contrast to Illing et al (2017) who found nearly all of the HCPC registrants studied understood 'well' or 'completely' each of the HCPC CPD standards. There appears to be something of a paradox within the profession and its relationship to its CPD standards, they cause anxiety yet very few paramedics fail their CPD audit overall. There is not likely to be a change from the HCPC based on these statistics especially as their standards for paramedics leave options open for self-reflection based on what individuals feel they need and how long they require for their CPD (Illing et al., 2017; Silversides, 2015) even if improved guidance is wanted. In providing minimum requirements paramedics may see CPD holistically as a tick box exercise with this attitude towards CPD seen as demotivating (Hobbs et al., 2021; Knox et al., 2014, Knox et al., 2015, Williams and Edlington, 2019) and stifling personal preferences and engagement. Though the opposite may also be true with a model of minimum requirements being successful for other healthcare registration bodies in the UK and paramedic registration bodies abroad. A proposed model of competence based CPD taking account of evolving job roles based in the workplace environment (Sargeant et al., 2018) which has additional support (Gould et al., 2007), could harness an individual's ability to self-reflect on their practice, explore their CPD requirements, align this to their practice, and assess the impact. This will move individuals away from completing CPD to show participation to a place where the impact of learning can be seen and evaluated in real terms. This process would cover the HCPC (HCPC, 2021b) expectations and provide more individualised guidance as to the requirements for CPD engagement.

LIMITATIONS

The piloted interview protocol was conducted internally only and designed by the authors, with adaptation throughout the early phases of data collection to make it as valid as possible (Howitt, 2020).

The participants knowing the researcher may have created an environment where socially desirable answers were given. Interpretation of the data was solely conducted by the lead author, meaning no investigator triangulation took place, opening the data analysis to observer bias (Flick, 2018).

The sample was of a small, homogenous group, and a wider spectrum of employers may have led to additional results, whilst the voice of employers, the HCPC and CPD providers has not been captured which may have triangulated the data further and offered differing views on the results found. It would have also allowed for a more balanced set of results.

Interviews were transcribed by a professional third party rather than the authors due to resource constraints. Though closeness to the data was achieved through repeated listening to the audio recordings and rereading of the transcripts (Wilson, 2014).

The reflexivity of this study was respected throughout considering the closeness of the lead author to the participants. It has meant an IPA methodology was appropriate given its axiology, with the inability of the author to detach from their influences (Gill, 2020), how interpretations of interpretations can be affected (Tuohy et al., 2013), and the lead authors position always acknowledged (Underwood et al., 2010).

CONCLUSIONS

It can be seen how CPD is a complex topic combining personal, professional, and employer requirements with the experiences and attitudes towards CPD that are individual to each paramedic but align with those seen with other AHPs, though novel ones have presented themselves. Albeit one of these (Covid-19) is likely to have also caused disruption within other AHPs CPD endeavours too but the overall impact of this requires additional focus. Though it has likely changed how providers and participants of CPD approach their requirements now and in the future. The majority of experiences and attitudes towards CPD are positive and support the constructive expectations of why CPD exists. Though paramedics would like a more structured and integrated collaboration between the profession, employers, regulators, and CPD providers to ensure greater understanding of the professional requirements whilst being provided with more focused and wide-ranging selections of CPD activities whilst not negating the kinaesthetic nature of the profession.

ETHICS

At the point of conducting this study The Health Research Authority (HRA), due to the Covid-19 pandemic, withdrew their application processes for students undertaking research within the NHS for academic qualification purposes. Utilising their guidance and toolkit (HRA, 2021) a recruitment strategy using personal contacts and social media was employed. Data collection was conducted outside of NHS time and premises, meaning HRA approval for this project was not required. Ethical approval was sought through and provided by the University of Cumbria. The research was conducted according to the principles of the Declaration of Helsinki

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RESEARCH REPORTS

HELICOPTER EMERGENCY MEDICAL SERVICES (HEMS) TRANSPORTATION UTILIZATION FOR ACUTE ISCHEMIC STROKES AT A COMPREHENSIVE STROKE CENTER IN SOUTH FLORIDA

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ABSTRACT

Background: A comprehensive stroke center (CSC) servicing remote areas in South Florida became HEMS direct-from-field capable on October 15, 2020. This analysis reviews the utilization of this service and compares it to ground EMS (GEMS).

Methods: This is a retrospective cohort study from October 15, 2020, to July 31, 2021, that collected HEMS adult stroke alert data and compared it to the prior year's summary GEMS stroke alert data. Using HEMS transportation logs, presenting stroke symptoms and prehospital assessment were abstracted, in addition to initial NIHSS, downgrade rate, stroke diagnosis percentage, treatment rate, and times.

Results: The analysis included a total of 52 direct transport HEMS stroke alerts. Assessment tools utilized by HEMS included the Cincinnati stroke scale (4%) and the FAST-ED (37%); most cases (59%) did not document a stroke assessment tool. The median NIHSS was 10, with 37% presenting a score <6. Cases were downgraded upon arrival in 27% and after CT imaging in 15% of cases. Significantly ($p<.001$), more HEMS cases were diagnosed as stroke (69%) compared to GEMS (57%). Stroke treatment rates remained similar (HEMS=23%; GEMS=24%). Median door-to-needle times were significantly faster for HEMS (15 min) than GEMS (25 min) ($p<.05$). Median door-to-puncture times were clinically faster for HEMS (61mins) than GEMS (66 mins).

Conclusion: Prehospital triage could be improved to better detect the 77% of patients who are not eligible for acute stroke reperfusion treatments and may benefit from ground as opposed to from the field air transportation. The current HEMS triage, although not consistently documented, appropriately selects stroke victims, but not necessarily those who need air transport to a higher care level. Patients arriving via HEMS receive similar access to stroke treatment and, if treated, significantly faster treatment times.

INTRODUCTION

In prior studies, the use of HEMS (Helicopter Emergency Medical Services) has been shown to improve patient outcomes. Still, there is concern about the overuse of HEMS in minimally in-

jured and/or acutely affected patients (Vercruysse et al., 2015). Professional associations have published guidelines to aid in the health care provider's decision on whether to use helicopter transport (Lenz et al., 2018). However, whether these guidelines are implemented correctly and accordingly could explain the discrepancy in patients who are inappropriately transferred to high-acuity hospitals. A retrospective study reviewed patients who were airlifted and cross-referenced the guidelines used by air transport with the recently published guidelines to determine if the correct criteria were met before airlifting each patient (Lenz et al., 2018). Results found that compliance with recommended policies varied from 50 to 85%, depending on which criteria were utilized (Lenz et al., 2018).

Over-triage of patients who are ineligible for acute stroke reperfusion therapies by HEMS places patients and clinicians at unnecessary risk (i.e., flight hazards, weather conditions, mechanical malfunction) and contributes to the waste of health care resources. The benefits of this transport modality must be weighed against the risks to patients and health care providers as well as the costs to the health care system and communities (Adcock et al., 2020). These studies highlight the need for additional research to find the appropriate balance between cost-effectiveness and appropriate stroke triage. This is especially important where resources are limited and may interfere with availability for other high-severity cases.

Our institution gained HEMS direct-from-field capability on October 15, 2020, prompting the inquisition of appropriate helipad processes and protocols related to acute stroke intervention. Using a retrospective study, we chose to review the differences between the two modes of transportation, ground versus air, with the aim of evaluating the correlation between triage severity (prehospital and hospital stroke assessments) and acute intervention (stroke treatment rate and times). Additionally, we compared the percentage of diagnosed stroke cases between the two categories (HEMS to ground emergency medical services (GEMS) cases). Lastly, for awareness and educational purposes, we tracked the prehospital stroke triage tool being used by our local public rescue organization.

METHODS

This retrospective study evaluated direct-from-field suspected stroke cases that arrived at our institution between October 15, 2020, to July 31, 2021 from a public rescue organization that provides ground and air transportation services to several communities within a set geographical location. Service dispatch, direct-from-field dispatch, and triage decision-making are guided by the rescue organization's protocols that are independent of the hospitals they serve. The HEMS serves rural regions in South Florida that lack certified primary stroke centers even though there are local hospitals with advanced imaging capabilities able to administer thrombolytics to acute ischemic stroke patients. Therefore, there are instances in which time-sensitive transfers by HEMS from these rural areas to a comprehensive stroke center (CSC) are required.

The inclusion criteria consisted of direct-from-field stroke alerts transported by HEMS. Those younger than 18 years and pregnant women were excluded from the study. The data was only collected from direct-to-field HEMS transportation logs (hospital-to-hospital HEMS transfers were excluded).

Variables included presenting stroke signs and symptoms (stroke alert status based on county protocols), the airlift location, the distance to the nearest stroke-certified hospital and community-based hospital facility (stroke-certified or not), and initial prehospital clinical and stroke assessment. This information was collected from the prehospital transportation logs. Airlift locations were grouped into general geographic locations for ease of calculating travel distance. Patient charts were reviewed for demographics such as age, sex, and ethnicity. Stroke assessments upon arrival were collected from the emergency department (ED) including the initial National Institute of Health Stroke Scale (NIHSS). Patient stroke priority was recorded upon arrival. Stroke priority 1 is given to those eligible for acute stroke reperfusion therapies such as thrombolytics or endovascular thrombectomy. Stroke priority 2 is given to those with acute stroke but deemed not eligible for such treatments. It was also noted if the patients were downgraded to priority 2 upon arrival or after CT imaging and patient disposition after arrival at the ED. Stroke priority was downgraded upon arrival if an individual was no longer deemed a candidate for acute stroke reperfusion therapies for any reason (i.e., being out of the treatment time window, hemorrhage found by CT, etc.).

Stroke treatment included the use of thrombolytics, mechanical reperfusion (MR), or both. Additional variables investigated include the date and time of the last known well and stroke treatment times. Diagnostic scores were collected including the Hunt and Hess Scale and intracranial hemorrhage (ICH) score in addition to any neurosurgical intervention performed (clipping, coiling, or drain). The final diagnoses were grouped into five categories transient ischemic attack (TIA), acute ischemic stroke (AIS), ICH, subarachnoid hemorrhage (SAH), and non-strokes. Final disposition and NIHSS upon discharge were also recorded. Special attention was given to factors that may help differentiate stroke, stroke mimics, and stroke treatment eligibility, as these factors may help improve EMS education and prevent over-triaging for stroke HEMS. This study was reviewed and approved by the local Institutional Review Board (BHSF1796419) with a full HIPPA waiver and full exemption from consent.

Statistical analysis

All HEMS data were compared to GEMS stroke summary data from 10/01/2020 to 07/31/2021 reported by the hospital (see Table 1). To enable comparisons and improve the study sample size, final diagnoses, and stroke treatment were consolidated into two categories--coded as stroke diagnoses (TIA, AIS, ICH, SAH) or non-stroke diagnoses (stroke mimics) and received stroke treatment (alteplase

Characteristics	HEMS N=52	GEMS N=501	P-Value
Stroke Type % (N)			
AIS	46.2 (24)	42.7 (214)	.36
ICH	15.4 (8)	7.2 (36)	<.05*
SAH	1.9 (1)	3.6 (18)	.39
TIA	5.8 (3)	3.2 (16)	.25
Coded Stroke	69.2 (36)	56.7 (284)	<.05*
Treatment % (N)			
Neurosurgery	1.9 (1)	2.4 (12)	0.25
Thrombolysis	11.5 (6)	17 (85)	<.05
MR	17.3 (9)	12.8 (64)	<.05*
Thrombolysis & MR	5.8 (3)	4.9 (25)	0.77
Stroke treatment	24 (12)	25 (125)	0.75
Metrics			
Door to Needle, M (IQR)	15 (7)	25 (5.75)	<.05*
Door to Puncture, M (IQR)	61 (17.5)	66 (17.5)	0.26

Note: HEMS= helicopter emergency medical support; GEMS= ground emergency medical support; AIS = acute ischemic stroke; ICH = intracranial hemorrhage; SAH = subarachnoid hemorrhage; TIA = transient ischemic attack; MR = mechanical reperfusion, Stroke treatment = all subjects treated with a stroke intervention; M = median; IQR = interquartile range; * = statistical significance.

Table 1. Characteristics for HEMS sample compared to GEMS summary reported data.

or mechanical reperfusion; for this analysis, neurosurgical interventions were not considered stroke treatment) or no stroke treatment. Nonparametric single-sample chi-square tests, using the GEMS data as the hypothesized test value, were used to assess categorical variable significance. Whereas one-sample Wilcoxon Signed Rank tests, using the GEMS data as the hypothesized test value, were used to assess continuous variable significance. Statistical evaluations were performed using SPSS (v27) at the 0.05 significance level. Sample descriptions were provided for the original and consolidated HEMS variables.

RESULTS

Demographics

HEMS transported 52 patients to a community-based CSC hospital in South Florida between October 15, 2020, to July 31, 2021, from five rural areas in South Florida. The cohort comprised 31 (59.6%) males and 21 (40.4%) females. Race and ethnicity percentages were: 63.5% White (n=33), 3.8% Black (n=2), 23.1% White Hispanic (n=12), 1.9% Black Hispanic (n=1), and 7.7% Other (n=4), which are consistent with the rural population and differs from the predominantly Hispanic population within the hospital's major metropolitan area. The average age was 68.13 (SD, range 24-90), and the average length of stay was 11.21 (SD, range 1-87).

All patients were last known to be well within the 24-hour time range required for endovascular treatment. Thirty-nine (75%) subjects were last known to be well within the 4.5-hour time range, whereas 12 (23.1%) fell outside this time window; one (1.9%) subject was missing this information. Most patients were diagnosed with AIS (46.2% n=24), followed by ICH (15.4% n=8), SAH (1.9 % n=1), and TIA (5.8% n=3). The remaining subjects did not receive a primary stroke diagnosis (30.8% n=16). Overall, 69.2% (n=36) received a stroke diagnosis with 21.2% (n=11) considered large vessel occlusions. Of the HEMS arrivals, 13 received acute intervention including neurosurgical coiling (n=1), thrombolysis (n=6), MR (n=9), and thrombolysis and MR (n=3). The remaining cases (75%; n=39) were medically managed and did not receive neurosurgical intervention.

Transport Distance

Subjects arrived from five rural locations with an average distance traveled of 70.2 miles (SD=15; range 16.6-101). Two of the five transportation sites are located more than 100 miles from the closest comprehensive center and accounted for 44% (n= 23) of the sample. Conversely, the closest transportation site (16.5 miles) accounted for 29% (n=15) of the sample. The closest site had the option to select either ground or airlift for transportation. The remaining two sites are respectively 79 miles and 37 miles from the closest comprehensive center and accounted for 27% (n=14) of the sample. When considering the average distance to an advanced imaging capable hospital that can also administer thrombolytics (not a certified stroke center), approximately, 64% (n=33) were within 21 miles, 7% (n=4) were within 11.5 miles, and 29% (n=15) were within 3.5 miles.

Prehospital Assessment Tools

The assessment tools utilized by HEMS included the Cincinnati stroke scale (3.8 % n=2) and the Field Assessment Stroke Triage for Emergency Destination (FAST-ED) (36.5%

n=19). The remaining subjects (59% n=31) lacked prehospital assessment documentation. The median initial NIHSS was 10, with 37% presenting with an NIHSS score <6. Downgrade upon arrival was 27% of cases and downgrade after CT imaging was 15% of cases. Forty-one (78.8%) subjects underwent a full stroke work-up. Significantly, more HEMS cases were diagnosed as a stroke (69%) compared to GEMS (57%) ($p<.05$, $2=3.57$). However, stroke treatment rates remained similar between HEMS (23%) and GEMS (24%). The observed median door-to-needle times were significantly faster for HEMS (15min) than GEMS (25min) ($p<.05$, $W=-2.0$). Median door-to-puncture times were clinically faster for HEMS (61mins) compared GEMS (66 mins), but this improvement did not meet statistical significance ($p=.26$, $W=-1.13$).

DISCUSSION

This study investigated direct-from-field HEMS usage, stroke treatment rates and times, and explored the assessment tools used by prehospital personnel serving a busy community CSC. Compared to GEMS, we found HEMS stroke transports to be associated with a high discharge diagnosis of stroke, similar treatment rates and faster acute stroke reperfusion therapies, for both thrombolytic and endovascular therapies. Unfortunately, more than of all transported cases did not qualify for acute stroke reperfusion therapies and could have likely benefitted from ground, rather than air transportation, highlighting an opportunity for triage improvement. Consistently implementing prehospital stroke assessment tools might help decrease the number of emergency air transports that would later be downgraded, thus allowing for an appropriate transfer modality to the correct health care facility. It is unclear if in this setting, additionally performing a prehospital brief telemedicine consultation with the receiving acute stroke treatment team would improve field triage. Of note, there is an opportunity to utilize local community advance imaging capable hospitals if LVO suspicion is low as 36% of transported patients were within 11.5 miles and all patients were within 21 miles from this facility. Brain imaging is critically valuable in the decision-making process on whether a higher level of stroke care is required.

Initial assessments are important for clinical decision-making. However, in our study we found that more than 50% of the patients brought in by HEMS had no documented prehospital assessment, making it difficult to ascertain appropriate triage and transportation selection. Efficiency in the transfer of patients with ischemic stroke amenable to acute reperfusion therapies is a vital factor in the patient's prognosis. EMS personnel should make these decisions using established prehospital assessment tools (Goyal et al., 2016; Regenhardt et al., 2018; Thomalla et al., 2018). Educating personnel on the importance of documenting the use of these prehospital scales will allow accurate compliance determination and process improvement initiatives to be made.

Notwithstanding these challenges, the current study reported that 75% of HEMS subjects arrived within the thrombolysis window, 11.5% underwent thrombolysis and 17.3% underwent MR, remaining consistent with GEMS. This finding aligns with a recent review that found that HEMS was not associated with higher MR treatment rates (Tal et al., 2021). Furthermore, a study by Hawk and colleagues reported that a 3-step EMS triage for AIS allowed for improved thrombolytic treatment times (Hawk et al., 2016). We found that most patients arrived within the thrombolytic treatment window and did have faster DTN and DTP times compared to their GEMS counterparts. Overall, these

results indicate our local HEMS triage efforts appear to be effective in detecting AIS victims but are less efficient at determining general eligibility for treatment. This suggests a potential benefit for either clinician input or a clinical decision-making algorithm prior to field HEMS. Limitations of this study included its single-center and retrospective design, small sample size, the absence of biomarkers (i.e. blood pressure, blood glucose, or heart rate) and the inconsistency of prehospital assessment documentation for stroke triage by HEMS. Future studies should focus on improving prehospital stroke triage tools to prevent unnecessary air transportation.

In conclusion, we found field HEMS to be associated with similar treatment rates, but faster treatment times, when compared to GEMS. Unfortunately, most field HEMS cases do not qualify for acute stroke reperfusion or neurosurgical interventions and may have been better triaged to GEMS to the closest local hospital for initial assessment.

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AN EXAMINATION OF THE DIFFERENCES IN ACCURACY BETWEEN PARAMEDICS AND EMERGENCY MEDICAL TECHNICIANS (EMTS) IN IDENTIFYING LOW-ACUITY PEDIATRIC PATIENTS

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ABSTRACT

Background: Alternative emergency medical services (EMS) disposition programs have been developed for adults with low-acuity complaints. One barrier to including children in such programs is a lack of evidence regarding whether paramedics and emergency medical technicians (EMTs) can accurately identify children with low-acuity complaints. Our primary objective was to compare the accuracy of EMTs to that of paramedics in identifying low-acuity pediatric encounters. Our secondary objective was to determine whether support for alternative EMS dispositions differed between paramedics and EMTs.

Methods: This was a planned secondary analysis of a cross-sectional study of children transported by EMS to an emergency department (ED). Acuity was defined using a composite measure that included physiological patient assessments, resources used (including laboratory tests and radiographs), and patient disposition. EMS clinicians rated on a Likert scale their level of agreement that a patient had a low-acuity problem and could have been transported by private vehicle, seen in clinic, or not transported. The sensitivity, specificity, and positive and negative predictive values (PPV and NPV) for paramedic and EMT acuity assessments were calculated.

Results: EMS surveys were completed for 84.0% of 996 participants (76.4% by EMTs, 22.6% by paramedics). 35.1% of participants were classified as having a low-acuity complaint. The sensitivity for identifying a child as low-acuity was 24% (95% CI 20%, 38%) for paramedics and 50% (46%, 54%) for EMTs. The PPV for identifying a child as low-acuity was 0.44 (0.28, 0.60) for paramedics and 0.62 (0.55, 0.68) for EMTs. Only 20.5% of paramedics and 22.5% of EMTs supported non-transport for children with low-acuity complaints.

Conclusions: Relying on EMS assessments of pediatric patient acuity may lead to under-triage, regardless of whether a paramedic or EMT makes this determination. Additional training and triage tools may be required before children can be safely included in alternative EMS disposition programs.

BACKGROUND

Of the 1.6 million children who seek help from emergency medical services (EMS) in the US each year (Duong et al., 2018), up to 50% have low-acuity complaints that do not require emergent medical interventions (Patterson et al., 2006; Ward, Badolato, et al., 2022). EMS activations for children with low-acuity complaints can result in unnecessary transports (Ward, Badolato, et al., 2022), increased healthcare costs (Alpert et al., 2013), and longer wait times for more critical patients(Mell et al., 2017) and can contribute to Emergency Department (ED) crowding (Derlet & Richards, 2000).

Alternative EMS disposition programs have been developed over the last 20 years for patients with low-acuity complaints (Millin et al., 2011). These programs include substituting taxis for ambulances, transporting patients to primary or urgent care clinics rather than the ED, and treating patients in place without transport (Jensen et al., 2015; Kamper et al., 2001; Millin et al., 2011). The novel coronavirus (COVID-19) pandemic increased the need for such programs. Many EMS agencies suffered critical workforce shortages (Satty et al., 2021), and patients were concerned about exposure to COVID-19 in healthcare settings (Ward et al., 2023). The federal government has also encouraged innovation in this area with the recent Emergency Triage, Treat, and Transport (ET3) program (Goldman et al., 2020).

Most alternative EMS disposition programs have not included children. In order to safely include children in these programs, it is essential that EMS clinicians accurately identify children with low-acuity complaints without missing patients with emergent illness or injuries, or at risk of rapid deterioration. Diagnostic accuracy in children can be particularly challenging as many are non-verbal and may not have a caregiver present. Furthermore, many EMS clinicians have limited pediatric training and exposure. (Hansen et al., 2015; Jeruzal et al., 2019; Rahman et al., 2015; Zaritsky, 1994) Little is known about whether EMS clinicians can accurately determine medical necessity for pediatric patients (Millin et al., 2011). Previous studies analyzing the accuracy of pediatric acuity assessments by EMS clinicians have excluded emergency medical technicians (EMTs). (Kahalé et al., 2006; Seltzer et al., 2001) In our previous study, we compared the accuracy of EMS clinicians (grouping paramedics and EMTs), caregivers and ED staff in determining patient acuity. For EMS clinicians we found a sensitivity of 0.46, specificity of 0.74, positive predictive value (PPV) of 0.60, and negative predictive value (NPV) of 0.62. (Ward, Badolato, et al., 2022) EMS clinicians had similar accuracy to ED nurses and providers. However, EMTs were grouped with paramedics in analysis, which may have obscured differences between paramedics and EMTs. This is important because many jurisdictions rely heavily on EMTs (National Registry of Emergency Medical Technicians, 2023) and 27% of pediatric calls managed by EMTs result in non-transport (Ward et al., 2022). Our aim, therefore, was to determine whether there are significant differences in accuracy between paramedics and EMTs when assessing pediatric patient acuity.

OBJECTIVES

Our primary objective was to compare the accuracy of paramedics and EMTs in identifying pediatric patients with low-acuity complaints. Our hypothesis was that EMTs would be less accurate than paramedics in identifying low acuity conditions due to limited pediatric training and patient exposure. Our secondary objective was to determine wheth-

er paramedics and EMTs differed in their support for use of alternative EMS dispositions for children with low-acuity complaints. Our hypothesis was that EMTs would be less supportive of alternative dispositions.

METHODS

Study Design and Setting

This was a planned secondary analysis of a prospective observational study of children transported by EMS to a pediatric ED. (Ward, Badolato, et al., 2022) Most EMS transports came from two EMS agencies with two-tier infrastructure, including paramedics and EMTs (collectively described as 'EMS clinicians' in this analysis). Based on information provided from the 9-1-1 caller, paramedics, EMTs, or both may be dispatched to a call and make decisions about transport disposition. Both agencies are large, fire-based public access EMS systems serving predominantly urban and suburban areas. One agency is staffed entirely by career EMS clinicians; the other includes career and volunteer clinicians. Both agencies require demonstration of pediatric skills in simulated events or skills stations at least once a year. The study site ED receives the majority of pediatric transports and serves as the local pediatric trauma center for both agencies. The local Institutional Review Board approved this study (Pro00013740).

Participants

Inclusion criteria for enrollment were patients under 18 years old transported by EMS to the ED. Exclusion criteria were interfacility transports, patients with an Emergency Severity Index (ESI) score of 1 (requiring immediate life-saving interventions), (Gilboy et al., 2011) and caregivers with a preferred language other than English or Spanish. Caregivers, EMS, and ED clinicians for eligible participants were approached by research staff and asked to complete a brief survey. This secondary analysis focuses solely on the EMS clinician surveys. Participants were enrolled from August 2020 to September 2021 during enrollment windows (8 am - 11 pm on weekdays and 2 pm – 10 pm on weekends).

Data Collection

The data for this study were collected from participant surveys and the electronic health care records of enrolled children. Participants (including caregivers, EMS clinicians and ED staff) were asked to complete a survey on an electronic tablet device as soon as possible after ED arrival. Participants were provided with a survey preamble that described potential EMS alternative dispositions that have been developed for low acuity patients. They were then asked four questions about whether their child could be considered to have a low acuity condition and if it would have been acceptable for their child to be included in these alternative dispositions (Figure 3 and Figure 4). Participants rated on a 5-point Likert scale their level of agreement with each statement. These survey questions closely match survey items developed in a previously validated survey (Power et al., 2019), and were pilot tested to ensure face validity. EMS clinicians were asked to base responses on their clinical impression and not with reference to a specific protocol.

Research staff extracted additional data from the ED and EMS electronic health care records to determine ED resource use and disposition and any return visits within five days of the index EMS encounter.

Outcome Measures

In the absence of established criteria for classifying EMS patient acuity (Schmidt, 2004), we derived a novel outcome measure based on consensus findings from the Neely Conference: Developing Research Criteria to Define Medical Necessity in EMS (Cone, 2004a, 2004b; Mann, 2004). Our study definition of low-acuity, which was used as the reference standard, incorporated physiologic assessments, resources used, and patient disposition. We have previously published full details of how acuity was defined and the prevalence and characteristics of patients with low-acuity complaints (Ward et al., 2023). To be classified as low-acuity, patients needed stable vital signs; did not require any procedures or medications from EMS; did not require any radiographs, blood tests, IV medications, or procedures in the ED; and were discharged home with no return visits leading to admission within five days. EMS procedures included airway intervention, IV placement, and splint or cervical collar application. ED procedures included laceration repair, fracture reduction, and procedural sedation.

Data Analysis

EMS clinician surveys and data abstracted from patient medical charts were used as the data sources for our analyses. Descriptive statistics were generated to describe the cohorts of patients transported by paramedics and EMTs. EMS clinician survey responses were dichotomized by grouping "agree" and "strongly agree" as agreement and all other responses as disagreement. We then calculated and compared the sensitivity, specificity, positive and negative predictive values (PPV and NPV) for paramedic and EMT acuity assessments when compared against the study reference standard for low-acuity. We defined sensitivity and positive predictive value as the correct detection of low-acuity because of our objective of identifying the accuracy of EMS clinicians in identifying children with low-acuity complaints. Thus, in these analyses, specificity and negative predictive value are measures of the correct identification of patients with emergent, or high acuity, illness. When calculating the level of support from paramedics and EMTs for specific alternative EMS dispositions, analysis was restricted to participants with low-acuity complaints using the study definition. We considered differences in accuracy to be statistically significant when the 95% confidence interval around the point estimate of one group did not overlap with the point estimate of the other group. Differences in the proportion of EMTs and paramedics supporting alternative dispositions were based on chi square tests. We decided a priori to enroll 1,000 patients for the parent study to ensure we had sufficient power for the primary study objective, analyzing the prevalence and characteristics of low-acuity pediatric patient transports. Analyses were performed using SAS (SAS Institute, Inc, Cary, NC) (SAS/STAT 15.3 User's Guide, 2023).

RESULTS

We enrolled 996 children in the parent study. EMS clinicians completed surveys for 837 participants (84.0%). Most EMS surveys were completed by EMTs (640/837, 76.4%), and the remainder were completed by paramedics (189/837, 22.6%). EMS clinician type was missing on 8 surveys. The mean age of the entire patient cohort was 6.9 years (SD 5.5). 401/837 (47.9%) patients were female. The most common race and ethnicity responses were non-Hispanic Black (532/837, 63.6%) and non-Hispanic White (87/837, 10.4%). 65/837 (7.8%) of the patients required interpreters in the ED. The patients transported by

paramedics and EMTs differed in several respects (Table 1). The cohort transported by EMTs was younger and more likely to be non-Hispanic Black and publicly insured. As expected for two-tiered EMS agencies, EMTs were more likely to transport patients with low-acuity complaints both as measured by ESI triage level and by our study reference standard. For participants transported by EMTs, 40.3% were triaged as ESI levels 4 or 5, and 39.5% were low-acuity using the study definition. For participants transported by paramedics, 29.1% were triaged as ESI levels 4 or 5, and 20.6% were low-acuity using the study definition.

For the enrolled participants defined as having a low-acuity condition, paramedics agreed that 19/39 (48.7%) were low-acuity, and EMTs agreed that 158/253 were low-acuity (62.4%). The sensitivity for identifying children with a low-acuity complaint was significantly lower for paramedics than EMTs (24% [95% CI 20%,38%] vs. 50% [46%, 54%] respectively) (Table 2 and Figure 1). The specificity for identifying children with emergent medical needs (not low-acuity) was significantly higher for paramedics than EMTs (83% [78%, 87%] vs. 70% [66%, 74%], respectively). The PPV for identifying a child as low acuity was 0.44 (0.28, 0.60) for paramedics and 0.62 (0.55, 0.68) for EMTs. The NPV for identifying children with emergent medical needs (not low-acuity) was 0.71 (0.63, 0.78) for paramedics and 0.59 (0.54, 0.64) for EMTs (Figure 2).

We observed limited agreement from both paramedics and EMTs in supporting that alternative dispositions would have been appropriate for patients they were caring for, who met the study definition for a low-acuity condition (Table 3). For patients defined as having a low-acuity complaint, 35.9% of paramedics and 54.5% of EMTs agreed that substituting a taxi for an ambulance would have been appropriate. For these low-acuity patients, 56.4% of paramedics and 53.4% of EMTs agreed it would have been appropriate for the child to be seen in a primary care or urgent care clinic rather than the ED. Both paramedics and EMTs demonstrated little support for treatment in place and non-transport for children with low-acuity complaints (20.5% and 22.5% agreement, respectively).

DISCUSSION

In this prospective observational study, both paramedics and EMTs had limited accuracy when identifying low-acuity pediatric patients as defined by our composite measure. EMTs had a higher sensitivity than paramedics when identifying low-acuity pediatric patients and a lower specificity. We did not observe a statistically significant difference between the PPV and NPV of paramedics and EMTs. The differences observed in sensitivity and specificity between paramedics and EMTs may stem from differences in the patient cohorts transported by each group, or could be attributable to the different training requirements and pediatric exposure for paramedics and EMTs. (Hansen et al., 2015; Jeruzal et al., 2019; Rahman et al., 2015; Zaritsky, 1994) We were surprised to find EMTs had a higher sensitivity in identifying low-acuity patients. This may reflect the larger proportion of low-acuity patients they see, with paramedics erring on the side of transport if they were dispatched to the scene. Greater exposure to high-acuity pediatric patients may also explain why paramedics demonstrated a higher specificity, i.e. ability to detect sick children. The overall limited accuracy observed from both EMTs and paramedics may reflect limited exposure to pediatric calls. We were not able to measure pediatric exposure in this study.

	EMT cohort, n (%)	Paramedic cohort, n (%)	Total, n (%)
VARIABLE	N=640 (%)	N=189 (%)	N=837[a]
Age (years)			
< 1	88 (13.8)	13 (6.9)	102 (12.2)
1 - 3	188 (29.4)	66 (34.9)	257 (30.7)
4 - 6	93 (14.5)	18 (9.5)	111 (13.3)
7 - 12	136 (21.3)	55 (29.1)	192 (22.9)
13 - 18	135 (21.1)	37 (19.6)	175 (20.9)
Mean age (std)	6.8 (5.5)	7.2 (5.4)	6.9 (5.5)
Sex			
Male	334 (52.2)	98 (51.9)	436 (52.1)
Race			
Non-Hispanic Black	426 (66.6)	101 (53.4)	532 (63.6)
Non-Hispanic White	57 (8.9)	30 (15.9)	87 (10.4)
Hispanic	104 (16.3)	35 (18.5)	141 (16.8)
Other	43 (6.7)	22 (11.6)	66 (7.9)
Not Documented	10 (1.6)	1 (0.5)	11 (1.3)
Interpreter			
Yes	46 (7.2)	19 (10.1)	65 (7.8)
Insurance status			
Private insurance	109 (17.0)	49 (25.9)	158 (18.9)
Public	466 (72.8)	114 (60.3)	587 (70.1)
No insurance	35 (5.5)	12 (6.4)	48 (5.7)
Unknown	30 (4.7)	14 (7.4)	44 (5.3)
Date/time arrival			
Office Hours (Mon-Fri, 8 am – 5 pm)	460 (71.9)	130 (68.8)	533 (63.7)
Chief Complaint			
Behavioral/psychiatric	40 (6.3)	3 (1.6)	43 (5.1)
Neurologic	65 (10.2)	56 (29.6)	125 (14.9)
Gastrointestinal	48 (7.5)	9 (4.8)	57 (6.8)
Global/general	119 (18.6)	24 (12.7)	143 (17.1)
Musculoskeletal/skin	250 (39.1)	44 (23.3)	297 (35.5)
Pulmonary	88 (13.8)	36 (19.1)	125 (14.9)
Other	30 (4.7)	17 (9.0)	47 (5.6)
Injury			
Yes	260 (40.6)	49 (25.9)	311 (37.2)
Motor vehicle crash victim			
Yes	52 (8.1)	8 (4.2)	60 (7.2)
ESI triage level			
1/2	76 (11.9)	36 (19.1)	113 (13.5)
3	306 (47.8)	117 (61.9)	428 (51.1)
4	237 (37.0)	34 (18.0)	273 (32.6)
5	21 (3.3)	2 (1.1)	23 (2.7)
Low Acuity[b]			
Yes	253 (39.5)	39 (20.6)	294 (35.1)

[a] There were 8 EMS surveys with no clinician type, so the total of EMT and Paramedic cohorts is 829 instead of 837.

[b] As defined using the novel composite definition developed for this study.

Table 1. Characteristics of enrolled children transported to the emergency department (ED) by Emergency Medical Services (EMS), grouped by EMS clinician type.

	Sensitivity (95% CI)	Specificity (95% CI)	Positive Predictive Value (95% CI)	Negative Predictive Value (95% CI)
EMT (N=640)	50% (46%, 54%)	70% (66%, 74%)	0.62 (0.55, 0.68)	0.59 (0.54, 0.64)
Paramedic (N=189)	24% (20%, 38%)	83% (78%, 87%)	0.44 (0.28, 0.60)	0.71 (0.63, 0.78)
All EMS Clinicians (N=837)[a]	46% (43%, 50%)	74% (71%, 77%)	0.60 (0.54, 0.65)	0.62 (0.58, 0.67)
[a] There were 8 EMS surveys with no clinician type, so the total of EMT and Paramedic cohorts is 829 instead of 837.				

Table 2. Ability of Emergency Medical Services (EMS) clinicians to predict low-acuity pediatric patients.

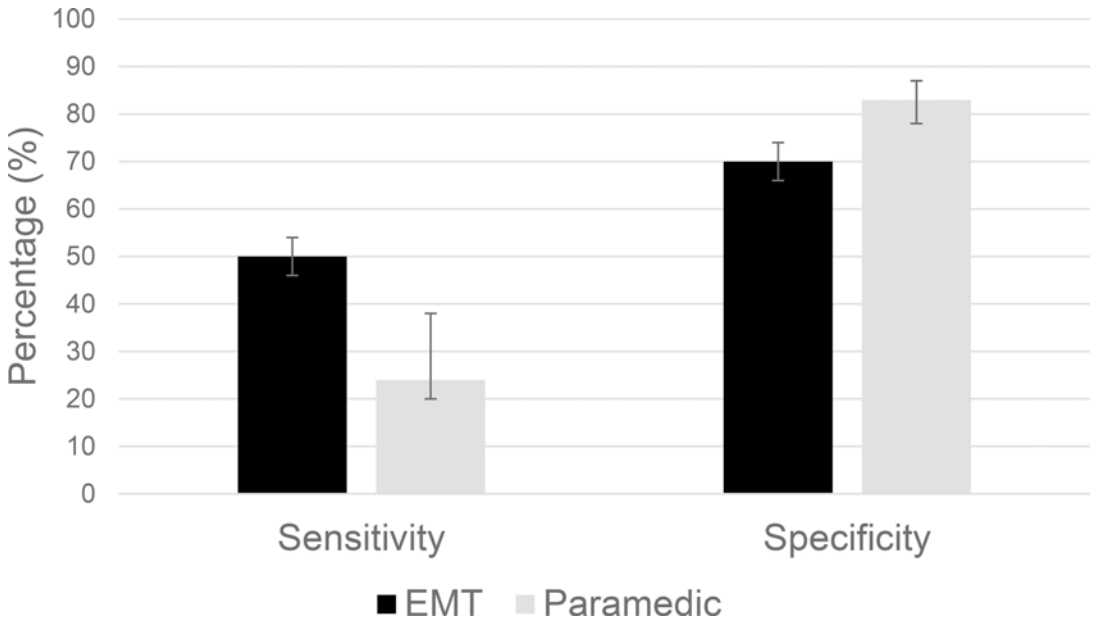

Figure 1. Sensitivity and specificity of EMTs and Paramedics for identifying children with a low-acuity condition. Error bars depict the 95% confidence intervals.

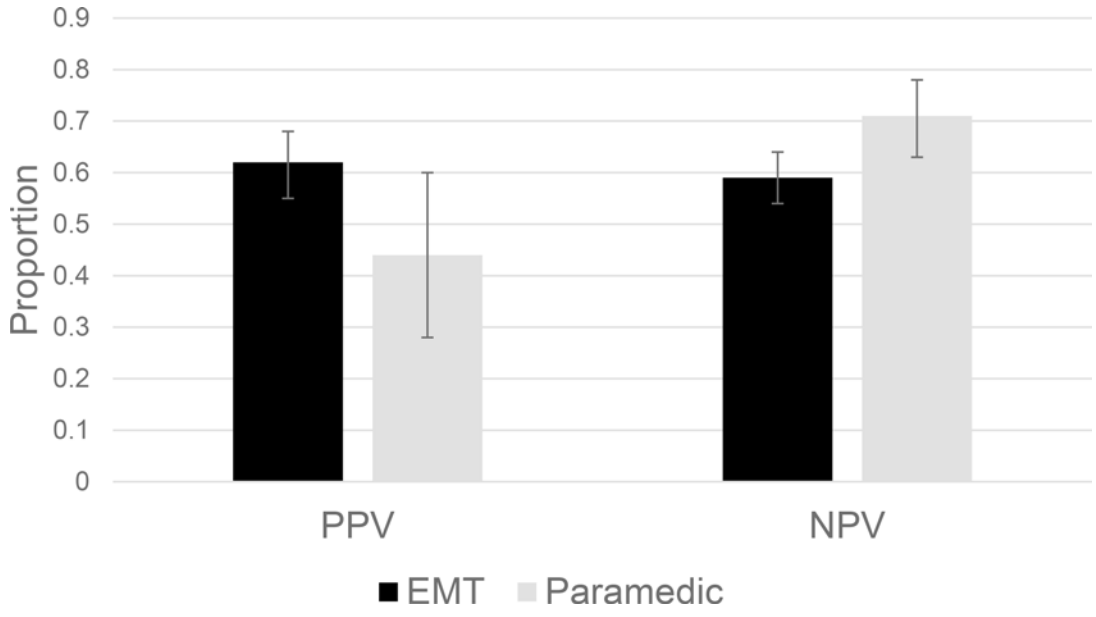

Figure 2. Positive and negative predictive values for EMTs and Paramedics when identifying a child as having a low-acuity condition. Error bars depict the 95% confidence intervals.

	EMT (N=253[a]) % Agreement	Paramedic (N=39[a]) % Agreement	Chi-Square Statistic	P-value
This child's complaint could be considered "low acuity."	62.4	48.7	2.7	0.102
It would have been acceptable for this child to be transported in a commercial ride-sharing service rather than an ambulance today.	54.5	35.9	4.7	0.030
It would have been acceptable for this child to be seen in a primary care clinic or urgent care clinic today rather than an ED.	53.4	56.4	0.13	0.722
It would have been acceptable for EMS to have assessed and treated this child today and left them at home.	22.5	20.5	0.1	0.778
[a] Number of participants transported by EMS who were classified as low-acuity using study composite definition				

Table 3. Agreement of Emergency Medical Services (EMS) clinicians for children with low-acuity complaints being managed by alternative EMS dispositions.

The PPVs observed in our study when EMS clinicians classified a child as low-acuity are lower than in previous studies. A previous meta-analysis found a predictive value of 0.91 (0.71, 0.98) for paramedic determination of patients not requiring transport and 0.68 (0.48, 0.83) for patients not needing ED evaluation. (Brown et al., 2009) There are several reasons we may have observed a lower PPV. First, most previous studies analyzing EMS acuity determinations have excluded children. EMS clinicians have limited pediatric training and less comfort managing children (Hansen et al., 2015; Jeruzal et al., 2019; Rahman et al., 2015; Zaritsky, 1994) and, therefore, may have lower accuracy when assessing acuity in children compared to adults. The only pediatric study in the meta-analysis reported a predictive value of 0.98 when identifying children with low-acuity complaints. (Haines et al., 2006) However, the reference standard was a physician assessment based solely on an EMS verbal report. Second, the reference standard used in our study for low-acuity may have excluded patients that other studies classified as low-acuity. For example, if a patient received a radiograph, we classified the encounter as not low-acuity regardless of whether any abnormalities were identified on the radiograph. Less conservative reference standards have been used in previous studies, including physician opinion (Haines et al., 2006; Pointer et al., 2001) and hospital admission status. (Levine et al., 2006; Price et al., 2005; Richards & Ferrall, 1999; Zachariah et al., 1992) Third, our study was restricted to children transported to the ED. Not including children managed on scene without transport may have resulted in spectrum bias and worse performance in identifying low-acuity children. Finally, our study included both paramedics and EMTs. While we observed some differences between these two groups, the PPV when identifying low-acuity encounters was not significantly different. This suggests that including EMTs in our study does not explain the lower PPV.

We observed limited support among both paramedics and EMTs for alternative EMS dispositions for children with low-acuity complaints. A narrow majority of EMTs agreed that transport to a clinic site (53.4%) or transport by taxi (54.5%) would have been acceptable for children who met the study criteria for low acuity. Paramedics showed a similar level of support for transport to clinic sites (56.4%) but a lower level of support for transport by taxi (35.9%). Both paramedics and EMTs demonstrated very little support for non-transport (20.5% and 22.5% respectively). These low levels of support are not surprising given that only 48.7% of paramedics and 62.4% of EMTs agreed that children defined by the study as low-acuity could be considered low-acuity. Previous studies have

found that EMS clinicians believe many of their patients do not require emergency ambulance transport to the ED. (Crowe et al., 2018, 2020; Ward, Singletary, et al., 2022) Most previous studies, however, have not assessed support for specific alternatives, and one recent study noted a lack of agreement among EMS clinicians about whether children should be included in such programs (Power et al., 2019). It is also important to note that decisions around the transport for children are not based solely on medical acuity, but also caregiver preferences and various social needs may need to be considered. EMS clinicians may be reluctant to recommend alternative dispositions if they believe caregivers will be opposed. (Ward, Singletary, et al., 2022)

To summarize, paramedics demonstrated significantly higher sensitivity when detecting high-acuity children, but lower specificity than EMTs. Both paramedics and EMTs collectively demonstrated low support for use of alternative dispositions, however paramedics demonstrated lower support for use of alternative means of transport.

There are several implications of our findings. First, relying on clinical impressions of acuity for non-transport decisions or alternative dispositions may be unsafe regardless of whether a paramedic or EMT makes this assessment. The lower limit of the 95% confidence interval for the NPV when identifying children as having emergent needs (not low-acuity) was 0.63 for paramedics and 0.54 for EMTs. This suggests that the under-triage for children could be as high as 37% and 46%, respectively. There is, however, no consensus on how under-triage should be defined, nor what an acceptable rate of under-triage would be. (Mann, 2004) The safety of EMS clinician acuity assessments is paramount, as one-third of all pediatric patients assessed by EMS are not transported from the scene. (Ward et al., 2022) There is a lack of validated pediatric non-transport protocols, so most of these non-transport decisions likely rely on the clinical gestalt of EMS clinicians and caregivers. Despite the high rate of non-transport for children, safety outcomes after pediatric non-transport in the US are poorly described. Most studies examining outcomes after pediatric non-transport have involved single EMS agencies enrolled in small total patient numbers and have low follow-up capture rates. (Haines et al., 2006; Seltzer et al., 2001) Our study suggests an urgent need to better understand patient outcomes after non-transport by EMS.

Second, our study suggests that the clinical gestalt of EMS clinicians (both paramedics and EMTs) may need to be enhanced with dedicated pediatric protocols and triage tools to identify children who can be safely managed through alternative dispositions. Existing EMS triage measures focus on identifying severely ill and injured patients, have low sensitivities, and perform poorly in children (Totten et al., 2018). EMS clinicians have noted there is a need for pediatric non-transport protocols that include clear endpoints, incorporate vital sign parameters, and can be integrated into the electronic record. (Ward, Singletary, et al., 2022) Tools such as the Paediatric Observation Priority Score (POPS) have been pilot-tested in the prehospital setting with some success, (Morgan & Cutter, 2023) but further research is needed to validate their use in standard EMS protocols.

Third, pediatric alternative EMS disposition programs may be challenging to implement if EMS clinicians continue to show only modest support for these alternative management options. (Martin & O'Meara, 2019; O'Meara et al., 2015) Further qualitative research is needed to understand EMS clinician perspectives on pediatric non-transport. It will be important that any pediatric non-transport protocols and triage tools are developed

with paramedics and EMT input and assessed for acceptability and feasibility with these distinct groups of EMS clinicians.

Finally, our results highlight the need for comprehensive pediatric readiness in EMS agencies. The recently launched National Pediatric Prehospital Readiness Project (NPPRP) provides an opportunity for EMS agencies to assess pediatric readiness. The project is based on a combined policy statement addressing pediatric readiness in EMS systems issued by the American Academy of Pediatrics (AAP), American College of Emergency Physicians (ACEP), Emergency Nurses Association (ENA), National Association of EMS Physicians (NAEMSP) and National Association of Emergency Medical Technicians (NAEMTs) (Moore et al, 2020). The survey assesses readiness in several key domains including: education and competencies for providers, equipment and supplies, interactions with systems of care, coordination of pediatric emergency care, patient and family-centered care, patient and medication safety, policies, procedures and protocols, and quality improvement/performance improvement. On completing this survey, EMS agencies will be provided with benchmark data, a gap report and links to resources to improve readiness.

Limitations

This study has several limitations. First, this single-center study was conducted in an urban setting with two-tiered EMS agencies with robust pediatric skills verification programs. Care should be taken extrapolating findings beyond this setting. Second, this study compared EMS clinical impressions against a more objective composite reference standard for low-acuity. Although we observed limited accuracy for paramedics and EMTs, this does not mean that EMS clinicians cannot apply triage protocols with fidelity to triage patients accurately. Third, this study was conducted during the COVID-19 pandemic, which altered both call volume and call types for EMS. (Lerner et al., 2020; Satty et al., 2021) This may have impacted EMS clinicians' acuity assessments and levels of support for alternative EMS dispositions. Fourth, this study was restricted to children transported to the ED by EMS. Excluding non-transported children, most of whom have low-acuity complaints, (Ward et al., 2022) may bias our results. Finally, there are limitations related to our survey methodology. Participants were enrolled during windows when research staff were available. Although the overall demographics of the enrolled participants were similar to overall ED data, there may have been differences in the patients enrolled and EMS clinicians between these enrollment windows and overnight periods. Second, EMS clinicians were not blinded to interventions performed on the participants, which may have led to us overestimating accuracy in identifying low-acuity children. We minimized this impact by not sharing the study definition of low-acuity with EMS clinicians. In addition, when completing the study survey EMS clinicians may have been influenced by the clinical impressions of other EMS clinicians involved in patient care prior to transport.

CONCLUSIONS

This prospective observational study is the first to show that both paramedics and EMTs have low accuracy when identifying children with low-acuity complaints. This may result in both overtriage and undertriage of pediatric EMS calls. We also observed limited support from both paramedics and EMTs for including children in alternative EMS

dispositions programs, with less support from both paramedics and EMTs for treatment in place/non-transport when compared to transport to alternative locations and transport via alternative means. These findings suggest significant challenges to implementing pediatric alternative EMS disposition programs. There is an urgent need for further research to develop and validate non-transport protocols and triage tools for children with low-acuity conditions. Our findings suggest that such triage tools must be assessed for feasibility, reliability, and validity with paramedics and EMTs.

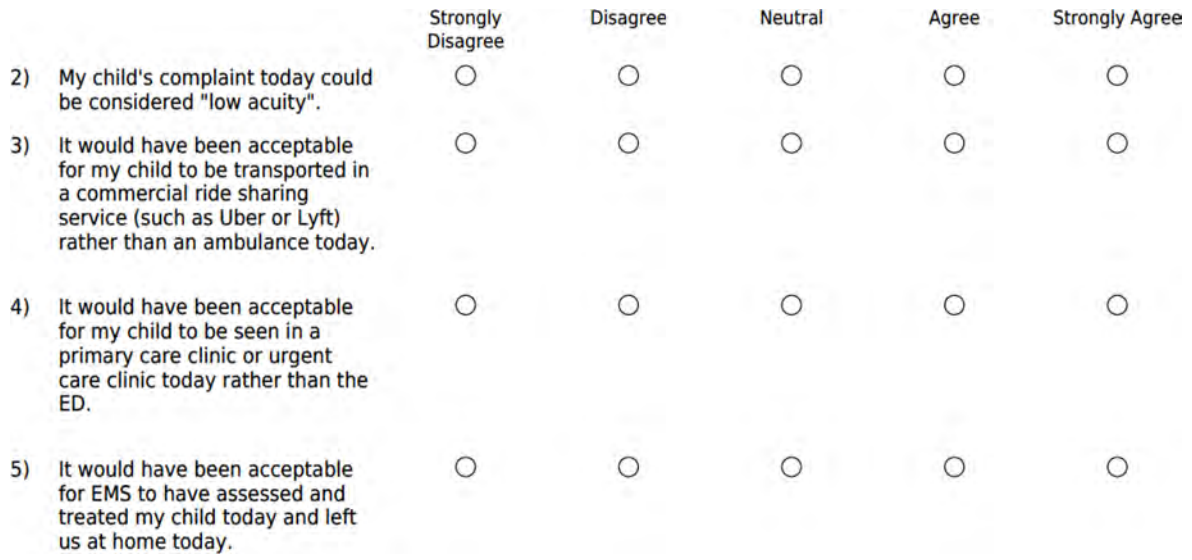

Figure 3. Survey questions administered to caregivers.

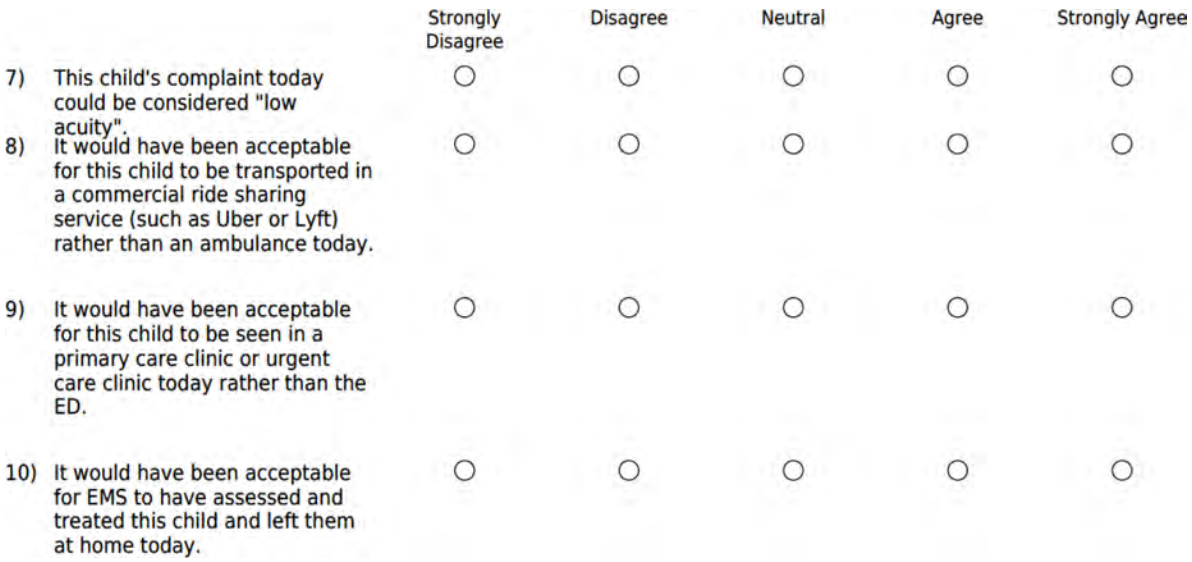

Figure 4. Survey questions administered to EMS clinicians.

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RESEARCH REPORTS

EMS CLINICIANS IN THE WEST TEXAS AREA FREQUENTLY ENCOUNTER FIREARMS DURING PATIENT ASSESSMENTS WITH LIMITED GUN SAFETY TRAINING

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ABSTRACT

Introduction: Firearms are commonly encountered in the prehospital setting, sometimes with devastating consequences. However, the frequency with which EMS workers find and handle firearms when evaluating patients in the field and the firearm safety training they have received remains largely unstudied.

Objectives: We sought to answer the following questions: 1) How frequently do EMS personnel in West Texas and Southern New Mexico USA encounter and handle firearms when caring for patients? 2) How many of these clinicians are aware of agency policy or have received agency training in the safe handling of firearms? 3) Do these clinicians support integrating firearm training into the EMS curriculum?

Methods: In this observational, cross-sectional study, a survey evaluating weapon and firearm encounters, confidence handling firearms, and formal firearms training was distributed to EMS providers in West Texas and Southern New Mexico between July 1, 2022, and January 1, 2023.

Results: Two hundred forty-seven out of a potential 609 EMS clinicians completed the online survey, representing a 41% response rate. Among respondents, 61% reported encountering firearms at least once per year. These firearms were handled by EMS personnel over a quarter of the time. Sixty-eight percent of prehospital providers were unaware of any agency policy regarding handling firearms. Despite broad personal experience with firearms, 90% of respondents received no agency training in gun safety. Eighty-seven percent of providers reported they would attend an agency training course on firearm safety, and 95% indicated that this topic should be added to the EMS curriculum.

Conclusion: EMS personnel in West Texas and Southern New Mexico routinely encounter and handle guns despite minimal agency firearm safety training. This initial study may demonstrate a potential need for introducing firearm safety didactics and training into the EMS curriculum, and the need for additional research.

INTRODUCTION

Firearm-related violence is a global public health issue that has claimed over 2.75 million lives in the last decade (Collaborators, 2020). In the United States specifically, firearm-related injury is the third leading cause of injury-related death overall and the

leading cause of death among those aged 1-19 years (Goldstick et al., 2022; Marczak et al., 2016; Reddy, 2016). There is a reported $2.8 billion worth of emergency department (ED) and inpatient charges spent on firearm-related injuries in the United States per year (Ketterer et al., 2019). Current data suggest that 35.3% of patients who present to the ED with an injury related to a firearm suffered those injuries unintentionally (Gani et al., 2017). Another study found that on a daily or weekly basis, guns or knives are introduced into 20% of emergency departments (EDs) in the United States (Kansagra et al., 2007). One survey identified that approximately 20% of attending physicians and 25% of resident physicians had encountered a firearm during their shift in the ED (Gani et al., 2017). Another investigation found that 5.6% of ED physicians experienced an assault involving a firearm or sharp object (Basak et al., 2017).

EMS personnel transport patients to the ED, often from high risk environments. The frequency of weapons encounters during these contacts is unknown. It is also unclear what policies or training may help enhance the safety of EMS personnel and patients when a weapon is unexpectedly encountered during patient care. We sought to answer the following questions: 1) How frequently do EMS personnel in West Texas and Southern New Mexico encounter and handle firearms when caring for patients? 2) How many of these clinicians are aware of an agency policy or have received agency training in the safe handling of firearms? 3) Do these clinicians support integrating firearm training into the EMS curriculum?

METHODS

A standardized questionnaire was developed for this observational, cross-sectional study to evaluate prehospital EMS weapon encounters using Research Electronic Data Capture (REDCap) (Appendix 1). The initial questionnaire underwent beta testing from a convenience sample of 6 EMS providers in west Texas, and a feedback form was used to collect the results. Changes to the initial survey were made, and the final survey was launched to gather feedback and acquire data for the study. A recruitment flyer with a QR code linking respondents to the questionnaire was delivered to a convenience sample of fire and EMS stations within El Paso, Texas, and the surrounding area, including Southern New Mexico, USA. All participants gave informed consent to participate in the research.

Study data were collected and managed using REDCap electronic data capture tools hosted at Texas Tech University of Health Sciences El Paso (Harris et al., 2019; Harris et al., 2009). REDCap is a secure, web-based software platform designed to support data capture for research studies, providing 1) an intuitive interface for validated data capture; 2) audit trails for tracking data manipulation and export procedures; 3) automated export procedures for seamless data downloads to common statistical packages; and 4) procedures for data integration and interoperability with external sources.

Public, private, and governmental EMS clinicians operating across professional and volunteer agencies were included. EMS practitioners from West Texas and Southern New Mexico who had previously worked in other states were also considered eligible for the study. Voluntary respondents were asked to answer questions regarding their encounters with weapons and patients. Data collection occurred between July 1, 2022, and January 1, 2023. The questionnaire was anonymous, with no identifiers.

Questions were asked about demographics, years of experience, location of weapon and firearm encounters, city size, visibility of the weapons, types of firearm encounters, comfort level in handling firearms, formal firearm training, and desire to add additional firearm training to EMS coursework (Appendix 1).

Data were compiled, and descriptive statistics of responses to these questions were tabulated. To visually display the frequency of weapon encounters among participants, the different types of weapon encounters, and the frequency with which EMS workers and non-EMS law enforcement removed firearms, figures of this data were created with Microsoft Excel. We also checked for any associations between participant characteristics or prior experience with firearms and interest in participating in EMS-based firearms training or support for integrating firearms safety into the EMS curriculum. Specifically, continuous variables were compared between groups using the Wilcoxon rank-sum test, and categorical variables were compared using the Fisher exact test with statistical significance set at an alpha level of <0.05. No attempt was made to impute missing data. Ethical approval for this study was secured from the Texas Tech University Health Sciences El Paso Institutional Review Board (approval number E22065).

RESULTS

Two hundred forty-seven EMS clinicians completed the survey out of a potential 609 respondents, representing a 41% completion rate. Respondents were 83% male, and mainly practiced in Texas (57%), and New Mexico (38%). The three major types of EMS involvement were through a professional fire department (53%), a private EMS agency (32%), and a volunteer fire department (6%). Personnel reported a range of EMS experience from 0-5 years (20%), 6-10 years (24%), to 30+ years (9%) (Table 1).

Characteristic	Number of Respondents n (%)*
Gender (N = 246)	
Male	204 (83%)
Female	38 (15%)
Prefer Not to Answer	4 (2%)
I currently work in the state of:† (N = 241)	
Texas	138 (56%)
New Mexico	92 (38%)
Arizona	6 (2%)
Other	5 (2%)
I am/was primarily involved in EMS through: (N = 247)	
Professional Fire Department	130 (53%)
Private EMS Agency	79 (32%)
Volunteer Fire Department	14 (6%)
DHS (Federal Law Enforcement, USBP, Coast Guard)	9 (4%)
Government EMS Agency	6 (2%)
Department of Defense (Active or Reserve)	2 (1%)
Local Law Enforcement (Police, Sheriff)	2 (1%)
Tribal	2 (1%)
Other	3 (1%)
How many years have you been involved in EMS for?‡ (N = 247)	
0-5	50 (20%)
6-10	58 (24%)
11-20	72 (29%)
21-29	45 (18%)
30+	22 (9%)

DHS = Department of Homeland Security; USBP = United States Border Patrol. All questions and statements are presented exactly as they appeared in the survey. All potential responses with any ancillary information are also shown unless otherwise specified.

*There were 247 participants in total. Categories with sample sizes less than 247 indicate that the remaining participants left the question blank. Percentages may not add to 100 due to rounding error.

†Respondents could answer with any US state. Subjects who reported currently working in states other than Texas and New Mexico belonged to EMS stations in these two states but were assigned to work in different locations at the time of the survey.

‡Answer choices included less than 1 year any numerical integer between 1-29 years, and 30 or greater years.

Table 1. Demographic characteristics of survey respondents.

Sixty-one percent of respondents reported encountering firearms at least once per year. By comparison, non-firearm weapons were encountered at least once per year by 86% of respondents (Figure 1).

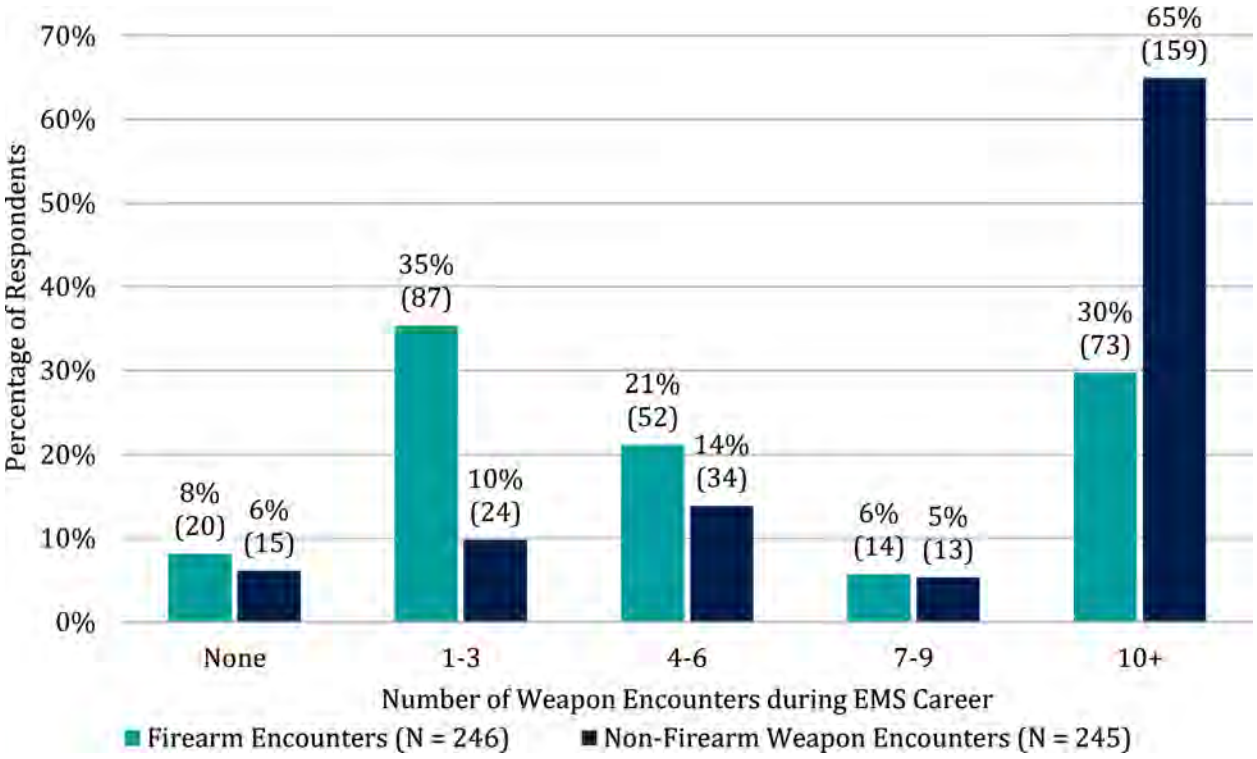

Figure 1. Frequency of firearm and non-firearm weapon encounters for EMS personnel over career.

Firearm encounters most often took place in Texas (52%), New Mexico (37%), and Arizona (3%). The Arizona encounters represent 8 encounters documented by the Department of Homeland Security United States Border Protection EMS clinicians. Practitioners found these weapons primarily in large cities (46%), and they were either openly visible (50%), or hidden and only discovered during assessment and treatment (41%). Handguns were found most frequently (59%), though rifles (17%), shotguns (16%), and military-style weapons (7%) were also reported (Table 2).

Among all weapon encounters over the last year of active service, knives (38%), firearms (25%), and blunt striking weapons (23%), were found most often (Figure 2).

Some groups include more than 247 as a total denominator due to multiple participant responses. Firearms were removed by EMS clinicians, a mean of 28% (standard deviation [SD]: 25%) of the time, and by law enforcement, a mean of 65% (SD: 30%) of the time (Figure 3).

EMS clinicians were asked if they knew the caliber of the firearm encountered, and 218 responses were documented; 62 respondents knew the caliber, 51 answered they knew the caliber "sometimes" and 105 did not know. When reporting if they knew the type of firearm encountered, 113 respondents reported the caliber or the specific firearm type/make, and 105 did not know (N=218). The most common caliber reported were

54 encounters with a 9 mm caliber firearm, followed by 24 encounters with a .45 automatic Colt pistol (ACP) (11.43x23mm) caliber. There were 13 encounters with shotguns and 7 encounters with weapons that shoot the 5.56 caliber round.

Thirty-two percent of participants reported having a policy for handling firearms discovered during patient care, while 68% either did not have any policy or were unsure. Only 12% of respondents indicated that they received training in the safe handling of firearms through their agency. Although 74% of our cohort stated they had at least moderate (have used firearms many times, comfortable using them safely and effectively) experience with firearms, and 78% said they felt safe handling, clearing, or engaging the safety system of a firearm discovered during patient care, 87% reported they would be interested in taking a firearm safety course. Ninety-five percent of participants believed basic firearm safety should be added to the EMS curriculum.

Among all participants, 78% belonged to a household that owned firearms, and 77% of EMS clinicians who owned firearms reported shooting their firearms several times a year or more.

Participation in a concealed carry/concealed handgun license course was most common (45%), followed by a hunter safety course (26%), and military or law enforcement firearms training (23%). 33% of the cohort reported not participating in any of the firearms training courses

Encounters	Number of Respondents n (%)*
When I encountered a FIREARM during patient care I was working in (check all that apply):† (N = 262)	
Texas	136 (52%)
New Mexico	97 (37%)
Arizona	8 (3%)
Utah	6 (2%)
New York	3 (1%)
California	2 (<1%)
Tennessee	2 (<1%)
Other	8 (3%)
What was the approximate population or city size when you encountered the FIREARM(s)? (N = 277)	
Large Urban City (>250,000 people)	128 (46%)
Midsize Urban City (100,00-250,000 people)	30 (11%)
Small City (50,000-100,00 people)	30 (11%)
Large Town (25,000-50,000 people)	21 (8%)
Small Town (less than 25,000 people)	27 (10%)
Rural Area	35 (13%)
Wilderness Area	6 (2%)
Of the times you have encountered a FIREARM during your EMS patient activities, was the weapon (select all that apply): (N = 337)	
Openly Visible	167 (50%)
Hidden and Only Discovered During Assessment/Treatment	139 (41%)
Other Location	31 (9%)
If a FIREARM has been discovered, what type was it? (Select all that apply) (N = 362)	
Handgun	213 (59%)
Rifle	63 (17%)
Shotgun	59 (16%)
Military-style	27 (7%)
All questions and statements are presented exactly as they appeared in the survey. All potential responses with any ancillary information are also shown unless otherwise specified. *Percentages may not add to 100 due to rounding error. †Answer choices included any of the 50 US states, a US territory, or outside of the USA.	

Table 2. Firearm encounters among survey respondents.

Interest in participating in an EMS firearm safety course was associated with fewer years of EMS experience (median [interquartile range]: 12 [6-20] vs. 20 [9-27], p = 0.005) and not having participated in a firearm safety course (36% [76/213] vs. 16% [5/32], p = 0.027). Additionally, more personnel interested in participating in an EMS firearm safety course had previously participated in a hunter safety course (23% [49/213] vs. 44% [14/32], p =

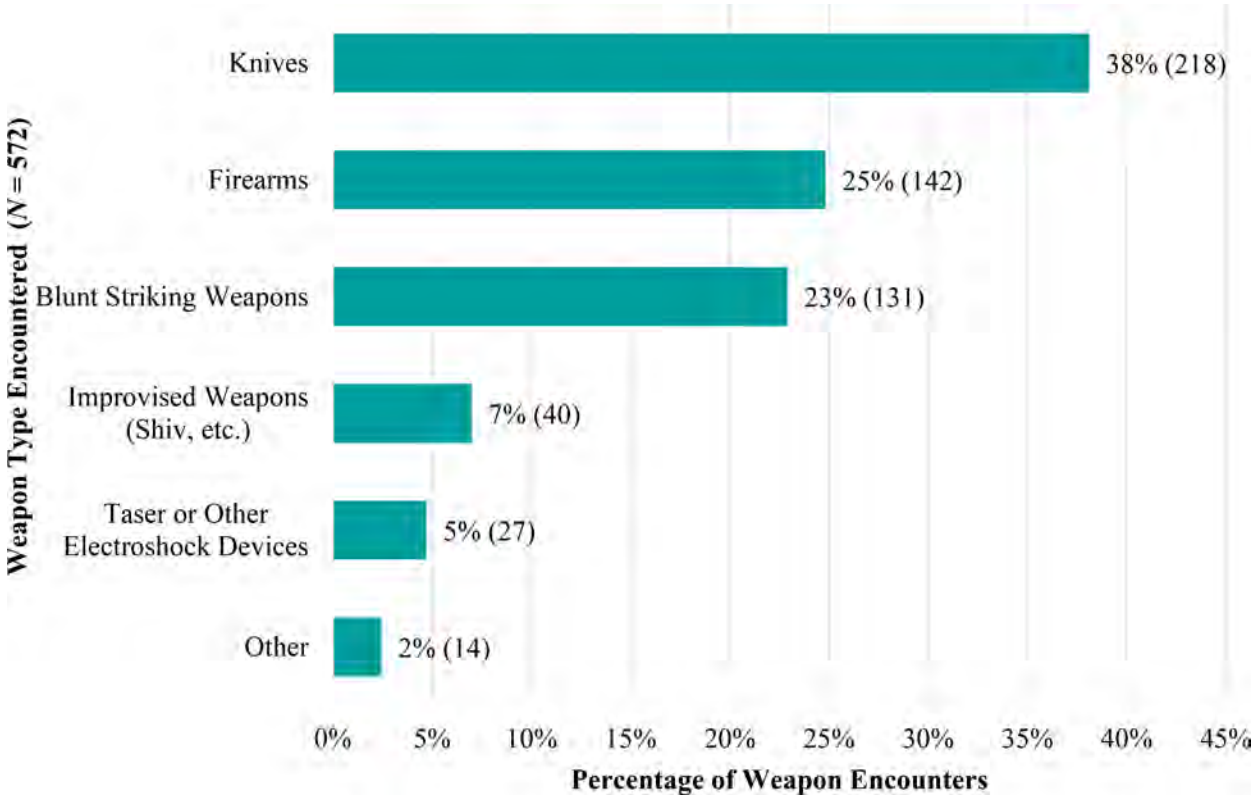

Figure 2. Different types of weapon encounters by ems personnel in the last year of active service.

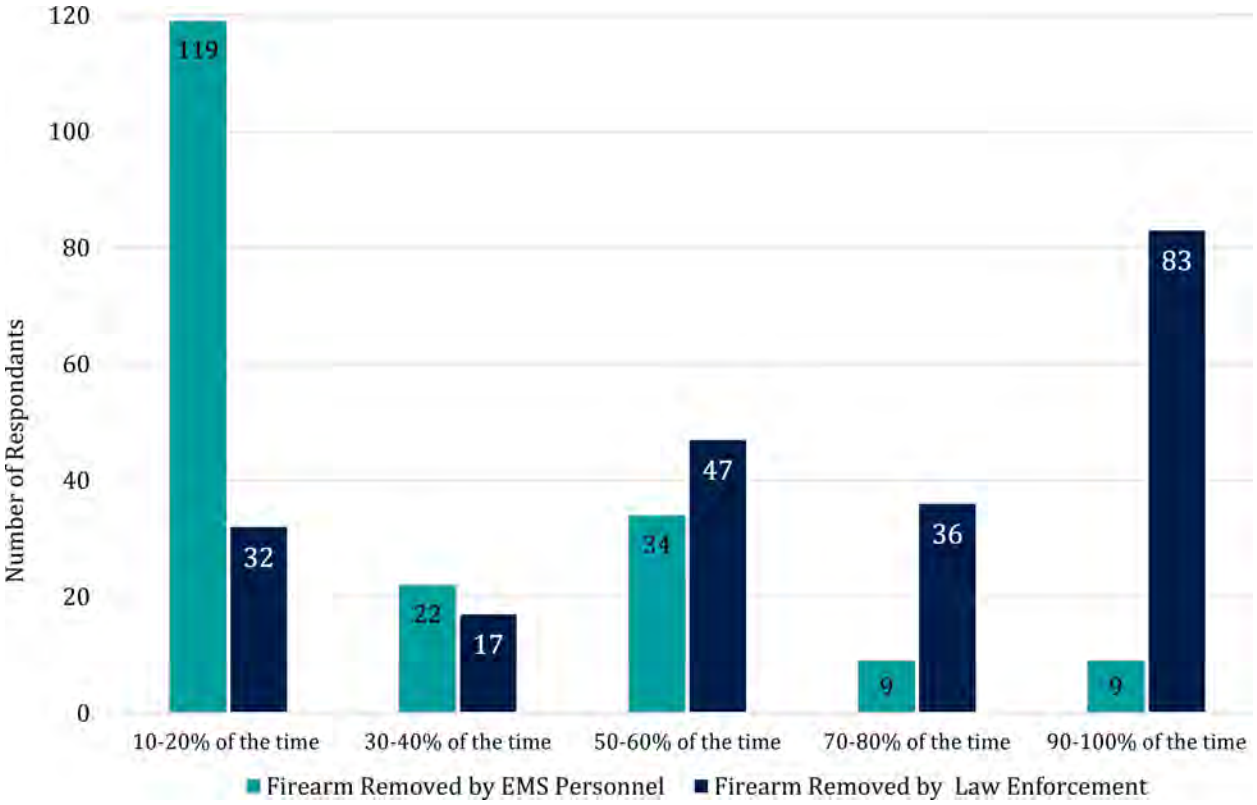

Figure 3. The reported frequency of firearm removal by EMS personnel versus law enforcement. There are gaps in the X-axis ranges because participants responded in intervals of 10 percentage points (i.e., 10%, 20%, 30%, etc.).

Perspectives	Number of Respondents n (%)*
Does your agency have a policy for handling firearms discovered during patient care? (N = 238)	
Yes	77 (32%)
No	107 (45%)
I don't know	54 (23%)
Have you received training in the safe handling of firearms through your agency? (N = 240)	
Yes	28 (12%)
No	214 (89%)
Do you feel safe handling, clearing, or engaging the safety system of a firearm discovered during patient care? (N = 240)	
Yes	186 (78%)
No	54 (23%)
How would you describe your personal experience with firearms? (N = 241)	
None; have never handled or fired a gun	17 (7%)
Minimal; have handled or been around guns, but never fired them	11 (5%)
A little; have fired guns once or possibly a few times	34 (14%)
Moderate; have used firearms many times, comfortable using them safely and effectively	98 (41%)
Significant; extensive background with firearms, comfortable teaching safe use to others	81 (34%)
Would you be interested in participating in a firearm safety course? (N = 245)	
Yes	213 (87%)
No	32 (13%)
Do you believe basic firearm safety should be added to the EMS curriculum? (N = 242)	
Yes	231 (95%)
No	11 (5%)
All questions and statements are presented exactly as they appeared in the survey. All potential responses with any ancillary information are also shown unless otherwise specified. *There were 247 participants in total. Categories with sample sizes less than 247 indicate that the remaining participants left the question blank. Percentages may not add to 100 due to rounding error.	

Table 3. EMS personnel perspectives on firearm training.

Ownership and Training	Number of Respondents n (%)*
Do you or anyone in your household own firearms? (N = 236)	
Yes	185 (78%)
No	51 (22%)
If you own firearms, how often do you shoot them? (N = 184)	
Never	9 (5%)
Less than once a year	16 (9%)
About once a year	17 (9%)
Several times a year	71 (39%)
About once a month	50 (27%)
About once a week	16 (9%)
More than once a week	5 (3%)
Have you participated in any of the following? (N = 247)	
Concealed carry/concealed handgun license permit course	112 (45%)
Hunter safety course	63 (26%)
Military or law enforcement firearms training	58 (23%)
Formal gun safety course (i.e., NRA basic pistol, Boy Scout camp, etc.)	47 (19%)
Professional firearms training	34 (14%)
Competitive shooting (i.e., IPSC, Cowboy Action, etc.)	19 (8%)
None	81 (33%)
All questions and statements are presented exactly as they appeared in the survey. All potential responses with any ancillary information are also shown unless otherwise specified. *There were 247 participants in total. Categories with sample sizes less than 247 or less than the total number of participants to which the question pertained indicate that the remaining participants left the question blank. Percentages may not add to 100 due to rounding error.	

Table 4. Firearm ownership and non-EMS agency firearm training among ems personnel.

0.017). However, gender, state of practice, EMS involvement, personal experience with firearms, or other training in the safe handling of firearms were not associated with willingness to engage in a training course.

Respondents who believed that firearm safety should be added to the EMS curriculum reported encountering firearms more frequently on average (median [interquartile range (IQR)]: once a year [once every 5 years to once every 6 months] vs. once every five years [never to once a year], p = 0.006) and that their agency had a policy for handling firearms more often (33% [75/225] vs. 0% [0/11], p = 0.008). Although firearm ownership was the

same between groups, gun owners who believed that firearm safety training should be integrated into the EMS curriculum shot their guns more frequently (median [IQR]: several times a year [several times a year to about once a month] vs. about once a year [about once a year to several times a year], p = 0.038). Otherwise, those who did and did not support the introduction of firearms safety into the EMS curriculum did not differ in any demographic characteristics, years of EMS experience, prior participation in gun safety training courses, or self-reported comfort with firearms.

DISCUSSION

Although firearm safety remains a significant concern among emergency providers, research is very scarce on firearms found in prehospital settings. In our study of prehospital personnel perspectives on firearms in the southwest United States, we found that EMS clinicians regularly encounter firearms when evaluating patients in the field. Furthermore, respondents reported that EMS personnel handled or removed firearms more than 25% of the time. Only 33% of respondents were aware of any agency policy regarding firearms handling. Despite broad personal experience with firearms among our cohort, there was considerable support for the development of formal EMS firearm training and the integration of firearm safety into the EMS curriculum. The addition of gun safety to prehospital education and policy may help protect EMS personnel and decrease potential injury to bystanders, patients, and equipment.

Violence is a significant prehospital problem (Maguire et al., 2018; Murray et al., 2020; Pourshaikhian et al., 2016). Up to 83% of EMS clinicians report experiencing some form of workplace violence annually (Xing et al., 2015). The rate of occupational fatalities among EMS workers matches that of firefighters and police, and the rate of non-fatal injuries is three to five times greater than the average for all US workers (Maguire et al., 2005; Maguire et al., 2002; Maguire & Smith, 2013). Although most episodes of workplace violence do not involve weapons, the presence of weapons and firearms magnifies the potential for significant trauma.

Firearms are encountered in the emergency department and sometimes with devastating consequences. One in five attending physicians and one in four residents will encounter a firearm in the emergency department annually (Gani et al., 2017; Ketterer et al., 2019). Studies of hospital shootings over the past several decades have shown that these events most often occur in the ED, with 154 hospital-related shootings resulting in at least one injured victim occurring between 2000 and 2011 (Kelen et al., 2012; Wax et al., 2019). Notwithstanding the dearth of research on the topic, it logically follows that guns are often found in prehospital settings where many ED patients are evaluated and originate. EMS personnel frequently arrive on the scene before law enforcement or when law enforcement is unavailable, and EMS must determine how to best deal with firearms. EMS perspectives on firearms encountered in the field and their knowledge of existing guidelines or appropriate training on handling these weapons have remained largely unstudied.

This study investigates how often EMS practitioners encounter weapons and firearms in the field. In a separate study of weapon encounters among EMS personnel in Boston and Los Angeles, 42% of EMS surveyed participants searched patients for weapons, and 62% found one (Thomsen et al., 2000). The number of times that personnel found a weapon

on a patient ranged from less than 5 (33% of the cohort) to greater than 10 (13% of the cohort), though practitioners had different levels of experience and no time domain was reported. Eighty-six percent of our participants reported finding non-firearm weapons in the field at least once per year, and 61% reported finding firearms in prehospital settings as or more frequently. This suggests that weapon encounters by prehospital clinicians may be a relatively common and regular occurrence.

The frequency with which our cohort reported encountering firearms may be related to the fact that most of our respondents were from Texas and New Mexico, two states with high gun ownership. 35.5% of households in Texas and 35.9% of households in New Mexico own firearms. Furthermore, these states rank 15th and 5th, respectively, in the rate of registered guns per 1000 people compared to the rest of the US (Gun Ownership by State, 2023). It also must be noted that within these states, most firearms were found in large urban cities, and prehospital firearm encounters have only been studied in this setting (Thomsen et al., 2000). Further research is needed to determine when prehospital practitioners routinely encounter firearms in areas of lower gun ownership and whether these encounters occur in large cities or other settings.

A significant number of prehospital clinicians reported they handled weapons during patient evaluation. There is a misconception that law enforcement is the only personnel to handle weapons found on patients; our findings show that EMS responders may be the first to arrive on the scene and be faced with the choice of whether to secure a firearm and to provide medical care or wait for law enforcement to arrive. A delay in care can often be life-threatening to the patient. Although prehospital practitioners are trained to ensure that they are safe before treating patients (Klein & Tadi, 2023), whether personnel feel comfortable securing weapons and firearms may depend on personal experience. Almost three-quarters of our cohort reported having at least moderate (have used firearms many times, comfortable using them safely and effectively) experience with firearms. For this reason, they may feel more comfortable safely securing these weapons when needed.

Clear agency policies and procedures should exist to help prehospital clinicians navigate weapon and firearm situations safely. We found that for most participants, this was not the case. Roughly 66% of respondents were unaware of any agency policy regarding firearm safety, and 90% received no agency training in handling firearms. This is consistent with earlier literature showing a deficiency of formal weapons training among EMS personnel. EMS weapon encounters in Boston and Los Angeles showed that 62% of prehospital responders have found weapons on a patient, yet 80% of participants stated that the firearm safety training they received was inadequate (Thomsen et al., 2000). There is also evidence to suggest that EMS personnel are poorly trained for facing violence in the field. A study assessing prehospital violence showed that over 50% of EMS clinicians have no protocol or guideline for handling violence when arriving on the scene (Tintinalli & McCoy, 1993). Another more recent study showed that 79% of prehospital clinicians had seen a weapon on a patient, and only 33% of clinicians had a known guideline for dealing with violence (Corbett et al., 1998). It is unclear whether job-specific training would be needed to mitigate the risk of firearm discharge when treating these patients. There is evidence to suggest that prehospital responders encounter high percentages of patients armed with different weapons. Most of these responders have not received formal weapons training, which may compromise their safety.

EMS responders in our study overwhelmingly supported adding firearm safety training to the prehospital curriculum. This support was seen in almost all participants regardless of their years of job experience or comfort level with firearms. Most personnel reported that they would be interested in participating in a firearms safety course. This seems to suggest that EMS clinicians see benefit in job-specific firearms training irrespective of background. These individuals may feel that specific knowledge of handling and securing different types of firearms or how to remove a firearm safely will keep them safer while on shift. Hospital ED personnel also benefit from additional training because this may lower the rate of armed patients in the emergency department (Goetz et al., 1991).

LIMITATIONS

Our study comprised a convenience sample of EMS personnel primarily from West Texas and Southern New Mexico USA, limiting our findings' generalizability to the EMS population nationwide. This investigation is the first to evaluate the perspective of prehospital clinicians on firearms, primarily in the southwest US. The small sample size of our study must also be acknowledged despite the novelty of this work. The response rate of 41% must also be noted, as this is below average for the typical survey response study and may lead to sampling bias. The national EMS workforce is primarily male, with females comprising 35% of those earning their National EMS Certification from 2008 to 2017 (Crowe et al., 2020); however, the National Fire Protection Association in 2020 reported of 89,600 firefighters in the USA, only 9% were female (Fahy, 2022). Our number of female respondents was 15%, below the female gender profile for EMS certifications earned, but above the firefighter employment profile. The exact female EMS workforce practicing in West Texas and Southern New Mexico is unknown. It is possible that those who had encountered more weapons while on the job or had stronger opinions about firearm safety were more likely to participate. It must be noted though, that a proportion of respondents reported never encountering a firearm while working. Using a QR code may have made it more difficult for those with less technological familiarity to complete the survey. Recall bias may have undermined the accuracy of the results reported herein. To combat this, weapon encounters over more recent periods were explored. Currently, the agencies involved in the study do not have an electronic patient care reporting system that utilizes a data collection instrument for firearm encounters requiring a survey for data collection. Similarly, the National Emergency Medical Services Information System (NEMSIS) does not have a data element that tracks EMS firearms encounters (C. F. Gregor, NEMSIS data analyst, personal communication March 26, 2024).

Although we reported the demographic characteristics and experience with firearms of EMS clinicians who would and would not participate in EMS-sponsored firearm safety training and who did or did not support introducing firearm safety training into the EMS curriculum, this study was not designed to compare differences between these two groups.

It also must be emphasized that firearm violence is a global public health issue. In the past decade alone, injury related to firearms has claimed over 2.75 million lives (Collaborators, 2020). Firearm injury accounts for over 250,000 preventable deaths and 46,000 disability-adjusted life years lost annually (Naghavi et al., 2018). The burden of disease is highest in low- and middle-income countries, with Central and South American coun-

tries such as Guatemala, Venezuela, and El Salvador exhibiting mortality rates of 40 per 100,000 compared to an international average of 6 per 100,000 (Naghavi et al., 2018). As only 10% of these deaths occur in military conflict, civilian patients' prehospital clinicians experience and treat the majority of firearm-related injuries (Werbick et al., 2021). Emergency medical services in many low- and middle-income countries remain underdeveloped, and the level of training that prehospital practitioners receive in these countries is unclear (Suryanto et al., 2017). Further investigation can explore these clinicians' experiences and perspectives on firearm encounters in the prehospital setting.

CONCLUSION

EMS personnel in West Texas and Southern New Mexico may frequently encounter firearms when evaluating patients in the prehospital setting and not infrequently handle these weapons. 68% of surveyed prehospital clinicians are not aware of any agency policy for handling firearms discovered during patient care, and only 10% have received agency training in firearms safety. There may be potential support among prehospital personnel for incorporating firearm safety training into the EMS curriculum. Based on these preliminary data, agencies may consider integrating firearm training in prehospital clinician education and simulation to adequately prepare personnel for the field.

There is a need for improved data collection mechanisms to accurately track encounters between EMS and firearms. The current lack of comprehensive data limits our ability to understand the frequency, circumstances, and outcomes of such encounters on a larger scale, hindering efforts to develop targeted interventions and policies to improve safety for both EMS personnel and their communities.

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APPENDIX 1

EMS Weapon Encounters Survey

We are interested in anonymously assessing how often EMS providers encounter firearms in the prehospital environment. This survey will take approximately 3-5 minutes to complete. Your participation is voluntary, and your responses are completely anonymous. You may skip any question you are not comfortable answering. If you are an employee, your participation in this study will not affect your employment status. By responding to the survey questions, you are consenting to participate in this research study.

Please complete the survey below.

Thank you!

Date
[MM-DD-YYYY]

Gender

- Male
- Female
- Prefer not to answer

I am currently:

- Active in EMS
- Involved in EMS administratively
- Retired from EMS

I currently work in the state of:

- Alabama
- Alaska
- Arizona
- Arkansas
- California
- Colorado
- Connecticut
- Delaware
- Florida
- Georgia
- Hawaii
- Idaho
- Illinois
- Indiana
- Iowa
- Kansas
- Kentucky
- Louisiana
- Maine
- Maryland
- Massachusetts
- Michigan
- Minnesota
- Mississippi
- Missouri
- Montana
- Nebraska
- Nevada
- New Hampshire
- New Jersey
- New Mexico
- New York
- North Carolina
- North Dakota
- Ohio
- Oklahoma
- Oregon
- Pennsylvania
- Rhode Island
- South Carolina
- South Dakota
- Tennessee
- Texas
- Utah
- Vermont
- Virginia
- Washington
- West
- Virginia
- Wisconsin
- Wyoming

I am / was primarily involved in EMS through:

- ○ Professional Fire Department
- ○ Volunteer Fire Department
- ○ Private EMS Agency
- ○ Government EMS Agency
- ○ Local Law Enforcement (PD, Sheriff)
- ○ DHS (Federal Law Enforcement, USBP, Coast Guard)
- ○ DoD (Active duty or Reserve)
- ○ Industrial Fire Department (aerospace, private industry)
- ○ Interfacility Transfer Company
- ○ Other (describe)

How many years have you been involved in EMS for?

- ○ less than 1 year
- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10
- ○ 11
- ○ 12
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- ○ 16
- ○ 17
- ○ 18
- ○ 19
- ○ 20
- ○ 21
- ○ 22
- ○ 23
- ○ 24
- ○ 25
- ○ 26
- ○ 27
- ○ 28
- ○ 29
- ○ 30 or greater year

How many times have you encountered a FIREARM during patient care over the last 5 (FIVE) years?

- ○ 0
- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10
- ○ greater than 10

How many times do you estimate you have encountered a FIREARM during patient care over the course of your EMS career?

- ○ 0
- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10
- ○ greater than 10

How many times do you estimate you have encountered a NON-FIREARM WEAPON (knives, bats, etc.) during patient care over the last 5 (FIVE) years?

- ○ 0
- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10
- ○ greater than 10

How many times do you estimate you have encountered a NON-FIREARM WEAPON over the course of your EMS career during patient care?

- ○ 0
- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10
- ○ greater than 10

When I encountered a FIREARM during patient care I was working in (check all that apply):

- Alabama
- Alaska
- Arizona
- Arkansas
- California
- Colorado
- Connecticut
- Delaware
- Florida
- Georgia
- Hawaii
- Idaho
- Illinois
- Indiana
- Iowa
- Kansas
- Kentucky
- Louisiana
- Maine
- Maryland
- Massachusetts
- Michigan
- Minnesota
- Mississippi
- Missouri
- Montana
- Nebraska
- Nevada
- New Hampshire
- New Jersey
- New Mexico
- New York
- North Carolina
- North Dakota
- Ohio
- Oklahoma
- Oregon
- Pennsylvania
- Rhode Island
- South Carolina
- South Dakota
- Tennessee
- Texas
- Utah
- Vermont
- Virginia
- Washington
- West
- Virginia
- Wisconsin
- Wyoming
- US territory
- Outside of the US

What was the approximate population or city size when you encountered the FIREARM(s)?

- Large Urban City (>250,000 people)
- Midsize Urban City (100,00-250,000 people)
- Small City (50,000-100,00 people)
- Large Town (25,000-50,000 people) Small Town (less than 25,000 people) Rural area Wilderness area

In what city(s), town(s), village(s) etc., did you encounter the patient(s) with the FIREARM(s)? [Free text answer]

On average, how often do you find FIREARM(S) during patient encounters?

- Once per shift
- Once a week
- Once a month
- Once every 6 months
- Once a year
- Once every 5 years
- Once every 10 years
- Never
- Other

Of the times you have encountered a FIREARM during your EMS patient activities, was the weapon (select all that apply):

- Openly visible
- Hidden and only discovered during your assessment/treatment
- Hidden and only discovered after your assessment/treatment
- Other location (describe)

On average, how often do you find NON-FIREARM weapon(s) during patient encounters?

- Once per shift
- Once a week
- Once a month
- Once every 6 months
- Once a year
- Once every 5 years
- Once every 10 years
- Never
- Other

Over the last 12 months or the last year you were active in EMS, have you found any of the following on or with patients: (Select all that apply):

- Knives
- Firearms
- Blunt striking weapons
- Explosives
- Improvised weapons (shiv, etc.)
- Taser or other electroshock devices
- Other (describe)

If a FIREARM has been discovered, what type was it? (Select all that apply)

- Handgun
- Shotgun
- Rifle
- Military-style rifle
- Other (describe)

Did you know the caliber or brand of FIREARM(s) found?

- Yes
- No
- Sometimes

What percentage of the time have FIREARM weapons been removed from the patient by EMS personnel? (0-100%)

- 10%
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
- 100%

What percentage of the time have FIREARM weapons been removed from the patient by Law Enforcement (non-EMS) (0-100%)?

- 10%
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
- 100%

When you encountered the firearm(s) in what capacity were you working? (check all that apply)

- Professional Fire Department
- Volunteer Fire Department
- Private EMS Agency
- Government EMS Agency
- Local Law Enforcement (PD, Sheriff)
- DHS (Federal Law Enforcement, USBP, Coast Guard)
- DoD (Active duty or Reserve)
- Industrial Fire Department (aerospace, private industry)
- Interfacility Transfer Agency
- Other (describe)

Does your agency have a policy for handling firearms discovered during patient care?

- Yes
- No
- I don't know

Have you received training in the safe handling of firearms through your agency?

- Yes
- No

Do you feel safe handling, clearing, or engaging the safety system of a firearm discovered during patient care?

- Yes
- No

How would you describe your personal experience with firearms?

- None; have never handled or fired a gun
- Minimal; have handled or been around guns, but never fired them
- A little: have fired guns once or possibly a few times
- Moderate; have used firearms many times, comfortable using them safely and effectively
- Significant; extensive background with firearms, comfortable teaching safe use to others

Do you or anyone in your household own firearms?

- Yes
- No

If you own firearms, how often do you shoot them?

- Never
- Less than once a year
- About once a year
- Several times a year
- About once a month
- About once a week
- More than once a week

Have you participated in any of the following? (Select all that apply)

- Hunter safety course
- Concealed carry/Concealed Handgun License permit course
- Formal gun safety course (i.e. NRA basic pistol, Boy Scout camp, etc.)
- Military or Law Enforcement firearms training
- Professional firearms training
- Competitive shooting (i.e. IPSC, Cowboy Action, etc.)
- None

Would you be interested in participating in a firearm safety course?

- Yes
- No

Do you believe basic firearm safety should be added to the EMS curriculum?

- Yes
- No

Thank you for completing the survey any comments or additional information you would like to provide?
[Free text answer]

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RESEARCH REPORTS

A SURVEY OF PATIENT UTILIZATION AND TRUST OF EMERGENCY MEDICAL SERVICES

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ABSTRACT

Little is understood regarding a patient's decision to go to the Emergency Department via Emergency Medical Services (EMS) versus a privately owned vehicle (POV). No studies exist evaluating patients' trust of the EMS system as related to patient race. Patients completed a multi-method survey during their ED stay. Quantitative data included: patient demographics (age, gender, race) income, insurance status, previous medical training, highest level of education, self-reported medical and social history, number of ED visits in the past three months, and two scales assessing trust and empathy: the Group-Based Medical Mistrust Scale and the Jefferson Scale. Patient characteristics were shown. A Wilcoxon signed rank test described differences in trust scales by race. Logistic regression showed factors influencing EMS utilization. Qualitative comments described patients' rationale for EMS versus POV. 23/72 (31.94%) patients utilized EMS transport and 49/72 (68.06%) utilized POV. 59.09% of patients self-identified as Black and 40.91% self-identified as White. The Group-Based Medical Mistrust Scale found Black patients had less trust in the EMS system (p=0.0001), while the Jefferson Scale of Patient Perception of Physician Empathy showed no significant difference in patient perceptions of EMS provider empathy (p=0.608). Patients who arrived via POV reported using marijuana, an illicit substance in the state of this study, more frequently than those who arrived by EMS (p = 0.01). Logistic regression indicated that age predicted the use of EMS over POV (p<0.001). Qualitative results indicated that lack of access to POV, physical limitations, cost, speed, perception of emergency, and fear were identified as reasons that support patients' decision to use EMS or POV. Triangulating the results, this study highlights that those factors in addition to trust, age, and social and economic factors likely impacted utilization of EMS. These findings could inform policy decisions and ensure emergency care systems that are accessible for all patients.

INTRODUCTION

Each year, approximately 130 million patients visit emergency departments (ED) in the United States (Cairns et al., 2022). Of those visits, about 18% are transported to the ED via emergency medical services (EMS) (Peters et al., 2023). Other patients may arrive via a privately owned vehicle (POV), taxi/rideshare, bus, or by foot. Little qualitative data exist about what factors inform

a patient's decision to utilize EMS versus POV. Although it may seem obvious to call EMS for higher acuity conditions, previous findings suggest that many factors contribute to the decision (Meisel et al., 2011; Shekhar & Blumen, 2021). Existing studies describe the frequent use of EMS by patients with lower acuity conditions; however, many patients with high acuity conditions do not utilize EMS. For example, less than half of all patients with a myocardial infarction arrive at the ED via EMS (Canto et al., 2002). Certainly, patients, who mostly do not have a medical background, may not have insight into the acuity of their own condition.

However, alternative factors – other than patient acuity - may also influence patient decisions to call EMS. Other studies have shown correlation between patient level factors and decision to use EMS. Patients with private insurance are less likely to arrive by EMS than patients with Medicaid or those without health insurance (Ward et al., 2023). Additionally, one-third of patients over the age of 60 arrive by ambulance and this association increases with each decade of age (Ashman et al., 2020). Previous studies have shown that a patient's age and insurance status correlate with EMS utilization, but we do not know whether a patient's race is a factor in one's decision to utilize EMS or whether race impacts trust of the EMS system. We also do not have insight into patient understanding of when it might be appropriate to utilize EMS. Given that no prior study has directly explored the patient's decision-making process around the decision to call EMS, we lack the information necessary to ensure all patients have equitable access to ED care. The aim of this study was to better understand patients' decision to use EMS or POV by triangulating with reference to 1) open ended questions around the decision to utilize EMS and 2) responses to a survey assessing race-based trust of EMS.

METHODS

Study Design

This study used survey design methodology to examine factors that influence patients' ED transportation decisions. A multi-method survey was administered to a random sample of ED patients during their stay over a three-month period (June 2022 to August 2022). Data were collected during weekday daytime hours by one trained medical student (AL). Open-ended questions elucidated patient reasoning for utilizing EMS versus POV. In the survey, patients were also asked their race, ethnicity, income, insurance status, medical history, and substance abuse history. Additionally, we reviewed in-hospital charts of all patients who took the survey to collect chief complaint, patient age, patient gender, patient disposition, and number of ED visits within the 3 months prior to enrollment.

For patients that arrived to the ED via EMS, we also administered two scales to assess trust and perceived empathy of EMS providers: the Group-Based Medical Mistrust Scale (GBMMS) (Thompson et al., 2004) and the Jefferson Scale of Patient Perception of Physician Empathy (JSPPPE) (Hojat et al., 2017). Both were five-point Likert scales validated in the hospital setting and modified to be applicable to EMS. The adapted GBMMS used included 7 race-based medical mistrust questions. The adapted JSPPE we included 5 questions. In the GBMMS, a higher score is associated with a higher level of mistrust (Appendix A). Previous studies of this scale have demonstrated strong validity and reliability (α = 8.7-8.9) (Shelton et al., 2010). In the JSPPPE, a higher score indicates a higher patient

perception of EMS empathy (Appendix B). This scale has also been validated in previous studies, in which Cronbach's α was between 0.81 and 0.88 (Domingues et al., 2019).

For the qualitative portion of the survey, patients transported via EMS were asked ten questions about their decision to utilize EMS as well as their overall patient encounter experience. These open-ended questions were asked orally with answers recorded in Qualtrics using an iPad (Appendix C). After the oral portion was completed, patients were given the iPad to answer the remainder of the qualitative survey privately because it contained potentially sensitive content that they might not feel comfortable answering aloud. Patients completed the surveys in English and were provided the option to respond to these questions orally.

Study Setting and Population

One trained medical student (AL), a Caucasian female, approached a convenience sample of adult patients in the ED who met inclusion criteria (≥ 18 years of age), agnostic to chief complaint and triage data, and invited them to participate in the survey. For those who were interested in participating, informed consent was obtained. Patients were excluded for altered mental status or inability to provide informed consent. Patients were also excluded if someone else made the decision for the patient to go to the hospital (e.g., if another person called EMS without patient input). Efforts were made to assure equal representation among patients triaged to the different locations of the ED (low and high acuity areas), however it must be noted that with the above exclusion criteria and fact that survey was only administered in the ED and not to the subset of patients who may have presented via EMS but went rapidly to other hospital areas (e.g. surgery, cath lab, etc), acutely ill patients were likely to be underrepresented.

The study took place at a large, tertiary care ED in Indiana, United States with an annual patient volume of 100,000 per year, of which about 33,000 arrive to the ED via EMS. The surrounding county is home to a population of 971,102, of which is 52% is female. 11% of the population was Hispanic; the racial breakdown was 62% White, 30% Black, 4% Asian, and 4% mixed or other races (Bureau, 2020). Median per capita income is $30,013 and over 14% of the population lives in poverty (Bureau, 2020). The self-reported demographics for the workforce of the largest EMS agency serving the jurisdiction in which the study took place included 385 employees with an average age of 35 years old, 42% female, 83% white/not Hispanic, 8% black, 9% other.

Data Analysis

The primary purpose was to identify factors that explain patients' decisions surrounding EMS utilization. Secondary purposes included testing for differences in EMS utilization based on race and other patient demographic characteristics, and for those that utilized EMS for transport, examining whether there exist differences in trust and empathy as measured by the adapted GBMMS and JSPPPE scales.

We stratified patients by mode of transport (EMS vs POV) and described patient demographics, self-reported medical and social histories, and ED utilization (based on chart review) for a three-month period. We performed a logistic regression to compare the odds of being transported to the ED by EMS compared to POV. For patients who present-

ed via EMS, we also used a Wilcoxon signed rank test to compare EMS trust responses by race.

We used thematic analysis to analyze the qualitative survey data. This process included familiarizing ourselves with the data, categorizing the data, and creating descriptive summaries (Braun & Clarke, 2006). One medical student (AL) read all the data line-by-line and noted interesting comments. She then observed how these comments fit together into six categories. The analytic team consisted of a medical student without an EMS background (AL), an Emergency Medicine physician (PM), and an EMS medical director and practicing ED physician (NG), who met every two weeks for a period of four months. Once the analysis team identified potential themes, they were presented to an Emergency Medicine non-clinical faculty with methodological expertise (SSS) for feedback and refinement. The final process named and defined these themes in order to support the creation of descriptive summaries. This study was approved by the Indiana University Institutional Review Board [Protocol #2008258080].

RESULTS

Quantitative Results:

Demographics, Medical and Social History

We enrolled 72 patients (Table 1) and of the patients who participated in the study, 23 arrived at the ED via EMS and 49 arrived via POV.

After performing a Bonferroni correction, where the critical p-value <0.0045 was identified for significant values, we found no significant differences between past medical history reported by patients utilizing EMS and those using POV (Table 2).

	EMS Transport (n = 23)	POV (n = 49)
Age		
Mean (SD)	59 (12.03)	44.04 (13.38)
Gender		
Female	12 (52.17%)	26 (53.06%)
Male	11 (47.8%)	23 (46.9%)
Other	0 (0.0%)	0 (0.0%)
Race		
Black	13 (59.09%)	29 (60.42%)
White	9 (40.91%)	19 (39.58%)
Other/prefer not to answer	1 (4.35%)	1 (2.04%)
Income		
<$30,000	16 (69.57%)	23 (49.94%)
$30,000-50,000	0 (0%)	12 (24.49%)
$50,000-100,000	1 (4.35%)	2 (4.08%)
$100,000+	0 (0%)	11 (22.45%)
Prefer not to answer	6 (26.09%)	1 (7.1%)
Insurance status		
Public	18 (78.26%)	34 (64.2%)
Private	3 (13.04%)	8 (16.33%)
Uninsured	1 (4.35%)	4 (10.20%)
Did not answer	1 (4.35%)	2 (4.08%)
Previous medical training?		
Yes	3 (13.04%)	10 (20/41%)
No	18 (78.26%)	39 (79.59%)
No response	2 (8.70%)	1 (2.04%)
Education		
Some high school	7 (30.43%)	5 (10.2%)
High school degree or equivalent	7 (30.43%)	20 (40.82%)
Some college	5 (21.74%)	11 (22.45%)
Associates degree	1 (4.35%)	4 (8.16%)
Bachelor's degree	0 (0%)	4 (8.16%)
Graduate/Professional degree	1 (4.35%)	2 (4.10%)
Did not answer	2 (8.70%)	3 (6.1%)
Number of ED visits in past 3 months		
Mean (IQR)	1.26 (1.96)	.69 (1.90)
Median	0	0

Table 1. Participant characteristics – Comparison of patients who presented by EMS versus POV.

	EMS Transport (n=23)	POV (n=49)	p-value*
Asthma, emphysema, or chronic bronchitis	10 (45.45%)	14 (29.17%)	0.21
Black	6	7	
White	4	7	
Other/prefer not to answer	0	0	
High blood pressure or hypertension	16 (72.73%)	21 (43.75%)	0.04
Black	9	15	
White	6	6	
Other/prefer not to answer	1	0	
High blood sugar or diabetes	9 (40.91%)	9 (18.75%)	0.06
Black	5	6	
White	4	3	
Other/prefer not to answer	0	0	
Arthritis or rheumatism (inflammation of the joints)	14 (63.64%)	16 (33.33%)	0.01
Black	10	10	
White	3	6	
Other/prefer not to answer	1	0	
Angina, heart failure, or other types of heart disease	5 (22.73%)	5 (10.42%)	0.19
Black	4	4	
White	1	1	
Other/prefer not to answer	0	0	
Stroke, seizures, Parkinson's disease, or another neurological condition	5 (22.73%)	6 (12.50%)	0.3
Black	3	5	
White	1	1	
Other/prefer not to answer	1	0	
Liver disease	1 (4.55%)	1 (2.08%)	0.58
Black	0	0	
White	1	1	
Other/prefer not to answer	0	0	
Kidney or renal disease	2 (9.09%)	3 (6.25%)	0.69
Black	1	1	
White	1	2	
Other/prefer not to answer	0	0	
Cancer diagnosed or treated in the last three years	3 (13.64%)	2 (4.17%)	0.16
Black	2	0	
White	1	2	
Other/prefer not to answer	0	0	
Anxiety or depression	9 (42.86%)	18 (37.50%)	0.84
Black	2	11	
White	7	7	
Other/prefer not to answer	0	0	

Table 2. Participant past medical history – Comparison of patients who presented by EMS versus POV using Chi-Squared test.

Patients who arrived in a POV reported using marijuana, an illicit substance in the state of this study, more frequently than those who arrived by EMS ($p = 0.01$ when $p<0.05$ is significant) (Table 3).

	EMS Transport (n=23)	POV (n=49)	p-value*
Cigarettes	6 (28.57%)	17 (35.42%)	0.47
Black	3	10	
White	3	7	
Other/prefer not to answer	0	0	
Alcohol	2 (9.52%)	5 (10.42%)	0.84
Black	2	2	
White	0	3	
Other/prefer not to answer	0	0	
Marijuana	1 (4.76%)	17 (35.42%)	0.01
Black	0	9	
White	1	8	
Other/prefer not to answer	0	0	
Cocaine	1 (4.76%)	2 (4.17%)	0.96
Black	1	1	
White	0	1	
Other/prefer not to answer	0	0	
Heroin	0 (0.00%)	0 (0.00%)	N/A
Black	0	0	
White	0	0	
Other/prefer not to answer	0	0	

Table 3. Self-reported participant drug utilization – Comparison of patients who presented by EMS versus POV using Chi-squared test.

When comparing the odds of arriving to the ED by EMS compared to POV using logistic regression, the only significant factor identified was age. Patients older than 65 years old were more likely than younger patients to utilize EMS rather than POV ($p < 0.001$). No statistically significant difference was found for gender or race. (Table 4).

Trust Scales

No statistically significant differences were found in GBMMS or JSPPE based on age greater than or less than 65 or gender. Black respondents had a higher GBMMS (indicating more mistrust), than white respondents ($p = 0.003$). However, in the JSPPE, no difference was found in response based on race (Table 5).

		Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Age	(years)	1.10 (1.05-1.16)	<0.001	1.10 (1.05-1.17)	<0.001
Gender	Female (referent)				
	Male	1.04 (0.38-2.81)	0.944	0.68 (0.20-2.25)	0.54
Race	White (referent)				
	Black	0.95 (0.34-2.70)	0.916	0.88 (0.26-3.00)	0.84

Table 4. Logistic regression model estimating the odds of arriving by EMS versus POV.

Qualitative Findings

We identified six themes in response to open-ended questions about the decision to use EMS or POV for transportation: 1) access to POV, 2) physical limitations, 3) cost, 4) speed, 5) perception of emergency, and 6) fear. The descriptive summaries for each theme are presented below.

	GBMMS	p-value	JSPPE	p-value
Overall	16.0 (15.0-18.0)		18.5 (16.3-20.0)	
Age				
< 65	16.0 (14.0-17.0)	0.136	19.0 (16.0-20.0)	0.945
65+	18.0 (15.5-22.5)		18.0 (17.0-20.0	
Gender				
Male	16 (15.5-17.0)	0.437	19.0 (180-20.0)	0.578
Female	18 (15.0-22.5)		17.0 (14.0-20.0)	
Race				
Black	18.0 (16.0-22.0)	0.003	18.0 (16.0-20.0)	0.531
White	15.0 (13.0-15.0)		20.0 (17.0-20.0)	

Table 5. Summed trust scores by demographics.

Access to POV

Five participants who arrived by EMS to the ED reported not owning or having access to a private vehicle. Four participants shared that they had access to a POV during certain hours, but not during others. Participants specifically described calling EMS at certain times of day when a POV was unavailable. For instance, when "it's 5 am" participants viewed EMS as "the only way" or the "only option" to get to the ED. On the other side of this, most participants who came via POV did so because they had access to a POV and a family member was "available" or "able to drive." Some participants described that owning a vehicle or borrowing one from a friend, family member, or neighbor factoring into their decision-making process. In fact, several participants described making contingency plans with a family member or friend to bring them to the ED in the event that their symptoms had not improved or worsened.

Physical Limitations

Twenty participants cited physical limitations as an influencing factor in their decision regarding mode of transportation. Twelve participants who arrived at the ED via EMS reported an inability to use a POV due to medical reasons such as being unable to walk, feeling weak, or being unable to navigate a home staircase. When participants described difficulty ambulating at baseline, extreme shortness of breath, or visual changes, they questioned whether it was "safe" to drive themselves and believed EMS "would know best" how to transport them to the ED.

For participants who presented via POV, eight did so because they felt confident about their ability to drive safely. One reason that some participants felt safe driving was because they lived extremely close to a hospital, thus their physical ailments did not limit their ability to drive a short distance. Finally, three participants stated that they were sent to the ED from a doctor's appointment to which they had already driven themselves and believed they could arrive safely.

Cost

The cost of EMS transport was one of the most frequently recurring themes among participants, especially those that arrived via POV. Eleven participants expressed concern about the cost of EMS care and believed that taking a car would be a "less expensive" option or that an ambulance was too expensive. Although some participants said they had insurance coverage, many did not know what the out-of-pocket cost or co-pays

would be, so they opted to decline using EMS rather than taking the risk of receiving a bill they could not afford to pay. Finally, some participants reported being underinsured or having no insurance and simply knew that EMS transport would not be covered.

Speed

The speed of transport and evaluation in the ED was discussed by thirteen participants in both the EMS and POV groups. Some participants thought the ambulance would take "a long time." Others noted being located just a few minutes from the ED, and thus, POV would be the fastest as they did not have to "wait for EMS." Interestingly, some participants believed the opposite: that they would receive expedited medical care and would be seen faster in the ED if they came in by EMS because they would bypass the triage lines.

Perception of Emergency

Twelve participants questioned what constitutes an emergency and described how that influenced their transport decision. Some participants stated that they did not think their condition was "serious enough" or "life threatening" and, therefore, did not believe it was an emergency. A couple of participants stated that they would only utilize EMS in a "severe emergency" such as being unconscious or experiencing a traumatic injury.

Fear

Fear as a theme was discussed in multiple ways: for the majority of participants fear was a pervasive reason to use POV. For example, some reported not wanting to come into the ED alone, so using POV ensured a family member or loved one could come too. Two participants discussed a "fear of judgment" from hospital personnel for utilizing EMS based on past experiences. And as a result, those participants decided to use POV so that they could control which ED would provide them care. One participant noted a fear around attracting the attention of his neighbors and not wanting to "make a scene," which led to his decision to use a POV for transportation despite acknowledging that EMS transport was a medically better option.

DISCUSSION

While many studies have investigated quantitative factors correlated with high-frequency EMS utilization, to our knowledge, this is the first study to explore the decision to utilize EMS from the patient perspective, including patient factors and an exploration of the relationship between perceived trust and empathy of the 911 system, and EMS utilization.

Approximately one-third of the participants arrived via EMS. That number is higher than national data showing utilization of EMS to access emergency care, which could be due to the nature of the facility (a tertiary care hospital), or as a result of the convenience sampling. Similar to prior studies, older participants utilized EMS frequently (Duong et al., 2018), and patients often utilized EMS even when they did not perceive a threat to life, organ or body function (Agarwal, et al. 2019). Even though older adults utilized EMS more often than younger ones, we did not appreciate significant differences between past medical history reported by the two groups. This could be a limitation of self-reporting; patients may not always be aware of their medical diagnoses. However, it

is interesting to note that there was no difference between the two groups in regard to self-reported medical history. Although patients with particular medical diagnoses or with a greater number of medical diagnoses may present with higher-acuity conditions, perhaps they have also found regular transportation to meet the needs stemming from those medical diagnoses.

Patients who arrived in a POV reported using marijuana more frequently than those who arrived by EMS. Other studies have demonstrated that patients sometimes fear calling "9-1-1" to engage EMS because they are concerned that law enforcement will also show up (Sasson et al., 2015). As the study took place in a state in which marijuana is classified as an illegal substance, this could be a reason that patients who use marijuana more frequently engaged EMS less often, although it was interesting to note that we did not see the same correlation with reference to other illicit drugs. This finding could also be related to the difference in utilization based on age previously noted, as it is known that use is highest among 18- to 25-year-olds and lower in older groups (National Academies of Sciences, Engineering, and Medicine, 2017).

Self-reported race, gender, and insurance status did not vary significantly with use of EMS over POV. As we gleaned from the qualitative data, selection of EMS over POV often reflected a multitude of patient-level factors that cannot necessarily be described with quantitative data. For example, some patients worried about the cost of taking EMS because of lack of insurance, while others took EMS because they did not have a car.

As shown by GBMMS and JSPPPE scales adapted for this study, black patients were less trusting of EMS than white patients, but no difference was found in patient perception of provider empathy when stratified by patient race. Those results are similar to comparable studies in the ED setting, even though the scales were adapted here to be applied to EMS (Kline et al., 2020). Our findings may result from a lack of racial diversity in the EMS workforce. Approximately 85% of nationally certified EMS personnel identify as non-Hispanic white (Cash et al., 2022). Additionally, only 8% of employees of the largest EMS agency serving the jurisdiction self-identify as Black. It is possible that since fewer black patients receive race-concordant care, they are less likely to trust providers. Previous work has found that patients with racially or ethnically concordant clinicians were 7.5 percentage points more likely to report trust than patients with non-concordant clinicians (Greene et al., 2023). These findings also suggest that efforts should continue to identify actual and perceived differences in care of patients by race and ethnicity.

Another question we asked to better understand the patient perspective was "did you feel that you had an immediate threat to life, organ, or body function today?" We did not observe a significant difference in response to this question between those who selected POV versus EMS. Published literature varies on this topic. Some studies demonstrated the low medical acuity of patients who frequently used EMS (Billittier et al., 1996; Gardner, 1990) while another demonstrated that patients utilizing EMS required more ED resources and had longer length of stays, suggesting higher acuity (Peters et al., 2023). Still other studies have shown little agreement between healthcare workers and patients as to what constitutes an emergency or appropriate utilization of emergency services (Dejean et al., 2016; Uscher-Pines et al., 2013). It is noteworthy that despite being in an ED when queried, more than half of patients stated that they did not think their condition constituted a threat to life, organ or body function.

A prior study identified four non-medical factors that paramedics considered to be justifiable use of the ambulance: patient age, lack of knowledge of the system, lack of social support, and systemic failures (Dejean et al., 2016). Specifically, EMS providers reported they were called by patients awaiting placement in long-term care facilities and patients who were unable to move themselves (Dejean et al., 2016). Those were consistent with some of the factors our patients identified as reasons to call EMS. Our patients further cited access to a POV and cost as reasons to engage EMS or not. A significant number of patients suffer from transport insecurity (Health Research & Educational Trust, 2017) and fear of surprise bills for ambulance transport is reasonable as in 2020, the median surprise billing for ground EMS transportation was $450 (Chhabra et al., 2020). Those factors suggest many opportunities for ways to improve access to and efficiency of our current system. For example, alternatives to EMS can appropriately address low-acuity concerns.

Another recurrent theme that presented during our study was the perception that patients had as to the speed in which EMS or POV would provide them with medical attention. Some patients came via EMS as they thought it would be faster after arrival at the hospital as they believed that presentation via ambulance would allow them to "skip" the triage line and receive medical care more rapidly. On the other hand, many of the patients who arrived at the ED in a POV stated that they did so as they thought this was the faster mode as they did not need to wait for EMS to arrive and could go directly to the ED. Previous studies find that EMS units in the United States average 7 minutes from the time of the call to the arrival on scene, however the median time increases to 14 minutes in rural environments (Borg & Mosier, 2021). Additionally, one study found that the door-to-doctor evaluation time was 5.3 minutes for patients arriving via EMS and 18.8 minutes for those coming via POV with a $p < 0.0001$ (Mell et al., 2017). This could lend credibility to the suggestion that EMS transport allows them to move ahead in the triage line but could also be related to the fact that many patients who come by ambulance are appropriately triaged to receive faster care given the acuity of their condition.

LIMITATIONS

This study is a pilot study in which the study design only captured a subset of the ED population; those too ill to be interviewed were not included and participation was voluntary. That could have created a selection bias. Although 11% of the population was Latinx and a Spanish survey was created, the findings only represent those who completed the survey in English. The study was limited to one hospital with a single catchment area and was only administered during the week. The student administering the survey was Caucasian. We attempted to limit the bias this might introduce by putting all sensitive questions into an iPad questionnaire that was administered when she had left the room. Future studies should examine the generalizability of our findings in a setting with a higher proportion of Latinx patients.

CONCLUSIONS

This study provides insight into patient decisions to utilize EMS or not, specifically identifying major themes driving the decision to select EMS or POV. It further highlights disparities in trust of the EMS system, which may impact healthcare access. It could be

used as a foundation for future studies exploring equitable access to healthcare and alternative non-emergent healthcare options.

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APPENDIX A

Adapted Group Based Medical Mistrust Scale (GBMMS). Answer choices included strongly disagree, disagree, neutral, agree, and strongly agree.

- EMS providers sometimes hide information from patients who belong to my ethnic group
- EMS providers have the best interests of people in my ethnic group in mind
- People of my ethnic group should not confide in EMS providers because it will be used against them
- People of my ethnic group should be suspicious of information from EMS providers
- People of my ethnic group cannot trust EMS providers
- People of my ethnic group should be suspicious of modern medicine
- EMS providers treat people of my ethnic group like "guinea pigs."

APPENDIX B

Adapted Jefferson Scale of Patient Perception of Physician Empathy. Answer choices included strongly disagree, disagree, neutral, agree, and strongly agree.

- EMS providers understand my emotions, feelings, and concerns
- EMS providers seem concerned about me and my family
- EMS providers can view things from my perspective (see things as I see them).
- EMS providers ask about what is happening in my daily life.
- EMS providers are understanding

APPENDIX C

Survey for English-speakers (qualitative questions marked with *)

How did you get to the emergency department today?

- 9-1-1 ambulance
- Private vehicle
- Not sure

Are you the one who decided to come to the hospital today?

- Yes
- No

If you came via EMS (a 9-1-1 ambulance), was the ambulance already on scene or did someone else make the decision to contact 9-1-1?

- I contacted 9-1-1
- I asked someone to contact 9-1-1
- Someone else contacted 9-1-1 without me asking for it

Did you feel that you had an immediate threat to life, organ or body function today?

- Yes
- No

*If "no" in the above question, what caused you to call 9-1-1?

Have you used EMS in the past?

- Yes
- No

Did anyone convince you to come to the emergency department today?

- No
- Yes, a friend
- Yes, a family member
- Yes, a co-worker
- Yes, other

*Why did you choose the type of transport you used?

If you used EMS, would you be willing to use this service again?

- Yes
- No

*If you used EMS, why or why not would you be willing to use this service again?

For the following questions, please consider your experience with EMS today. (Answer choices for all were: Strongly disagree; Disagree; Neutral; Agree; Strongly Agree)

- EMS providers sometimes hide information from patients who belong to my ethnic group.
- EMS providers have the best interests of people of my ethnic group in mind.
- People of my ethnic group should not confide in EMS providers because it will be used against them.

- People of my ethnic group should be suspicious of information from EMS providers.
- People of my ethnic group cannot trust EMS providers.
- People of my ethnic group should be suspicious of modern medicine
- EMS providers treat people of my ethnic group like "guinea pigs."

For the following questions, please consider your experience with EMS today. (Answer choices for all were: Strongly disagree; Disagree; Neutral; Agree; Strongly Agree)

- EMS providers understand my emotions, feelings, and concerns.
- EMS providers seem concerned about me and my family.
- EMS providers can view things from my perspective (see things as I see them).
- EMS providers are understanding EMS providers.

What is your ethnicity?

- Hispanic or Latino
- Not Hispanic or Latino
- Other/Prefer not to answer

What is your race?

- White or Caucasian
- Black/African American
- Asian
- Native Hawaiian or Other Pacific Islander
- Other/Prefer not to answer

Do you have any medical training?

- Yes
- No

What is your income?

- Prefer not to answer
- >$100,000 per year
- $50,000-100,000 per year
- $30,000-50,000 per year
- <$30,000 per year

Insurance status

- Private insurance
- Public insurance
- Uninsured

Has a doctor or another health care worker diagnosed you with or treated you for one of the following medical problems in the past three years? (Answer choices were: Yes; No; Refuse to answer)

- Asthma, emphysema or chronic bronchitis
- High blood pressure or hypertension
- High blood sugar or diabetes
- Arthritis or rheumatism (inflammation of the joints)
- Angina, heart failure or other types of heart disease
- Stroke, seizures, Parkinson's disease, or another neurological condition

- Liver disease
- Kidney or renal disease
- Cancer diagnosed or treated in the last three years
- Anxiety or depression
- Some other psychiatric disorder

Do you have any other medical problems that we did not ask about?

In the past 3 months have you used any of the following drugs? Your answers are confidential. (Answer choices were: Yes; No; Decline to Answer)

- Cigarettes
- Alcohol 4 or more times per week
- Marijuana
- Cocaine
- Heroin

After the patient portion of the survey was completed, the researcher would answer the following questions by reviewing the patient's chart:

Which area in the emergency department is the patient?

- High acuity
- Low acuity

What is the room number?

What is the chief complaint?

How many ED visits did the patient have in the past 3 months?

What is the patient's age?

What is the medical record number?

What is the patient's gender?

- Male
- Female
- Non-binary/Third gender
- Prefer not to say

Was the patient admitted?

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RESEARCH REPORTS

COMPARING THE EFFICACY OF SIMULATED OUT-OF-HOSPITAL VENTILATION WITH SMART BAG-VALVE AND TRADITIONAL BAG-VALVE DEVICES

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Keywords: cardiopulmonary resuscitation; ventilation rate; tidal volume; bag-valve-mask; SMART bag-valve-mask, emergency medical services, EMS, paramedicine

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ABSTRACT

Aim: Optimal Bag Valve Mask (BVM) ventilation is crucial during the management of cardiac arrest because it provides gas exchange to patients, improving chances of survival until advanced care becomes available. Clinicians often hyperventilate patients, leading to an increased risk of aspiration and barotrauma. The SMART BVM has been released, incorporating a pressure-responsive valve limiting airflow if/when the operator is hyperventilating. The aim of this study was to compare mean ventilation rates, singular tidal volume, and one-minute volume of asynchronous ventilations of the SMART BVM and the more traditionally used Adult, and the Pediatric BVMs during an out-of-hospital (OHCA) cardiopulmonary resuscitation simulation amongst a group of novice paramedicine students.

Methods: Thirty paramedic students, working in pairs, completed three simulated cardiopulmonary resuscitation exercises (SIMEXS) inside a stationary ambulance utilizing the three BVMs (randomised order of exposure), lasting four minutes each with one participant providing two minutes of asynchronous ventilations and the second participant providing chest compressions at a rate of 100–120 per minute for two minutes before defibrillating. Measures of ventilation rates, singular tidal volume, and one-minute volume were taken for comparison against international recommendations.

Results: The SMART and Adult BVM mean ventilation rates were within recommended guideline parameters (i.e., 10–12 BPM). Adult BVM mean singular tidal volume (524mLs, p=0.179) and one-minute volume (5894mLs, p=0.399) were not dissimilar to the International Liaison Committee on Resuscitation (ILCOR) recommendations (i.e., 500mLs per inspiration and 5000–6000 mLs minute volume). However, mean tidal volumes for the SMART BVM and Pediatric BVM were below ILCOR recommendations (443mLs, p<0.010 and 280mLs, p<0.001, respectively), as was the Pediatric BVM mean one-minute volume (2992mLs, p<0.001).

Conclusion: In a simulated OHCA cardiac resuscitation, novice paramedic students were able to meet ILCOR recommendations for tidal and one-minute volume using a standard Adult BVM; however, when using the Pediatric and SMART BVM, the ventilatory provisions were below ICOR guidelines, thus resulting in hypoventilation due to insufficient tidal volume and one-minute volume.

INTRODUCTION

Out-of-Hospital-Cardiac-Arrest (OHCA) is a leading cause of mortality worldwide, with survival rates being low, ranging from 3.1–20.4% internationally when patients are resuscitated by emergency medical service clinicians (Meaney et al., 2013; Nishiyama et al., 2023; The, 2018). During cardiopulmonary resuscitation (CPR), the Bag Valve Mask (BVM) provides lifesaving positive pressure ventilations to the compromised patient with absent or ineffective breathing, delivering oxygen to the respiratory tract, thus enabling gas exchange, and the BVM has been the mainstay of prehospital ventilation since its creation in 1953 (Ambu., 2023; Australia., 2020a; O-Two et al., 2015). The design of the Adult BVM allows a large variability in volume delivery, and research has historically identified a lack of compliance with ventilation guidelines during OHCA CPR (Aufderheide & Lurie, 2004; Baskett et al., 2005). Studies indicate clinicians can overzealously ventilate patients when using a self-inflating bag valve mask at rates two to three times above the International Committee on Resuscitation (ILCOR) recommended 10 breaths per minute (BPM) (Abella et al., 2005; Aufderheide & Lurie, 2004; Soar et al., 2020). Hyperventilation can lead to aspiration, barotrauma, and raised cerebral pressure (Bucher et al., 2019; Wenzel et al., 2001). However, despite the international ventilatory guideline incrementally decreasing from the measurable 1992 recommendation of 12–15 BPM, singular tidal volume ventilation of 800–1200mLs to the 2015–2020 ventilatory recommendation of 10 BPM and singular tidal volume ventilation of 500mLs (Baskett et al., 1996; Monsieurs et al., 2015), prehospital, clinical, and simulated studies still indicate poor compliance with ventilatory guidelines on both unprotected and advanced airways, leading to both hypo/hyper-ventilation and insufficient or excessive tidal and minute volumes (Culbreth & Gardenhire, 2021; Dafilou et al., 2020; Kroll et al., 2019; Siegler et al., 2017; Vissers et al., 2019).

Thus, the traditional Pediatric BVM has been trialled within in-hospital and tabletop studies to assess if the reduced size of the self-inflating bag decreases inadvertent hyperventilation within OHCA. Results indicate the traditional Pediatric BVM may well provide more efficacious ventilations compared to the Adult BVM (Dafilou et al., 2020; Doerges et al., 1999; Siegler et al., 2017). Alternatively, the Synchronous Manual Actuation Response Technology (SMART) BVM has been engineered with an incorporated pressure-responsive valve (an actuating mechanism) that limits the inspiratory gas flow depending on the operator's applied squeeze of the bag into the patient's airway. The SMART BVM-activated valve increases the bag's resistance when squeezed too hard, indicating to the clinician that they are ventilating too forcefully. A red-coloured indicator valve within the neck of the BVM indicates if gas is flowing too rapidly (Figures 1 and 2). In-hospital tabletop studies found the SMART BVM provided ventilations and tidal volumes closer to recommended guidelines than other Adult BVMs (Wagner-Berger, Wenzel, Stallinger, et al., 2003; Wagner-Berger, Wenzel, Voelckel, et al., 2003).

ILCOR has identified that additional research is required to inform optimal ventilation, airway, and compression practices in pre-hospital environments (Olasveengen et al., 2017). Additionally, improvements in CPR outcomes need a high-quality chain of survival from essential to advanced life support, including optimal ventilation from a BVM (Soar et al., 2021). The present study investigated which of three established BVMs (SMART, traditional Pediatric, and traditional Adult) provided efficacious ventilation

rates and tidal volumes most closely aligned with ILCOR guidelines during a simulated OHCA amongst novice paramedicine students.

METHODS

Thirty paramedic students, working in pairs, completed three simulated cardiopulmonary resuscitation exercises (SIMEXS) utilizing three BVMs (randomised order of exposure), lasting four minutes each with one participant providing two minutes of asynchronous ventilations at a rate of 10–12 breaths per minute, and inspired volume of 500mLs, and the second participant providing chest compressions at a rate of 100–120 per minute for two minutes before defibrillating. Measures of ventilation rates, singular tidal volume, and one-minute volume were taken to compare against international recommendations (i.e., mean ventilations per minute of 10–12 BPM (Australia., 2020a) mean singular tidal volume of 500mLs per inspiration and one-minute tidal volume of 5000–6000mLs (Australian Resuscitation Council, 2021)).

Participants

Participants in this study were first-year undergraduate paramedical science students enrolled at Edith Cowan University (ECU) in Western Australia (WA) who had undertaken CPR training. First-year students were deemed most appropriate given they possessed a foundational understanding of CPR, removing the need to provide basic CPR training (as would be the case with non-specialists) whilst simultaneously limiting the variability of experience that would have occurred in higher-year level student cohorts. Clinicians and volunteers responding to OHCA vary with respect to clinical

Figure 1. SMART B VM (Smart Bag Specifiation, 2022).

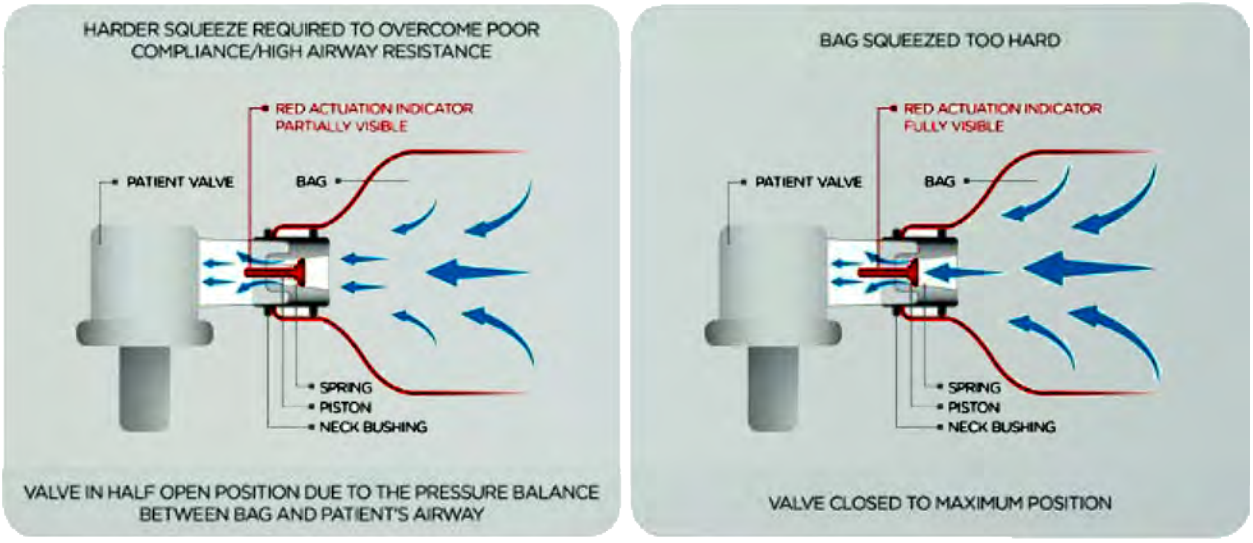

Figure 2. SMART BVM Valve (Smart Bag Specification, 2022).

experience and training. Thus, novice students were also chosen for the research given they emulate (if not exceed) the more inexperienced clinicians that could be exposed to OHCA patients.

A short demographic questionnaire collected data about age, sex (male/female/other), prior CPR training such as first aid training, certificates or diplomas, surf lifesaving, or paid employment in health care, including any previous exposure to CPR events.

Equipment

AMBU Adult and Pediatric SPUR II BVM (traditional)

The Artificial Manual Breathing Unit (Ambu) has been formulated as a highly responsive self-inflating BVM with minimal mechanical ventilation resistance. It has been developed with a disc valve for forward airflow and positive pressure ventilation. The traditional Adult and Pediatric BVM vary only in self-inflating bag sizes (1574mLs and 683mLs, respectively), with a single-hand delivery of approximately 600mls and 450mls, respectively (Ambu, 2021).

O-Two-O Adult SMART BVM

The SMART BVM has been developed with an actuating mechanism to intentionally limit the potential for excessive gas flow into the patient's airway. The SMART BVM has a single-hand delivery of approximately 900mls (O-Two Medical Technologies, 2000, 2015, 2021).

Collection of Outcome Variables

This study required the measurement of manual singular ventilation rates and singular-inspired tidal volumes, thus quantifying the calculation of one-minute volume (ventilation rate × tidal volume) per BVM, including the capacity for participants to receive visual and audible feedback throughout chest compression (100–120 CPM) (Australia, 2020; Olasveengen et al., 2017). The pre-hospital ZOLL X Series Advanced with REAL BVM Help (ZOLL et al.. Ltd) measures ventilatory rate and tidal volume for intubated (and non-intubated) patients through an AccuVent sensor; the sensor was interconnected between the BVM neck connector and a 7.5mm endotracheal tube (ETT) and intubated into a full-bodied Laerdal QCPR Resusci Anne mannequin (Laerdal et al.). Furthermore, the ZOLL X series chest compressor puck was placed on the lower half of the Laerdal mannequin sternum and connected to the monitor via the monitor defibrillator with training defibrillation pads applied, thus enabling live participant feedback, and measurements of chest compression rate, depth, recoil, and providing an avenue to view post-case data online (ZOLL Medical, 2015). The research team tested all the equipment to manufacturer protocol specifications before each SIMEX began, ensuring the reliability of the data. During SIMEXs, the ventilation rate and tidal volume measurements on the display screen were covered from the participant's view (Figure 3).

Research Protocol

Following receipt of signed informed consent, participants completed the demographic questionnaire. Each participant pair was positioned in the rear of a stationary ambulance. A member of the research team provided a standardised demonstration of how

Figure 3. Laerdal mannequin positioned within the ambulance, and ZOLL X series AccuVen attached to SMART BVM.

to apply pressure to each BVM using the dominant hand positioned in an inverted grip, with the thumb, pointer, and middle finger, whilst supporting the BVM using the ring and little finger upon the air-inlet one-way valve and O2 reservoir socket. Participants were allowed to familiarize themselves with each BVM to their satisfaction and ask questions before beginning the OHCA SIMEX. At the beginning of each of the three SIMEXs, one of the two participants (allocated at random) was instructed to administer asynchronous ventilations at the rate of 10–12 BPM, aiming for an approximate tidal volume of 500mLs per inspiration using an inverted hand grip, whilst simultaneously the second participant provided cardiac chest compressions at a rate of 100–120 per minute (Australia., 2020a, 2020b). The mannequin was defibrillated at the two-minute mark, following ILCOR guidelines (Soar et al., 2021) at which time participants swapped roles and continued for a further two minutes before ending the SIMEX.

SIMEXs comprised three successive CPR sessions (each utilizing a different BVM in a randomized order) lasting four minutes each. There was a six-minute allocated rest period between the three scenarios, replicating the rotation of paramedic cardiac compressors throughout CPR to reduce compressor fatigue following Australian and New Zealand Committee on Resuscitation (ANZCOR) CPR guidelines (Australian Resuscitation Council, 2021). During this time, the research team exchanged the randomized BVM.

Statistical Analysis

Data were recorded by the ZOLL X series defibrillator series software package (ZOLL et al. Ltd) and imported into Microsoft Excel (Version 11) before being manually transferred into IBM SPSS Statistics (Version 26.0) for analysis. Outcome variables of mean ventilations per minute, mean singular tidal volume per minute, and mean one-minute volume

were calculated across the three BVM study conditions and compared using a series of one-way repeated measure ANOVAs. Further, a series of one-sample t-tests were used to compare outcome variable means against upper and lower ventilatory guideline boundaries (i.e. mean ventilations per minute of 10–12 BPM (Australia., 2020a) mean singular tidal volume of 500mLs per inspiration and one-minute tidal volume of 5000–6000mLs (Australian Resuscitation Council, 2021)). An alpha value $p<0.05$ was considered statistically significant. Shapiro-Wilks normality tests suggested that all outcome variable data for each BVM did not violate assumptions of normality ($p>0.05$).

Ethical Approval

Ethics approval was granted by the ECU Human Research Ethics Committee in alignment with the National Health and Medical Research Council National Statement on Ethical Conduct in Human Research. Participants returned signed consent forms prior to the beginning of data collection.

RESULTS

Thirty first-year ECU undergraduate paramedic students (12 male, 18 female) with an average age of 24±7 years participated in the study. Independent samples t-tests indicated no differences between sexes or experience levels (0–30 months versus 31–60 months) across BVMs for all outcome measures. Technological faults led to data not being captured for two participants from the traditional Adult BVM condition. Therefore, comparative analyses between the three BVMs were examined on the remaining 28 complete data sets.

Mean Ventilations Per Minute

A total of 1930 ventilations were analysed. Mean ventilation rates did not significantly differ across BVMs (Table 1[a–c]). While the SMART and Adult BVMs mean ventilation rates were within the St John clinical guidelines recommended rate of 10–12 BPM (St John Ambulance Australia, 2020b), the Pediatric BVMs mean ventilation rate was slightly lower than the state ambulance ventilation rate (St John Ambulance Australia, 2020b) (Table 1[b]).

Mean Tidal Volume

The mean singular tidal volume for the traditional Pediatric BVM (280.5 mLs) (Table 1[e]) was significantly lower than both the SMART BVM (443.4 mLs) (Table 1[d]) and traditional Adult BVM (524 mLs) (Table 1[f]). Further, the SMART BVM had a mean singular tidal volume significantly lower than the traditional Adult BVM (80.1 mLs; $p<0.001$*) (Table 2[a]). Whilst in comparison to ILCORs recommended singular tidal volume (500mLs), both the SMART BVM (-56.5 mLs; $p<0.010$) (Table 3[a]) and traditional Pediatric BVM ($p<0.001$*; -219.4 mLs) (Table 3[b]) were significantly below ILCORs recommendation, yet the traditional Adult BVM was no different to ILCORs singular (500mLs) tidal volume guidelines (24.0 mLs; $p>0.179$) (Table 3[c]).

Mean One-Minute Volume

The traditional Pediatric BVMs mean one-minute tidal volume was lower than both the SMART BVM (1918.3 mLs; $p<0.001$*) (Table 2[b]) and traditional Adult BVM (2828.7 mLs;

p<0.001*) (Table 2[c]). Further, the SMART BVM had a mean one-minute tidal volume lower than the traditional Adult BVM (910.4 mLs; p<0.008*) (Table 2[d]). The SMART BVM mean one-minute tidal volume (4893.5 mLs) (Table 1[g]) was no different than the lower boundary of ILCORs recommended 5000mLs (-106.5 mLs; p=0.386) (Table 3[d]) and the traditional Adult BVM one-minute tidal volume (5894.2mLs) (Table 1[i]) was no different to the upper boundary of ILCORs recommended 6000 mLs (-105.7mLs; p=0.399) (Table 3[e]). However, the traditional Pediatric BVM mean one-minute tidal volume (2992.8mLs) (Table 1[h]) was significantly below the lower boundary of the ILCOR recommended 5000mLs (-3007.2; p<0.001) (Table 3[f]).

	SMART BVM	Pediatric BVM	Adult BVM
Bag size volume (mLs)	1700	683	1547
One-minute ventilation rate	11.1 ± 3.06 (CI: 10.0 – 12.1)[a]	10.4 ± 3.70 (CI: 9.0 – 11.7)[b]	11.3 ± 3.17 (CI: 10.1 – 12.4)[c]
Singular tidal volume (mLs)	443.4 ± 126.7 (CI: 396.0 – 490.7)[d]	280.5 ± 61.4 (CI: 257.4 – 303.3)[e]	524 ± 135.7 (CI: 471.3 – 576.6)[f]
One-minute volume (mLs)	4893.5 ± 1999.3 (CI: 4178.0 – 5608.9)[g]	2992.8 ± 1389.7 (CI: 2495.5 – 3490.0)[h]	5894.2 ± 2165.6 (CI: 5106.7 - 6681.6)[i]
CI is defined as 95% Confidence Intervals.			

Table 1. Bag size volume, mean one-minute ventilation rate, mean singular tidal volume and mean one-minute tidal volume for each of the three BVMs.

	Singular-Inspired Tidal Volume			One-Minute Volume		
	Mean Diff (mLs)	95% CI	p-value	Mean Diff (mLs)	95% CI	p-value
Adult vs SMART BVM	80.1	(41.9–118.3)	<0.001* [a]	910.4	(212.7-1608.0)	<0.008* [d]
Pediatric vs Smart BVM (b)	163.3	(111.3–215.4)	<0.001*	1918.3	(1167.8-2668.9)	<0.001* [b]
Adult vs Pediatric BVM (c)	243.5	(194.7–292.3)	<0.001*	2828.7	(2273.7-3383.7)	<0.001* [c]
*Denotes statistically significant difference at α=0.05						

Table 2. Pairwise Comparisons for mean singular inspired tidal volumes and one-minute volumes.

BVM	Breathes per Minute				Singular Tidal Volume		One-Minute Volume			
	Mean Diff (Lower Boundary)	p-value	Mean Diff (Higher Boundary)	p-value	Mean Diff from Test Value	p-value	Mean Diff (Lower Boundary)	p-value	Mean Diff (Higher Boundary)	p-value
SMART	1.1	<0.030	-0.9	<0.059	-56.5	<0.010 [a]	-106.5	0.386 [d]	-1106.5	<0.003
Pediatric	0.4	0.271	-1.6	<0.013	-219.4	<0.001 [b]	-2007.2	<0.001	-3007.2	<0.001 [f]
Adult	1.3	<0.019	-0.6	0.128	24.0	0.179 [c]	894.2	<0.019	-105.7	0.399 [e]
*Denotes statistically significant difference at =0.05										

Table 3. One sample t-test comparisons to upper and lower boundaries of established guidelines for breaths per minute (10–12 BPM), singular tidal volume (500 mLs per inspiration) and one-minute volume (5000–6000 mLs).

DISCUSSION

While the efficacy of positive pressure ventilation during cardiac arrest can be challenging to measure, particularly in prehospital settings, utilizing equipment that best optimizes ventilation to meet recommendations is imperative to improving clinical outcomes (Wang et al., 2023). Our study utilized the ZOLL X series, providing access to post-case review data on ventilation rate, singular tidal volume, and one-minute tidal volume (ventilation rate × tidal volume) from participants applying ventilations. This allowed a clear comparison of the ventilation efficacy of three self-inflating BVMs upon an endotracheal intubated (ETT) mannequin within an OHCA-simulated setting using a procedural inverted hand grip. We believe this to be the first study leveraging the ZOLL X series comparing traditional Adult and Pediatric BVMs with the SMART BVM, making it an important first step in analyzing equipment best suited to the prehospital environment.

No differences were noted across mean ventilation rates for the SMART and Adult BVM, with the mean ventilation rates falling within the Western Australian state ambulance service guidelines of 10–12 BPM (Australia., 2020a). However, although the Pediatric BVMs mean ventilation rate was within the 10–12 BPM boundary (10.4 ± 3.70 BPM), the mean rate did approach the lower boundary of the ambulance service guideline (95% CI [9.0 – 11.7] $p>0.271$), with the SJAWA ventilation rate allowing more flexibility than the more rigid ILCOR recommendation of 10BPM (Soar et al., 2020). Nevertheless, taken together these data indicate the type of BVM had little to no impact on the operator's ability to deliver ventilations at an appropriate rate, particularly when leveraging the inverted hand grip. This result is of particular interest when considering that the actuating mechanism inside the SMART BVM is designed to intentionally limit gas flow, having seemingly little to no impact on ventilation rate in comparison to the traditional Adult and Pediatric BVM.

However, mean singular tidal volume delivery did differ among the three devices. When using the traditional Pediatric BVM, participants delivered, on average, a smaller singular tidal volume compared to the SMART and traditional Adult BVMs—on average, 219.5mLs per inspiration lower than the ILCOR recommended mean tidal volume of 500mLs per inspiration. The SMART BVM also delivered mean singular tidal volume significantly lower than the ILCOR recommendation of 500mLs per inspiration, however, by a far smaller margin of (on average) 56.6mLs per inspiration. The traditional Adult BVM provided mean singular tidal volume most closely aligned to the ILCOR guideline.

The differentiation noted across BVMs with respect to mean singular tidal volumes, coupled with the lack of apparent differentiation across BVMs for mean ventilation rates, explain one-minute tidal volume findings. Participants using the traditional Pediatric BVM delivered one-minute tidal volumes that were far lower in comparison to the other two BVMs and well below the lower boundary of ILCOR recommendations of 5000–6000mLs per minute. The traditional Adult BVM mean one-minute tidal volume fell within ILCOR recommendation boundaries, and the mean SMART BVM one-minute tidal volume was below the prescribed 5,000mLs, but this difference was not statistically significant.

Reviewing study ventilation and tidal volume findings together, the traditional Adult BVM was utilized most optimally amongst this group of novice undergraduate paramedicine students, with the SMART BVM and Pediatric BVM both providing tidal

volume below that recommended by ILCOR. These findings are at odds with previous literature examining tidal volume efficacy of both the Pediatric and SMART BVM. Previous studies, both with in-hospital and pre-hospital focus, demonstrate a decreased risk of hyperventilation when using the Pediatric and SMART BVM whilst still maintaining adequate singular tidal volume and minute volume in comparison to more traditional Adult BVMs (Doerges et al., 1999; Kroll et al., 2019; Siegler et al., 2017; Wagner-Berger, Wenzel, Voelckel, et al., 2003; Wenzel et al., 1999). While our findings similarly demonstrated minimal risk of hyperventilation, the traditional Pediatric BVM (and, to a lesser extent, the SMART BVM) demonstrated an increased risk of hypoventilation. In contrast, the traditional Adult BVM performed within accepted ILCOR recommendations.

It is possible the variations of our study findings in comparison to previous literature could be due to methodological differences across existing studies. For example, previous research makes use of a range of different professional cohorts acting as research participants, some with prior experience of administering ventilations in simulated and/or real-world in-hospital or pre-hospital settings, each with varied experience with different BVMs. Contrasting findings between novice and more experienced clinicians can be managed. However, they are made more difficult, particularly amongst those more experienced, when pre-exposure to different BVMs may impact measured outcomes. Our study targeted novice paramedicine students to mitigate between-participant comparison issues resulting from differing prior BVM experience and exposure. While advantageous to mitigate the risk of non-homogeneity, generalizability to practicing clinicians is unclear. Also, different hand grip techniques have been demonstrated to impact ventilatory efficacy (Kroll et al., 2019; A. J. Nitzsky et al., 2018), with many studies not standardizing grip technique across participants. While not standardizing grip technique potentially provides a more accurate reflection of real-world ventilatory behaviours (occurring at the discretion of each individual clinician), it also makes comparing findings across studies problematic. Future research may provide stronger and more comparable contributions to the evidence-base by seeking to standardize (or at the minimal record) grip technique application across participants. In addition, over the previous three decades, ILCOR clinical recommendations have incrementally decreased target ventilation rates and tidal volumes, with resultant research studies changing prescribed target ranges to match. With participants and resultant analyses actively applying different clinical target parameters over time, the viability of cross-comparisons to dated research becomes more problematic. However, it is worth noting that despite ventilation rate and tidal volume guideline reductions over time, hyperventilation and hyperinflation above ILCOR guidelines does seem to be commonplace in simulation-based research with both in-hospital and pre-hospital clinicians. (Charlton et al., 2021; Culbreth & Gardenhire, 2021; Vissers et al., 2019; Wang et al., 2023). Lastly, our leveraging of the ZOLL X Series has provided an accurate and reliable measure of tidal volume with the ventilation feedback sensor placed between the catheter mount and ETT during OHCA scenarios.

Limitations of cross-research contrasts comparing different BVMs notwithstanding, our findings demonstrated clear hypoventilation using the traditional Pediatric BVM and some risk of the same with the SMART-BVM. The activated restrictor valve alerts rescuers when they are forcefully ventilating to directly combat hyperventilation, but (as per other BVMs) has no embedded functionality to combat or alert rescuers to the risks of

hypoventilation. The Laerdal mannequin used in this study had an advanced airway in situ, which provides further contrast difficulties to some of the prior studies which used unprotected airways, laryngeal mask airways (LMA), and supraglottic airways (SGA) with only a few previous studies inserting an ETT. However, the ZOLL X series AccuVent sensor was located between the catheter mount and ETT and not within the simulated mechanical lung. Thus, we would expect higher tidal volumes compared to prior studies using unprotected airways (and some LMA and SGA), given the increased risk of gas leakage around inspiratory sites (oropharynx/nasal cavity or laryngeal inlet). Yet, in comparison to many previous investigations using unprotected airways (Doerges, Ocker, Wenzel, et al., 1999; Soar, 2015; Wagner-Berger, Wenzel, Voelckel et al., 2003), present study tidal volume findings were lower. A potential explanation for these variations could be due to differences in tidal volume measurement instruments across studies or the potential impact of the inverted hand grip technique. Interestingly, respective BVM instruction manuals (Ambu, 2022; Bucher et al., 2019; O-Two Medical Technologies, 2015) do not specify where the clinician should grip the BVM or how many digits should be applied to squeeze the self-inflating section. Nor do most prior related investigations report on what hand grip techniques were employed (or whether they were standardized) across participants (Aufderheide et al., 2004; Busko et al., 2009; Doerges et al., 1999; Meaney et al., 2013). Accordingly, research has demonstrated that one versus two hands, or varying the number of digits used to squeeze the self-inflating bag, hand size, hand grip strength, glove size, levels of experience, and that grip strength decreases over time whilst applying ventilatory inspiration can impact tidal and one-minute volumes (if the ventilation rate is standardized) (Hess & Spahr, 1990; Kroll et al., 2019; Lee et al., 2008; McCabe, 1993; Austin J Nitzsky et al., 2018; Sall et al., 2018). Thus, use of the inverted hand grip when administering ventilations using any of the BVMs may have a more noticeable effect on the inspiratory tidal volume. Moreover, the inverted hand grip may have intermittently activated the inspiratory-pressure valve within the SMART BVM, thus reducing tidal volumes compared to prior studies (note that activation was not measured within the study). Furthermore, the student's prior education and training regarding the risks of hyperventilation during CPR might have led to a more cautious approach when ventilating with the devices. This cautionary approach could have impacted inspiratory volume, especially given that Pediatric BVMs are typically smaller, resulting in lower inspiratory volumes. As the BVMs lack an inspiratory gauge, the combined effect of using the inverted grip and the student's education may have further decreased overall one-minute volumes.

STUDY LIMITATIONS

Like most studies evaluating BVM efficacy in simulated environments (Doerges et al., 1999; Siegler et al., 2017; Wagner-Berger, Wenzel, Stallinger, et al., 2003), the present study setting, whereby we attempted to simulate realistic conditions of a prehospital OHCA in the back of a stationary ambulance, would have fallen short of wholistically reflecting real-world OHCA pre-hospital conditions. For example, utilizing a Laerdal mannequin in a stationary ambulance is unlikely to duplicate the highly stressful and dynamic prehospital OHCA environment, including respiratory complications during CPR such as secretions, aspiration, vomiting, airway obstruction, or difficult ventilation. Further, using SMART and traditional Pediatric BVMs could distort findings due to a lack of familiarity with these more novel BVMs. However, this effect was likely mediated by choosing a

study cohort with basic training only and allowing participants unlimited time to familiarize themselves and practice with all BVMs before data collection began. In addition, following the 2020 ILCOR scientific review, guidelines were revised to the less prescriptive patient chest rise and fall instead of a specific tidal volume of mLs/per/kg (Soar et al., 2021). Present study participants were instructed to inflate the adult mannequin to ~500mLs per ventilation. Another consideration of this study is the use of novice student practitioners. If the study were to be repeated with experienced healthcare clinicians, the results may differ. Repeating the study with different cohorts of clinicians may add to the knowledge base and provide further evidence of the efficacy of each type of BVM.

CONCLUSION

The efficacy of positive pressure ventilatory parameters is critical for favorable neurological outcomes post-OHCA, yet these aspects are challenging to measure in the pre-hospital setting. Thirty first-year undergraduate paramedic students performed asynchronous ventilations using the SMART and traditional Adult and Pediatric BVMs upon an intubated ETT mannequin within an OHCA-simulated setting using a procedural inverted hand grip. The ZOLL X series measured ventilation rates and singular inspired tidal volume, allowing calculation of one-minute tidal volume, each compared against ILCOR clinical guidelines. The SMART and Adult BVM mean ventilation rates were within the recommended guidelines, and Pediatric BVM slightly lower. Traditional Adult BVM mean singular tidal volume and one-minute volume were no different to ILCOR recommendations; however, mean singular tidal volumes for the SMART BVM and traditional Pediatric BVM were below ILCOR recommendations, as was the traditional Pediatric BVM mean one-minute volume. Our findings suggest that bag-valve-mask ventilation during a simulated OHCA using the procedural inverted hand grip with the SMART BVM and traditional Pediatric BVM may result in hypoventilation due to insufficient tidal volume and minute volume.

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REVIEWS

QUANTIFYING THREAT OR CHALLENGE RESPONSE OF UNDERGRADUATE PARAMEDICINE STUDENTS DURING HIGH-STRESS CLINICAL SCENARIOS: A NARRATIVE REVIEW

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ABSTRACT

Paramedicine practice can be inherently stressful. Encountering critically unwell patients, managing long shift hours and dealing with the unknown expose paramedics to mental, physical and emotional stress. In the learning environment, these types of stresses are difficult for educators to authentically replicate. Traditionally, students have been tested under pressure in scenario-based situations as a means of stress inoculation. However, the literature is unclear as to whether this exposure to stress enhances or hinders learning. A recent scoping review identified an acceptable level of stress during simulation can be beneficial, although a level of a balance is required. Too much stress can hinder learning and lead to underperformance. Ideally, high-acuity patient scenarios should be designed to invoke a challenging state of appraisal in the student to support both their learning and knowledge retention. To obtain a more holistic understanding of how students appraise these types of scenarios, quantitative physiological and psychometric data needs to be obtained and analysed. However, across the health care education literature, inconsistent methodologies and a variety of physiological and cognitive measures make it challenging to draw firm conclusions. This narrative review searched three prominent databases using common search terms to produce a subset of high-quality publications that we believe were most pertinent and insightful. Based on these findings, our paper presents guidance for appropriate physiological assessment and interpterion of challenge appraisal in students undertaking high-acuity, low-occurrence clinical scenarios.

INTRODUCTION

Paramedicine is a domain of practice that involves exposure to dynamic and stressful situations where lifesaving decisions are often made under immense pressure. Stress can be defined as a mental, physical, or emotional factors causing bodily or mental tension (Singh et al., 2018). The physical response to stress, or more accurately a group of adaptive physiological responses, was discussed in the early 1930's as 'general adaptation syndrome' (Selye, 1936), and is a mechanism by which the body attempts to restore internal homeostasis following exposure to adverse

stimuli. This leads to the fight (confronting the situation) or flight (attempting to flee) response - an immediate and involuntary reflex exhibited when faced with the danger of a stressful situation. First discussed by Walter B. Cannon when studying epinephrine secretion in laboratory animals in 1929 (Cannon, 1994), this response signals the amygdala to activate the autonomic nervous system to release stress hormones (such as epinephrine and cortisol) into the blood to initiate a physiological response (Jansen et al., 1995).

Along with Cannon's study, much of the early stress and performance research was based on laboratory studies of animals such as mice, chickens and kittens (Cole, 1911; Dodson, 1915). However in 1955, seminal work published by Hebb (1955) introduced the concept of 'arousal' as drivers of "sensory excitations" (pg.248) within the human central nervous system. Researchers now know in any pressure situation, low levels of hormones such as cortisol and adrenaline are released (Domes et al., 2004; Hellhammer et al., 2009). These hormones help to arouse or stimulate us to a point of optimal performance when our creativity or productivity is maximised – known as the goldilocks point – and highly sought after by elite athletes (Jones et al., 2009). Too little pressure or stress can lead to a lack of alertness, disengagement, or under-performance and too much stress leads to anxiety and disorganisation where the ability to think and communicate clearly can be lost. This evolutionary response ultimately leads to a point where the participant perceives the situation to be so pressured they lose awareness of their surroundings and cease effective communication and movement all together. This behaviour is a protective response to excessive pressure, although if the pressure remains too high for long periods of time, chronic stress or burnout can manifest.

The aims of this paper are to identify and recommend appropriate modalities for assessment of physiological stress in paramedicine students which can further be generalisable to other healthcare educators. Our lens for this paper is from that of paramedic educators, but it is important to note that themes discussed here are relevant to all healthcare education settings where emergency or stressful scenarios are utilised as an andragogic tool. By providing individualised quantitative stress data to students in pre-employment simulated environments, it is hoped a better understanding of their own acute and chronic stress may be obtained. Acknowledging that the incidence of distress and burnout commonly seen in healthcare workforce is a major concern (Baier et al., 2018; Crowe et al., 2017; Shah et al., 2021), any pre-employment strategies to counter these must be thoroughly researched and implemented.

Search Strategy and Selection Criteria

We searched three prominent databases (Medline, PubMed and Scopus) for peer-reviewed, English language articles published between 2000 and 2023. Search terms (simulation OR scenario) AND (education OR undergraduate OR training) AND (health OR medical) AND (physiological OR psychophysiological OR stress) were used to garner publications suitable for our narrative paper. Titles and abstracts were reviewed to confirm these criteria. Where all search terms were present or remained uncertain from initial review, each publication was read fully. Articles that did not meet requirements or were of poor-quality (lacking significant contribution of new knowledge, poorly written, or from predatory journals) were excluded. Additional studies were obtained from reference lists of retrieved articles. This structured search and selection approach was adopted to minimise potential article selection bias based on author knowledge and perspec-

tives, however as a narrative review we acknowledge this cannot be avoided fully. This review has included a subset of high-quality publications that we thought were most pertinent and insightful to address the aims of this article.

BACKGROUND

To understand the stress experienced by paramedicine students, the psychophysiological relationship between stress and performance must first be addressed. The seminal biopsychosocial model, conceptualised in 1977 by George Engel an American academic and psychiatrist (Engel, 1979), identified that a person's medical condition was not only influenced by biology alone; it also involved psychological and social factors. A collaboration between Jim Blascovich, a Professor of Psychological and Brain Sciences, and Joe Tomaka, a Professor of Public Health, in 1996 led to a published update linking Engel's model to Hebb's work of arousal regulation (Blascovich & Tomaka, 1996). These authors discussed cognitive, physiological, and social dimensions as arousal-regulators with proposed impacts on stress levels.

In 1997, Tomaka and Blascovich teamed with others to publish work on challenge and threat (CAT) appraisal, determining that cognitive appraisal precedes physiological responses (Tomaka et al., 1997). This theory suggests that during the pursuit of a goal/s, increased psychological processes (anxiety, excitement, arousal, etc.) lead to specific patterns of cardiovascular responses - sympathetic nervous system innovation (SNS) in effect. The SNS, one of two branches of the autonomic nervous system, is activated when the brain senses a stressful situation. This leads to increases in visual acuity, strength and reaction speed in times of physiological or cognitive distress.

Considering the biopsychosocial model and expanding on the above theories, if a student feels they lack cognitive or procedural resources to meet the demands of a stressful clinical scenario, then a state of 'threat' appraisal occurs. However, if resources are perceived to sufficiently meet the demands of the scenario, then a state of 'challenge' appraisal emerges. Threat is correlated with 'losses' or poor performance, whereas 'challenge' has linkages to promotion or perceived 'gains' (Sassenberg et al., 2015). Positive and negative emotions can occur in a challenge state, while a threat state is associated with negative emotions only (Jones et al., 2009). The appraisal of the situation as a threat or challenge may be linked to previous experience or the perceived stress of the upcoming situation, with researchers identifying patterns of cardiovascular responses correlated to the level of stress exhibited (Tomaka et al., 1993; Tomaka et al., 1997).

Research proposes that while threat and challenge both involve physiological and psychological movement toward goal achievement, threat state is likely to be the more variable, fragile, and stressful of the two (Blascovich, 2013). Some of the first researchers to explore this field identified individuals who appraised situations as a challenge were more likely to exhibit confidence and less likely to be emotionally overwhelmed than those in a threat appraisal state of mind (Lazarus & Folkman, 1984). Importantly, research from the field of psychology demonstrated that during stressful situations, a challenge mindset enhances performance, whilst the threat mindset has been shown to hinder performance (Blascovich et al., 2004; Seery et al., 2010). In these studies, the stressful situation varied from a high-stakes athletic competition (Blascovich et al., 2004) to a theory-based college exam (Seery et al., 2010). This demonstrates that the while the con-

text of the stressor varies, a heightened stress response is often a significant indicator of poor performance. Importantly, no one agreed method for measuring stress response has been established, and much research on stress and threat appraisal is laboratory-based with the source of stress often unrelated (Kirschbaum et al., 1995) or lacking relevance to the task at hand (Domes et al., 2004).

The phrase 'Arc of Performance' was coined by Doctor Stephen Hearns, the lead consultant for Scotland's Emergency Medical Retrieval Service and author of Peak Performance under Pressure (Hearns, 2020). Hearns based his Arc on the Yerkes-Dodson curve, first discussed in the psychological literature in 1908, as shown in Figure 1. In the original paper, Yerkes and Dodson (1908) reported on learning discrimination in dancing mice. Three different experiments were undertaken using various levels of non-injuring electricity and light stimulus to assess rates of learning. Forty-two mice completed the experiment over three consecutive days, each given a choice of an interchangeable white or black box to enter. If the mouse entered the white box, a correct choice was determined. If the mouse entered a block box, a weak electrical shock graduating to a higher intensity was delivered and an incorrect choice recorded. The first experiment evaluated the speed at which the mice could discriminate white from black relative to the intensity of the shocks administered. The result produced the now well-known inverted U-shaped curve suggesting the point where optimal level of arousal for peak performance occurs. Despite acknowledging flaws in their research and lacking any statistical analysis, the empirical research by Yerkes and Dodson is now widely used in research focusing on stress and performance.

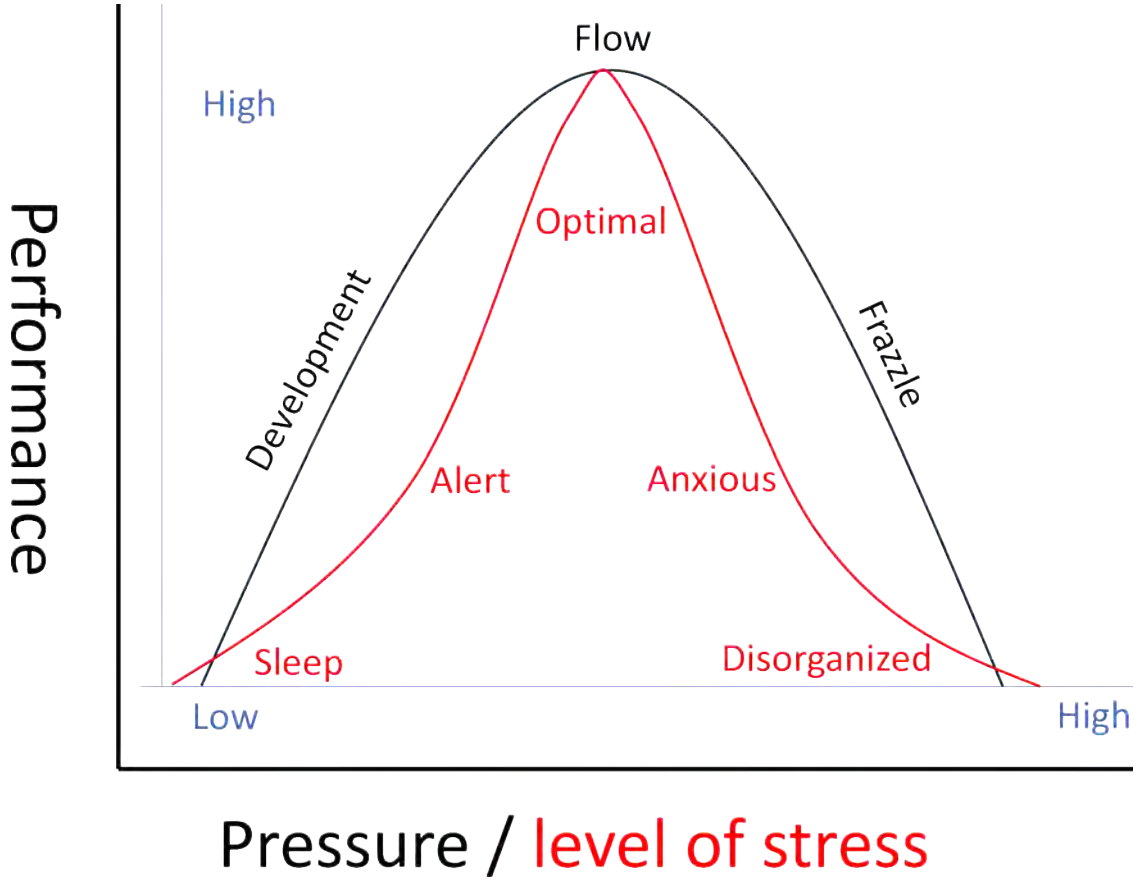

Figure 1: Hearns' Arc of Performance (in black) overlayed on Yerkes-Dobson (in Red).

The Yerkes-Dodson curve was first reported over a century ago and was conceived whilst studying mice, however, technological advancements now allow researchers to gain stress and performance data on human participants in real time. Considering Hearns' Arc of Performance in the context of CAT associated physiological changes to stress, researchers must gather objective data from several body systems, such as cardiovascular, respiratory, and neurological.

Measuring Cardiovascular Responses to Infer Physiological Stress

In response to a stressor, the heart and vascular system work together to ensure sufficient oxygenated blood is available to facilitate a flight response if required. Vital organs remain well perfused, while other body systems, such as digestion and reproduction, may be slowed or paused entirely (McCarty, 2016). In the context of CAT, appraising a situation as a challenge leverages high resources and low demands; conversely, threat appraisal results from a situation of low resources and high demands. Both states have been shown to increase heart rate (HR) and cardiac output (CO) when compared to rest (Seery, 2013). However, challenge leads to a decrease in total peripheral resistance (TPR) with a subsequent decrease in systolic blood pressure (SBP) and a decrease in blood volume of the microvascular bed of tissue. In the clinical setting, estimates of CO can be both invasive and expensive, leading to commonly used validated methods of obtaining estimated CO from HR and the mean systolic and diastolic blood pressure in non-clinical studies (Hill et al., 2011). Mean arterial pressure (MAP) is determined from a widely used algorithm (MAP (mmHg) = [1⁄3 SBP (mmHg)] + [2⁄3 DBP (mmHg)]). TRP is then calculated by dividing the CO by MAP, with that total multiplied by 80 (Sherwood et al., 1990).

Wearable devices, such as the Equivital monitoring system (ADInstruments, United Kingdom), the Biosignalsplux Hybrid (PLUX – Wireless Biosignals, Portugal) or the Hexoskin (Carre Technologies, Canada) are well established at measuring cardiovascular responses such as HR and SBP changes. This portable technology can also measure changes in skin sweat levels via a Galvanic Skin Response (GSR) sensor and an infrared Thermopile to detect peripheral skin temperature changes. A decrease in skin temperature accompanying an increase in sweat levels is indicative of a threat response from the vasoconstrictive sympathetic reflex. This can also be measured via a photoplethysmogram (PPG) sensor or a plethysmograph, which assesses Blood Volume Pulse (BVP) variability at common sites such as the fingers, forearms or calves. During the threat appraisal stage, most people will demonstrate a reduction in blood volume to the microvascular tissue beds at these sites.

To objectively measure CAT-induced cardiovascular responses, a triangulation of data should be gathered including HR, TPR and GSR, to obtain a full picture of the physiological changes. Ideally, one device or system should be capable of acquiring the cardiovascular data described. However, researchers must be aware that some systems require annual software licencing or cloud-based subscription that can significantly impact costs associated with the technology purchase.

Measuring Hormones for Stress Response

It has already been established in the review that stressful situations predominantly trigger a cardiovascular response. This, in turn, facilitates neurohumoral activation leading

to secretion of the glucocorticoid cortisol from the adrenal cortex (Kim et al., 2009). Cortisol is considered the main biomarker in physiological stress research (Hellhammer et al., 2009). In experimental studies, mean cortisol responses to acute stressors have ranged from 29% to > 200% above baseline levels (Bohnen et al., 1990; Buchanan & Lovallo, 2001; de Quervain et al., 2000). Once released into the bloodstream, cortisol acts on almost every cell in the body to maintain allostasis. Furthermore, cortisol stimulates gluconeogenesis (Melmed et al., 2015) and glycogenolysis with rapid increases in circulating blood glucose levels (Pradhan & Goel, 2011). By mobilising energy to deal with actual or perceived environmental or physiological stressors, internal equilibrium can be maintained. Blood glucose levels can easily be measured by a single drop of blood from a finger and an inexpensive glucometer.

Cortisol also increases cardiovascular output, redistributes blood flow, increases immune response, and causes a marked spike in cerebral perfusion and glucose utilisation (McEwen & Seeman, 1999). To assess the impact of stress on the neuroendocrine axis, researchers can sample adrenal medullary catecholamines (epinephrine and norepinephrine) from either plasma, saliva or urine (Noushad et al., 2021). During periods of acute stress, sympathetic neurotransmitters epinephrine and norepinephrine levels increase and are subsequently regulated in the flight or fight response by the parasympathetic neurotransmitter acetylcholine (ACh) (Won & Kim, 2016). Due to the rapid action of catecholamines and the transient nature of recordable levels, researchers often focus on more stable hormones as indicators of CAT appraisal.

The adrenal hormone dehydroepiandrosterone (DHEA), released from the hypothalamus-pituitary-adrenal cortex (HPA) as a physiological response to stressful situations, is one of those that can be sampled (Sherwood, 2008). While the complete actions of DHEA and it's sulphated ester dehydroepiandrosterone-sulphate (DHEAS) are not fully understood, research has shown that it is released at higher levels in individuals experiencing stress-related situations (Oberbeck et al., 1998) and in people with symptoms of exhaustion (Sonnenschein et al., 2007). A study by Roth et al. (2002) on primates showed that diet control and caloric restriction resulted in DHEAS levels being maintained at youthful levels, leading the popular press and social media to label DHEAS as the 'fountain of youth' (Dhatariya & Nair, 2003). Despite a lack of human testing, this paper by Dhatariya and Nair (2003) supported earlier work by Nawata et al. (2002) to hypothesise that if DHEAS serum levels were artificially maintained as humans aged, better health maintenance, increased longevity and less burnout might result.

The non-invasive nature of salivary cortisol and DHEA testing and the ability of participants to administer the test themselves makes it an appropriate test for stress levels. Salivary cortisol samples have been found to be stable when stored at 5oC for up to three months and up to one year when stored at -20oC (Garde & Hansen, 2005). A consistently high correlation between the accuracy of saliva cortisol testing and plasma cortisol testing has also been found (Francis et al., 1987; Ryoji, 1981; Vining et al., 1983). Urine sampling research has also been undertaken to assess cortisol levels (Soo-Quee Koh & Choon-Huat Koh, 2007); however, as urine can remain in the bladder for extended periods and the half-life of cortisol is known to be approximately one hour (Gatti et al., 2009; Weitzman et al., 1971) the validity and practicality of urine sampling may be difficult in some settings.

Duplicate analyses of the salivary DHEA or cortisol levels are recommended using an enzyme-linked immunosorbent assay (ELISA) technique in a commercial laboratory (Gatti et al., 2009). Researchers need to be aware of the possible interactions of diet and DHEA / cortisol secretion. Proteins, specifically meat products, have been shown to stimulate cortisol secretion (Anderson et al., 1987; Benedict et al., 2005; Slag et al., 1981), and care must be taken not to allow diet to influence testing. Furthermore, consumption of alcohol, nicotine and caffeine (Kudielka et al., 2007) and certain medications (Brody et al., 2002; Fries et al., 2006) have been shown to impact the magnitude and duration of the stress response. Researchers assessing salivary DHEA or cortisol as an objective measure of stress must request that participants refrain from eating large portions of food or consuming any alcohol, nicotine or caffeine prior to testing. Also, participants should be excluded based on specific medications that might impact hormone, catecholamine or glucose levels. Based on this literature, it is our recommendation that salivary cortisol samples be obtained after a period of fasting for a minimum three hours. For studies that assess student response over multiple days, subsequent samples must be obtained at the same time of the day under the same conditions. The addition of DHEA sampling is expensive and would not be required for most studies of acute stress response where cortisol sampling is relatively simple to facilitate.

Cognitive Capacity and Cognitive Overload

The physiological stress responses discussed thus far are relatively easy to measure using simple wearable devices and collection aids. More challenging for researchers is the ability to gather objective measures of cognition and cognitive capacity in realistic situations away from the large-scale laboratory-based environment. Before exploring novel ways of doing this, a brief overview of cognition and memory processing follows.

Short-term memory, particularly the working memory, is the part of cognition where information is processed quickly, and decisions are made rapidly. Under pressure, the working memory can become overwhelmed, leading to cognitive overload. As part of the survival mechanism, the brain also utilises automatic processing (Hasher & Zacks, 1984), a subconscious rapid response reliant on previous exposure to a situation to where the brain matches the previous encounter and outcome achieved. This is pattern recognition and is seen as a 'cognitive shortcut' (Hearns, 2020). A novice may not have sufficient experience to facilitate automatic processing and is, therefore, more likely to rely on a thorough and considered process of analytically assessing each situation. This slows decision-making, uses more cognitive resources, and increases stress levels. As a way of attempting to reduce stress and reduce the cognitive overload, novices may practice repeatedly until their actions become more automatic in nature. This is known as procedural or muscle memory, and research shows that when under pressure, procedural memory is accessed preferentially (Knowlton & Greenberg, 2008; Siller-Perez et al., 2017; Wirz et al., 2018).

Another potential issue affecting novice clinicians is the Dunning-Kruger Effect, sometimes referred to as unconscious incompetence (Bradley et al., 2022), as shown in Figure 2. In this scenario, inexperienced clinicians will underestimate the severity of the problem they face, or more commonly, overestimate their abilities. A degree of stress should be associated with a high acuity patient presentation, so when the inexperienced clinician presents overtly calm in that situation it may indicate that they are unaware of the

clinical severity of the presenting patient. Kruger and Dunning (1999) first reported their findings in response to a series of studies evaluating participants' level of knowledge, along with their social and logical reasoning. They found that individuals commonly overestimated their performance whilst simultaneously lacking the ability to recognise their incompetence. This led Nancy Diekelmann, a transformative figure in nurse education, to famously quip "you only know what you know, and you don't know what you don't know…don't you know?" (Diekelmann & Diekelmann, 2009) (pg. 85). For researchers in this field, the ability to objectively measure cognition or neural activity, alongside clinical ability, may provide valuable insight into the Dunning-Kruger Effect. Researchers would expect to see large increases in neural activity for particularly stressful or high acuity scenarios; however, if this was not evident, then we may determine that the student is either underestimating the severity of the problem they face or overestimating their abilities. Insight via quantifiable data, may provide the learner and researcher with strategies to mitigate the Dunning-Kruger Effect.

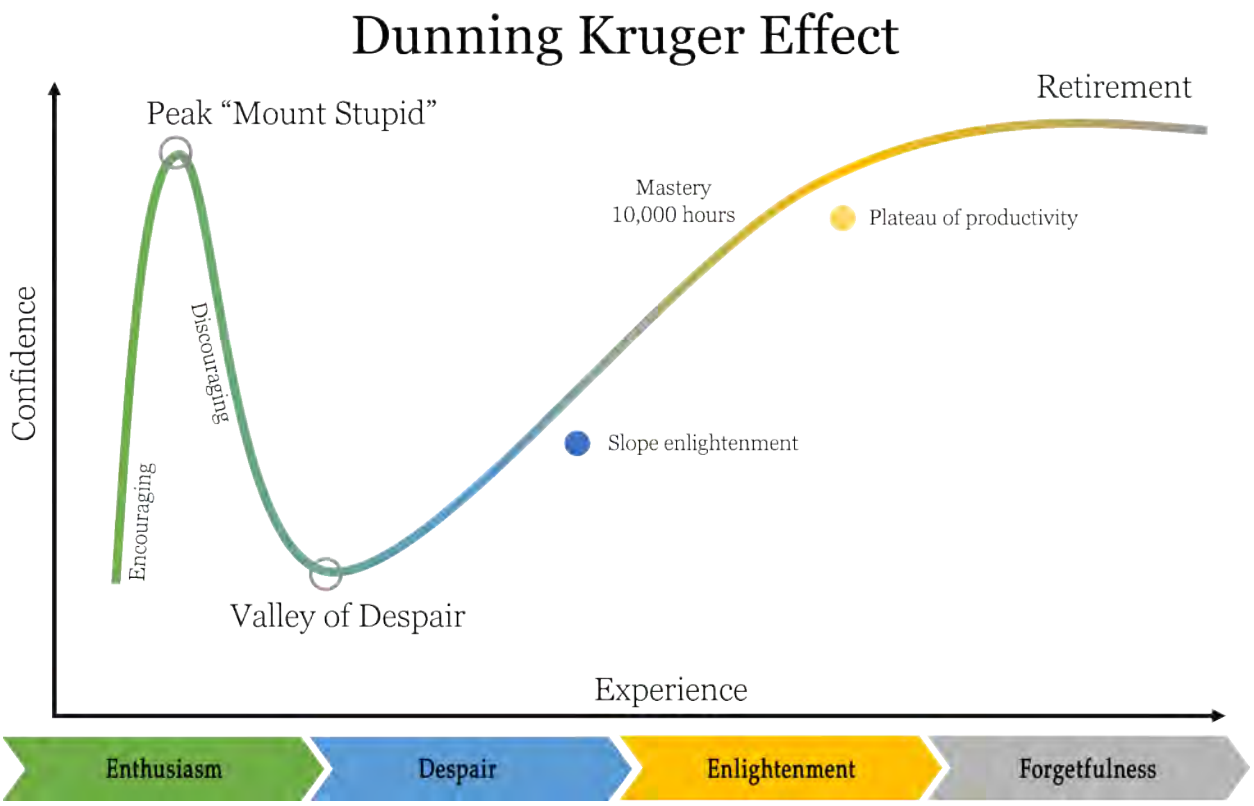

Figure 2: The Dunning Kruger Effect – adapted from work by Kruger and Dunning (1999)

Methodology of Wearable Devices for Cognitive Load Assessment

German Psychiatrist Hans Berger first used electroencephalogram (EEG) on human subjects in the 1920's as a tool in psychiatric diagnosis (Perron, 2015). Recently, EEG has expanded from clinical diagnostics to being used more widely in research aiming to assess cognitive load. The term cognitive load, like stress, is an umbrella term that encompasses different concepts in different disciplines. Cognitive load theory, first discussed in the 1950s, is based in instructional education (Miller, 1956). Miller's theory centres around the ability of the human memory to process a limited number of new elements of infor-

mation at any particular time. Once this capacity has been exceeded, further learning is impaired (Bong et al., 2016). Whilst Miller's theory explained cognitive load in relation to learning, further work has linked increased cognitive load to decreased acquisition of motor skills (Paas & Sweller, 2011) and decreased performance in complex tasks (Van Gog et al., 2011).

The threat response leads to elevated physiological stress levels, increased cerebral perfusion, and increased beta band (13-25 Hz) activity at the anterior temporal sites (Seo et al., 2010). Antonenko and Niederhauser (2010) further identified increased oscillations in the alpha and theta bands correlated with increased cognitive load. Additionally, EEG recordings obtained from the parietal, central, and frontal lobes of the scalp have also been shown to demonstrate increased arousal and brain activity during periods of stress (Rahnuma et al., 2011). With the rapid expansion of wearable EEG technology, ranging from high-end amplifiers such EEGO (ANT Neuro Pty Ltd, The Netherlands) and SmartingPRO (mBrainTrain, Serbia), to 'off the shelf' real-time monitoring devices such as the Muse 2 Band (InteraXon Inc, Canada) or EMOTIV Insight 2.0 (EMOTIV, USA), it may be possible to obtain unobtrusive measures of the physiological response in brain activity (Gradl et al., 2019) to the threat appraisal. For any researcher, cost is a constant consideration. Cheaper products rely on pre-built software algorithms to define stress and cognitive load, which may need further study and validation. Another consideration for portable EEG monitoring is that participant movement can greatly affect the EEG signal and present as gross artifact which may be a limitation in data acquisition during mobile scenarios.

Technological advancement has seen rapid expansion in the use of functional near-infrared spectroscopy (fNIRS) to assess cognitive load. fNIRS uses wavelengths of near-infrared light as a method for studying neural activity outside the clinical laboratory (Pinti et al., 2020). In a similar way to functional magnetic resonance imaging (fMRI), fNIRS uses near-infrared light to estimate cortical hemodynamic activity and increased cerebral metabolic demands as proxies for increased neuronal activity (Meidenbauer et al., 2021). In simplistic terms, when brain activity increases, metabolic demand increases and so does the flow of oxygenated blood. The non-invasive nature of fNIRS allows neural activation to be measured in naturalistic settings and has been shown to be an excellent tool for tests of cognitive stress (Buxton, 2010). As discussed earlier, stress affects both neurological and cardiac function and leads to an increased HR. Typically, HR is assessed using an ECG or chest-worn HR monitor. Of note, HR can also be obtained from the fNIRS signal and has been shown to be better align with mental stress as opposed to chest-worn measurements of HR alone (Hakimi & Setarehdan, 2018). This can also reduce the need for multiple biosensors in the same experiment. These systems range in price from high-end research products such as the NIRSport2 (NIRx Medizintechnik GmbH, Germany), mid-range such as Octamon+ (Artinis Medical Systems, The Netherlands), to more consumer-orientated products such the Biosignalsplux Hybrid (PLUX – Wireless Biosignals, Portugal). The benefit of this emerging and evolving research technology is the ability to connect wirelessly to the recording computer allowing for full mobility studies with less artifact than EEG produces.

In summary, to objectively measure CAT-induced stress responses, researchers must gather a combination of cardiovascular and cognitive data while concurrently assessing hormonal changes to obtain a holistic appraisal of the participant's physiological stress

state. Which individual device or combination of wearable technology that researchers chose will depend on funding and specific data acquisition requirements. The Biosignalsplux Hybrid system has a fNIRS component along with cardiovascular sensors, allowing researchers to utilise just one system and avoid the need for multiple software interfaces and charging stations. Ultimately, our recommendations are for researchers to test this technology and chose a system that delivers the objective data they require within available funding constraints.

Quantitative Psychometric Tools – Demand and Resources Questionnaires

To support objective data, researchers must utilise qualitative or subjective questionnaires to add detail and context to objective data recorded. The word psychometric literally means "measurement of the mind" (Hammond, 2006), and there are a great many psychometric tools available to researchers. One of the first attempts at measuring stress on a numerical scale was the Social Readjustment Rating Scale (SRRS) developed by Thomas Holmes and Richard Rahe in 1967 (Holmes & Rahe, 1967). The SRRS consisted of 43 items with Yes/No responses relating to life experience events over the preceding 12 months, so in effect, became a measure of chronic as opposed to acute stress. A variety of other scales were adapted from or attempted to improve the SRRS; such as The Hassles Scale (Kanner et al., 1981), Stressful Life Experience Screening (SLES) (Stamm, 1996) and the Life Stressor Checklist – Revised (Wolfe et al., 1997), amongst others. In realty, these tools are measures of 'stressors' and do not measure acute stress.

Numerous and diverse psychometric tools exist to assess acute psychological response to stress. Early questionnaires, such as the Taylor Manifest Anxiety Scale (TMAS) (Taylor, 1953), utilise a large number of true/false questions (50 in the case of TMAS) to produce a sole outcome measure (such as anxiety). Another commonly used questionnaire is The State-Trait Anxiety Inventory (STAI) (Spielberger, 1970). The STAI works from the TMAS to measure trait anxiety from half of the questions and also measures state anxiety (an acute situational-dependent psychological state) from the other 20 questions (Everly & Lating, 2002; Fein, 2017). The Subjective Stress Scale (SSS) (Berkun et al., 1962) is frequently reported in the literature and utilises 14 descriptors to measure situational (state) stress during a stressful situation. Both the STAI and SSS are validated (Johnston & Hackmann, 1977; Taylor et al., 1968) and can be administered rapidly, making them useful tools for assessing subjective stress in scenario-based education.

The scales discussed so far are all non-appraisal based, intended to determine a point-of-time score for acute stress. The Stressor Appraisal Scale (SAS), validated and described by Schneider (2008), is used to determine cognitive appraisal before a stressful event is attempted. Primary appraisal items include: (1) how threatening do you expect the upcoming task to be?, and (2) how demanding do you think the upcoming task will be?, amongst other similar questions. Secondary appraisal items included: (1) how well do you think you can manage the demands imposed on you by this task?, along with two other similar appraisal questions. Using a 7-point Likert scale to quantify results, if resources are deemed to be greater than or equal to demands, then the scenario can be deemed a challenge. If demands are scored as higher than resources, then the participant perceives the scenario as a threat. Recommendations by Hase et al. (2019) suggest the CAT score difference is calculated in place of a ratio, as ratio scores often produce highly nonlinear distribution (Vine et al., 2013).

Both the SAS and STAI are validated in the literature, providing excellent test-retest reliability, and are inexpensive and easy to administer. However, the SAS is targeted specifically for cognitive appraisal of CAT and is therefore recommended as a subjective adjunct to support objective data gathered in this field of research.

LIMITATIONS

As a narrative review, the intention is not to discuss all possible measures of psychophysiological stress nor the ever-evolving technology to obtain these measures. This is acknowledged as a limitation, and researchers in the field should explore novel technologies and questionnaires most suited to their experimental protocols. Other limitations are acknowledged regarding the inherent nature of the search and selection of relevant published work for narrative reviews. The lack of structured methodologies and standard quality assessment criteria can lead to subjectivity in literature selection and interpretation, potential overrepresentation or underrepresentation of certain viewpoints, and challenges in replicability. Whilst a large body of literature examining physiological and psychological stress exists, very few publications quantify both in the same sample population. Even fewer specifically study healthcare students. This scarcity of published literature can be seen as a limitation but also a reason for producing a narrative review to give a broad perspective and encourage future research of this topic. Finally, the intention of this paper is to provide guidance and suggestions to researchers, unlike a systematic review which would present definitive generalized conclusions on a specific topic.

CONCLUSION

The biopsychosocial model emphasizes the interconnectedness of biological, psychological, and social factors in shaping an individual's response to stress. The appraisal of a situation as a threat or challenge is a subjective process influenced by these multiple factors. Research in business and sport shows that challenge appraisal leads to improved performance, and it is reasonable to assume similar correlations exist in health education. However, inconsistent methodologies that utilise a variety of physiological and cognitive measures make it challenging to draw firm conclusions. A combination of objective physiological data with behavioural observations and self-reported assessments may help researchers obtain a well-rounded view of whether an individual perceives a situation as a threat or challenge. Specifically, it is our recommendation that researchers undertaking experiments in this novel field gather objective data from multiple body systems that are supported by validated and convenient subjective stress appraisal scales. Additionally, the interpretation of data should consider individual differences, contextual factors, and the dynamic nature of stress responses. Only once this has been done can a succinct understanding of challenge or threat appraisal be determined.

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CASE REPORT

AGGRESSIVE HYPERKALEMIA TREATMENT IN THE PREHOSPITAL SETTING: A CASE REPORT

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ABSTRACT

This is a case of profoundly unstable hyperkalemia encountered in the American prehospital 911 setting, with subsequent aggressive treatment and stabilization. Although hyperkalemia may be present in the prehospital setting, it is difficult to diagnose without laboratory testing or a reliable history of illness. It is frequently encountered in the prehospital setting, especially in communities with high levels of comorbidities and multiple dialysis centers. However, in the spectrum of hyperkalemia presentations, many of these patients are either early in their disease presentation or found when already in cardiac arrest. Early identification and rapid, aggressive treatment are paramount to decreasing morbidity and mortality in these patient populations. This case shows how aggressive prehospital critical care can have a significant impact on patient outcomes.

BACKGROUND

This case was encountered by a suburban fire department-based Emergency Medical Service (EMS) serving a population of approximately 50,000 residents in the United States with a call volume of 3,000-4,000 calls per year. The response area is home to a suburban community hospital without dialysis capabilities and is located near a metro area with a Level I tertiary care center approximately 25 minutes away. This agency provides advanced life support level service, with paramedics being present on all ambulances, as well as some of the fire suppression apparatus. Daily staffing includes three ambulances, three engine companies, one truck company, one Battalion Chief, and one Paramedic Shift Supervisor. New Paramedics go through a field-training process with a Paramedic preceptor, with periodic reviews and ultimate clearing by the department's Physician Medical Directors. Expansive "Patient Care Guidelines" are in place, with Paramedics in this system given the latitude to deviate from these guidelines if the patient's condition warrants.

CASE REPORT

EMS was dispatched to a skilled nursing facility for an elderly male patient for difficulty breathing. The response to this call included an ambulance, engine company, and Paramedic Shift Supervisor. All three paramedics responding to the call had at least three or more years of experience providing advanced life support care. Nursing staff on location noted the patient to have a sudden change in responsiveness, being unable to arouse him during normally scheduled rounds. His reported baseline mental status was alert, oriented, and able to carry on normal conversations. Nursing staff also noted an increased difficulty breathing, but no additional information on chronic medical history was made available to responding personnel.

Upon physical exam, the patient was responsive to verbal stimuli but had confused conversation and difficulty speaking. Lung sounds were diminished, crackles were noted in the left and right lung bases, and no unilateral neurological deficits were observed. The skin was pale, cool, and dry, with no obvious signs of trauma. The patient was noted to be slightly hypotensive with a blood pressure of 88/50 and notably hypoxic on room air with an oxygen saturation of 81% on initial contact. To immediately address this initial presentation, the patient was placed on supplemental oxygen at 15 liters per minute by a non-rebreather mask. This intervention resolved the hypoxia and slightly improved his mental status. Capillary blood glucose was 166 mg/dL, and the patient was afebrile. The nursing staff noted the patient had labs drawn the previous evening and was found to have a newly elevated serum potassium level of 6.9 mEq/L. The lab report also revealed hypocalcemia.

With the finding of the lab report, combined with the patient's critical condition, aggressive management was started. Paramedics on location decided to stabilize the patient prior to transport, as it appeared to be the safer option for the patient due to the patient's vital signs and altered mental status. The cardiac monitor revealed wide complex tachycardia, with a 12-lead ECG showing a wide QRS complex concerning for hyperkalemic instability. Initial treatment included 1 gram of Calcium Gluconate IV and 100 mEq Sodium Bicarbonate IV. The patient became more somnolent during this time, with a decreased respiratory drive. Due to the progressively deteriorating respiratory status combined with a projected poor clinical course, the decision was made to intubate the patient.

The patient was pre-oxygenated with oxygen at 15 liters per minute via non-rebreather mask, combined with passive oxygenation at 15 liters per minute via nasal cannula. Pre-induction capnography was noted to be 17 mmHg with normal plateau waveform. A push dose of 30 mcg of epinephrine IV was given prior to induction to optimize blood pressure to greater than 100 systolic blood pressure. Following SpO2 optimization to greater than 94%, 30 mg of etomidate IV and 160 mg of rocuronium IV were administered for induction and paralysis, respectively. The patient was intubated with video laryngoscopy on the first attempt. Following confirmation of tube placement, three combined doses of 2.5 mg Albuterol sulfate were administered in-line via nebulizer simultaneously, which ran continuously throughout transport. After these three doses were completed, three DuoNeb (ipratropium bromide and albuterol sulfate) treatments were started simultaneously, which ran continuously for the remainder of transport. DuoNeb was chosen as the crew had expended its supply of albuterol.

Following intubation, the patient was hypotensive again. An additional 30 mcg of Epinephrine IV was given. Norepinephrine infusion was also started for sustained blood pressure control, which adequately stabilized blood pressure. Paramedics on scene decided to limit crystalloid fluid administration to limit fluid overload in the presence of presumed new acute renal failure in the setting of hyperkalemia and lung physical exam findings consistent with volume overload.

Following the stabilization of the patient, emergent transport was started to a tertiary care facility capable of providing emergent dialysis. During transport, the crew was directed to hyperventilate the patient to maintain capnography near 17 mmHg to limit worsening metabolic acidosis. The patient also received an additional 1 gram of Calcium Gluconate IV and 50 mEq Sodium Bicarbonate IV during transport. Pt was sedated with Ketamine and Fentanyl was given for analgesia during transport.

The emergency department was given advanced notice to have staff and resources available to continue treatment and potentially arrange emergent dialysis. Ultimately, the patient remained critical throughout transport, and care was turned over to emergency department staff with the patient in critical condition.

DISCUSSION

This case is an excellent representation of a departure from the mantra of "load and go," which has been present within EMS for generations. Many times, especially in trauma, it is appropriate to initiate early and rapid transport to definitive care; sometimes, it may be necessary to depart from this mantra. Remaining on a scene through initiating and continued patient care for resuscitations has shown improved outcomes, especially in out-of-hospital cardiac arrests (Grunau et al., 2020). The focus is placed on performing essential interventions and procedures that lead to decreased morbidity and less so on packaging a patient for transport, which may impair or delay best practices, including high-quality CPR. In this case, the crews were concerned about lethal arrhythmia, respiratory failure, and hypotension if stabilization did not occur before transport.

Hyperkalemia is well-supported in literature with cardiac sequelae. Kovesdy (2016) described a heightened risk of mortality associated with hyperkalemia in all patient populations, including those with normal kidney function. Early rises in potassium concentration are attributed to lowering the cardiac membrane potential, often resulting in the classic 'peaked' t-waves. Larger rises in potassium concentration have been demonstrated to result in a lengthening of the PR interval and widening of the QRS complex. This often occurs prior to the patient progressing into a 'sine wave,' often associated with cardiac arrest following shortly thereafter (Montford & Linas, 2017). The patient's initial ECG showed a wide QRS complex tachycardia, commonly associated with severe hyperkalemia. As such, the decision was made to treat this patient aggressively on scene to ensure safer and rapid transport. Prehospital rhythm strips were not available from this patient; however, Figure 1 shows the patient's ECG that was obtained in the emergency department following interventions by EMS. The ECG shows a wide complex tachycardia with nonspecific ST segment changes. These ECG findings show a narrower QRS complex than the ECG initially acquired by EMS. The QRS segment reportedly narrowed with additional hyperkalemia treatments in the emergency department.

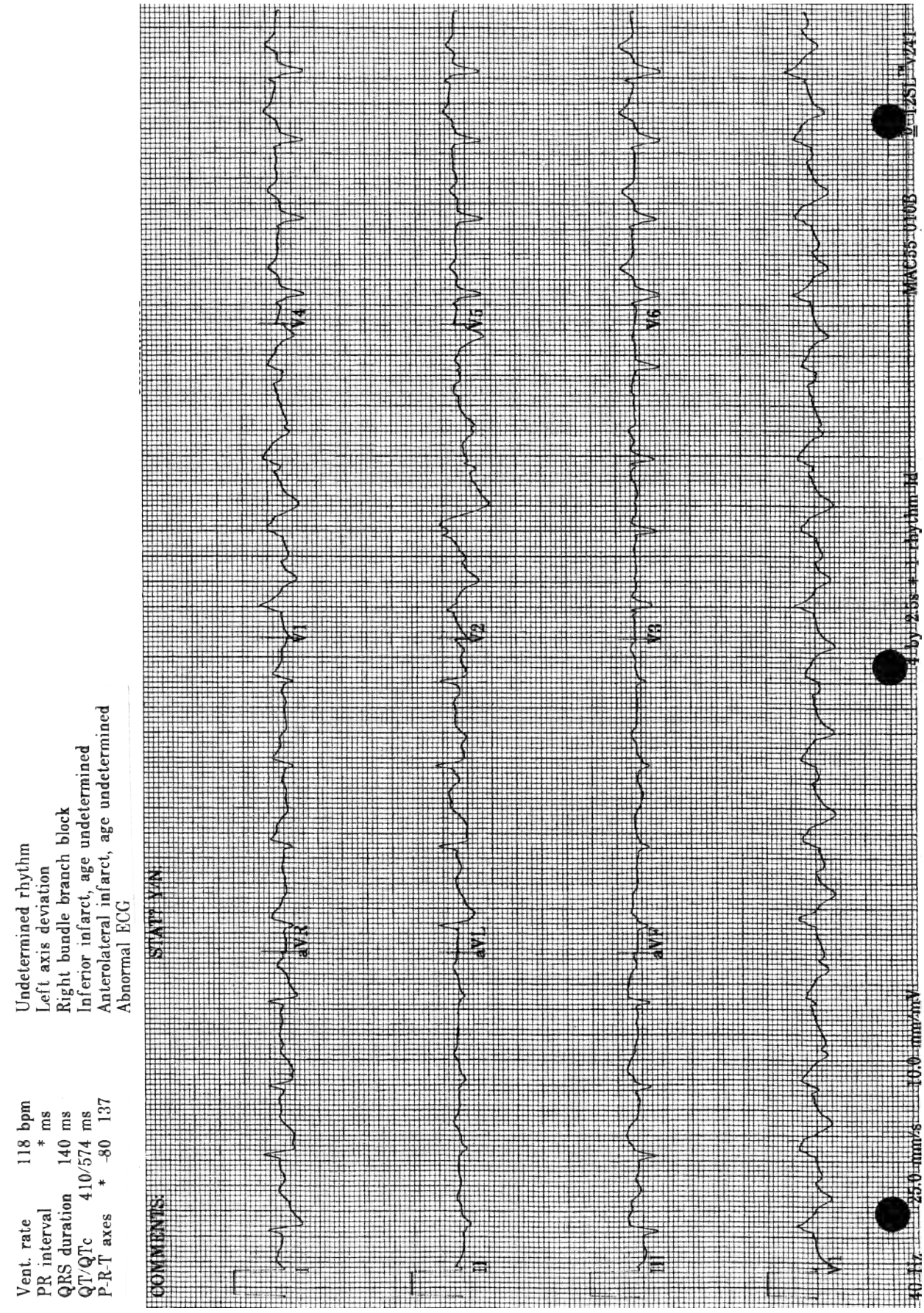

Figure 1. ECG obtained in the emergency department following interventions by EMS

In determining the ventilatory rate, this decision was made based on knowledge of the patient's physiologic status. As a homeostatic mechanism, brainstem chemoreceptors will affect large changes in minute volume based on small changes to pH and PaCO2 in the blood and cerebro-spinal fluid (Jung et al., 2019). Given this was a presumed metabolic acidosis, steps were taken to prevent an accumulation of carbon dioxide, further worsening the patient's acidosis. The pH will decrease by 0.08 for every 10 mmHg increase in PaCO2 (Berend et al., 2014). While the crew, in this case, did not have the benefit of arterial blood gas values to guide decision-making, end-tidal capnography was utilized to guide the ventilatory rate. The decision was made to titrate the ventilatory rate to maintain the pre-intubation end-tidal capnography reading to continue respiratory compensation for the patient's metabolic acidosis. The crew did not have access to a ventilator, so a provider was tasked with titrating manual ventilations to maintain this end-tidal capnography level. This provider was tasked with providing ventilation up to 30 cycles per minute.

Hyperkalemic cardiac arrest is also associated with poor neurologic outcomes. Choi, et.al. (2020) explored trending serum potassium levels in cardiac arrest in relation to neurologic outcomes. The study found 1.6% of patients in the hyperkalemia group were found to have a positive neurologic outcome (Choi et al., 2020). By aggressively treating this condition early in the field, we can attempt to prevent poor long-term neurologic outcomes. Hyperkalemic emergencies are treated with intravenous calcium infusions to decrease cardiac excitability. Insulin is the most common agent to assist in moving potassium into the intracellular space, albeit not commonly found in EMS systems. Beta-agonists, such as Albuterol, and Sodium Bicarbonate are commonly utilized in the management of hyperkalemia to assist in treating this acidosis. Hemodialysis, although invasive, is the ultimate tool for rapid elimination of potassium in these patients. Montford, et.al. (2017) defines 'hyperkalemic emergency' as a serum potassium greater than 6 mEq/L. They further suggest these patients be treated with agents capable of rapidly shifting potassium into the cells and using emergent dialysis to decrease the serum potassium level and the long-term complications of this condition (Montford & Linas, 2017). Paramedics on scene for this case elected to transport this patient to a facility capable of providing emergent dialysis, which was located 25 minutes away at the tertiary care center.

CONCLUSION

After the patient was transported to the emergency department, past medical history was obtained, including diabetes mellitus, coronary artery disease, chronic obstructive pulmonary disease, and recently diagnosed mild chronic kidney disease. Upon arrival, a lab test confirmed hyperkalemia with a level of 7.0 mEq/L and the patient received additional doses of calcium gluconate, sodium bicarbonate, and was given intravenous insulin and a dextrose infusion, as well as an isotonic crystalloid bolus. The patient's ECG reportedly narrowed following interventions with potassium lowering to 5.8 mEq/L but remained hypotensive despite vasoactive agents and broad-spectrum antibiotics for undifferentiated shock. The patient was continued on multiple vasoactive infusions and was found to have worsening kidney function based on laboratory findings. He was admitted to the intensive care unit, where his status did not improve. During hospitalization, next-of-kin opted for comfort measures, and the patient was shortly after declared deceased with no found cause of hypotension

This is a case of aggressive treatment of profound hyperkalemia in the 9-1-1 prehospital setting. This case illustrates how aggressive and critical treatment and transport in the 9-1-1 setting could potentially have a profound impact on reducing morbidity and mortality in this patient population. Prehospital treatments led to temporary stabilization and improvement of the patient's ECG while they were in a critical state. Without instant laboratory testing, paramedics determined, based on previous labs, ECG findings, and the patient's vital signs, that hyperkalemia was a treatable diagnosis that was contributing to the patient's ill status. Although unknown to what extent, there were likely multiple processes contributing to the patient's sudden decline, including worsening kidney function and hyperkalemia. This case also shows the benefit of training paramedics to act as practitioners and make sound clinical decisions in the field. Paramedics, in this case, relied on clinical judgment and expanded from defined patient care guidelines, when necessary, in order to aggressively treat this patient and limit the cardiac effects of the patient's hyperkalemic state.

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CONCEPTS

EXPLORING THE ROLE OF PARAMEDICS IN IDENTIFYING CRIMINAL ACTIVITY: A CONCEPT PAPER

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ABSTRACT

This concept paper covers the potential role of Australian paramedics in identifying and reporting various forms of crime such as organized crime (ACIC, 2017) and radicalization (Australia, 2015). Specifically, this paper will focus on the human trafficking element (Langhorn, 2018). This article discusses the knowledge gap of Australian paramedics and hypothesizes that, with improved awareness, human trafficking could be exposed.

Background - Paramedics, through their routine interactions with individuals, are observers of sexual health conditions (Lederer & Wetzel, 2014; Zimmerman et al., 2008) and the aftermath of violent assaults, and may witness indicators that could be crucial for law enforcement and crime prevention (Awerbuch et al., 2020; Wilson & Hill, 2021). The lack of adequate awareness among Australian paramedics in identifying the emerging crime of human trafficking is highlighted, along with the absence of robust reporting processes.

Design - This paper employed a scoping review using online databases, guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) (Sarkis-Onofre et al., 2021) and the Joanna Briggs Institute methodology (Khalil et al., 2021). A total of 80 articles were identified, with 29 deemed relevant.

Results - The scoping review revealed a scarcity of Australian paramedicine research, particularly in the context of human trafficking awareness and reporting processes.

Conclusions - The scoping review emphasized the need for paramedic-specific training and education in identifying and reporting such crimes, drawing inspiration from awareness curriculums implemented in American emergency medical systems. The findings underscore the need for further research to enhance Australian paramedic awareness, contribute to operational guidelines, and develop targeted education programs. Cohort studies and organizational inquiries can establish the current understanding of Australian paramedics regarding human trafficking. This paper advocates for integrating human trafficking awareness into Australian paramedic training to empower them as potential contributors to crime identification and reporting.

INTRODUCTION

This article addresses the escalating global issue of human trafficking, a crime often concealed from public view (USFA, 2018) and on the increase in Australia (Langhorn, 2018). Considering the potential role of Australian paramedics in identifying such

crimes, a scoping review was conducted to systematically map existing research and identify gaps in Australian paramedic awareness of human trafficking. Through literature review and expert consultations such as Grant Edwards (AFP), the aim is to shed light on the level of awareness among Australian paramedics and explore the feasibility of incorporating human trafficking awareness into paramedicine training.

Human Trafficking

This paper acknowledges the different forms of human trafficking, such as forced marriage, sexual exploitation, and forced labor, emphasizing the need for increased awareness among paramedics.

"Transnational Organized Crime, the Protocol to Prevent, Suppress and Punish Trafficking in Persons, Especially Women and Children" provides the following definition:

> Trafficking in persons' shall mean the recruitment, transportation, transfer, harbouring or receipt of persons, by means of the threat or use of force or other forms of coercion, of abduction, of fraud, of deception, of the abuse of power or of a position of vulnerability or of the giving or receiving of payments or benefits to achieve the consent of a person having control over another person, for the purpose of exploitation. Exploitation shall include, at a minimum, the exploitation of the prostitution of others or other forms of sexual exploitation, forced labour or services, slavery, or practices similar to slavery, servitude or the removal of organs. (UN, 2022)

CONCEPT DESCRIPTION

The primary objective of this concept paper is to evaluate the level of awareness among Australian paramedics regarding human trafficking and to explore existing awareness programs, training, and reporting procedures within Australian ambulance services. Emphasising that paramedics are not meant to replace law enforcement but do have a responsibility to report criminal activity, the article advocates for improved awareness and user-friendly reporting systems.

METHOD

The study utilized the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) protocol (Sarkis-Onofre et al., 2021) . A data-charting form was developed to extract relevant variables from eligible studies, focusing on key study characteristics, first responder engagement, and contextual factors. 80 articles were initially identified. Duplicates were removed and with additional articles being excluded for various reasons including not being related to the cohort, unrelated interventions, or outcomes not related to the topic of research. The remaining 29 articles were deemed relevant for further analysis.

Research studies, grey literature, policy documents, and position statements from various organizations were included. The literature search encompassed databases including Embase, Medline, PubMed, Google Scholar, Science Direct, Scopus, and the Queensland University of Technology (QUT) library.

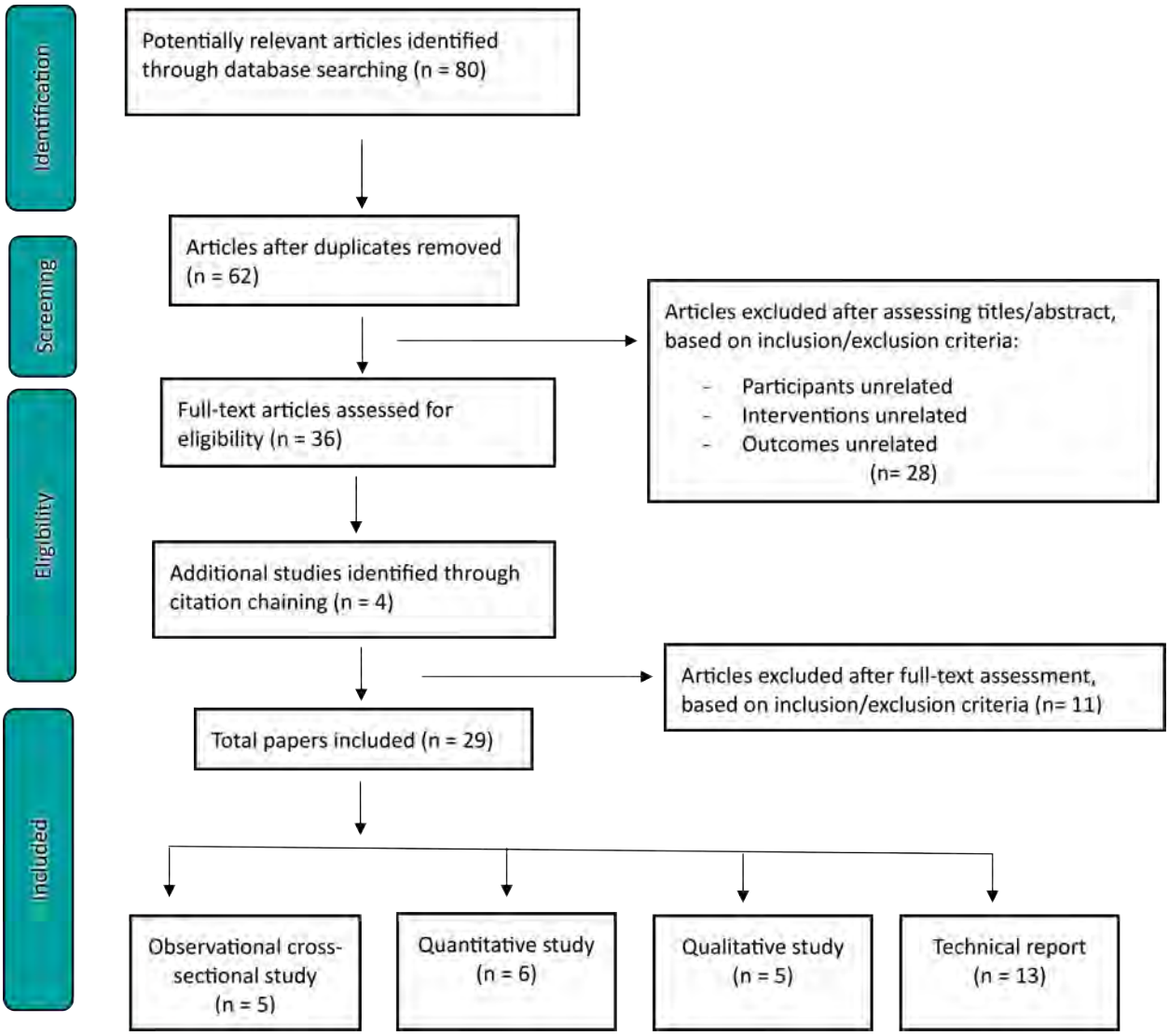

Figure 1. Modified PRISM flow diagram of article screening and selection (Sarkis-Onofre et al., 2021).

RESULTS

The scoping review revealed a paucity of specific Australian paramedicine research on human trafficking awareness and reporting. Existing studies predominantly focused on American hospital-based medical practitioners, law enforcement agencies, and allied agencies (Awerbuch et al., 2020). There were several American EMS agencies delivering awareness program (USFA, 2018), contrary to the gap in Australian paramedic-centric research. American research has shown that less than half of the EMS professionals had human trafficking training (Donnelly et al., 2019).

DISCUSSION

Paramedics, as front-line responders, have the potential to be invaluable sentinels in identifying human trafficking. However, there are challenges facing paramedics in reporting crimes, particularly crimes against children, due to unclear procedures, fear of reprisal, and lack of awareness training. Research has found that Australian paramedics are "reasonably well educated and informed"(Sawyer et al., 2023) when it came to identifying child abuse and neglect but paramedics experienced barriers reporting this. Draw-

ing parallels with awareness programs on domestic family violence, this paper suggests that integrating human trafficking awareness into Australian paramedicine training may enhance their ability to identify red flags (Australia, 2015) in relation to human trafficking.

In the course of their daily duties, paramedics develop a unique professional intimacy with patients, prompting the consideration that they serve as exceptional guardians for the broader community. Lederer and Wetzel (2014) propose that paramedics, in their routine interactions, may encounter situations not readily exposed to law enforcement agencies. It is suggested that individuals, both patients and bystanders, may find themselves in a vulnerable state with lowered defenses in the presence of ambulance or paramedic responses.

Unlike practitioners based in hospitals, paramedics possess a distinctive exposure to the living and working conditions of their patients. Beyond extracting medical information, paramedics can discern potential indicators of human trafficking within the surrounding environment. This nuanced understanding, derived from the firsthand experiences, underscores the significance of paramedics as keen observers capable of identifying red flags associated with human trafficking. Consequently, the information gathered by paramedics holds the potential to raise suspicions and prove the value of their role in reporting such incidents.

In Australia, the reporting of various incidents, especially offenses against children, typically involves notifying a third party, such as hospital staff, ambulance supervisors, or the police (QAS, 2020). However, research evidence suggests that paramedics often face uncertainty in reporting crimes against children. Attributing to this challenge is a lack of clear procedures and awareness training in this specific domain (Brady, 2018). This paper posits that the complexity of reporting in the current prehospital environment arises from the demanding workloads and staffing pressures experienced by all stakeholders.

While ambulance services in Australia provide awareness training on prevalent social issues such as domestic family violence (DFV), discrimination, and inappropriate workplace behaviors, there is limited awareness training on the emerging issue of human trafficking. A review of existing literature reveals that some American emergency medical systems have implemented awareness curriculums addressing human trafficking (USFA, 2018). Despite undergoing awareness training, paramedics may not be fully confident in reporting current prevailing social issues, as suggested by Brady (2018) and Sawyer et al. (2023). Therefore, it is plausible to assume that paramedics may lack confidence in reporting incidents related to human trafficking.

The 2021 Working for Queensland survey indicates that 80% of Gold Coast (Australia, Queensland) paramedics feel confident in sensitively communicating with colleagues affected by DFV, and 79% are confident in effectively referring a colleague affected by DFV to appropriate support (State of Queensland, 2021). While these results suggest increased confidence in dealing with specific issues through targeted training, they also highlight the need for additional awareness training to empower paramedics in recognizing and reporting inappropriate actions. By delivering appropriate awareness training, there is a greater potential for paramedics to become vigilant observers, capable of identifying subtle red flags and confidently playing a proactive role in addressing human traffick-

ing (Falkiner et al., 2017; Sawyer et al., 2023). Some human trafficking signs may present like mental health issues such as unresponsiveness to questions, inappropriate anger, unusual loyalty to the traffickers, or the person not being able or allowed to speak for themselves. Physical signs may include intentional self-harming, malnutrition, evidence of violence or trauma, scarring, unusual tattoos that may indicate ownership, and the person not carrying or having access to their personal identification (USFA, 2018). Intense character changes or physical appearance could present as mental health deterioration to the paramedic, so the targeted and focused training may help distinguish between mental health deterioration and human trafficking.

Human Trafficking

Forced marriage, sexual and labor exploitation, and other coercive actions constitute elements of human trafficking (Lyneham, 2019). The Australian Federal Police (AFP) data indicates an increasing prevalence of forced marriage within the broader context of human trafficking from 2013 to 2021. Forced marriage was criminalized in Australia in 2013 (Simmons & Wong, 2021). This paper posits that identifying forced marriage is more intricate than recognizing sexual or labor exploitation, necessitating heightened awareness among Australian paramedics regarding this evolving issue and the impacts on its victims. Forced marriage is defined by the Cambridge English Dictionary (2023) as a marriage occurring without the agreement of one or both parties. Information or suspicion may manifest through patient conversations and behaviors, or behaviors of their relatives, often showing signs akin to domestic violence, including physical or sexual abuse, coercive control, and manipulation (Courts, 2022).

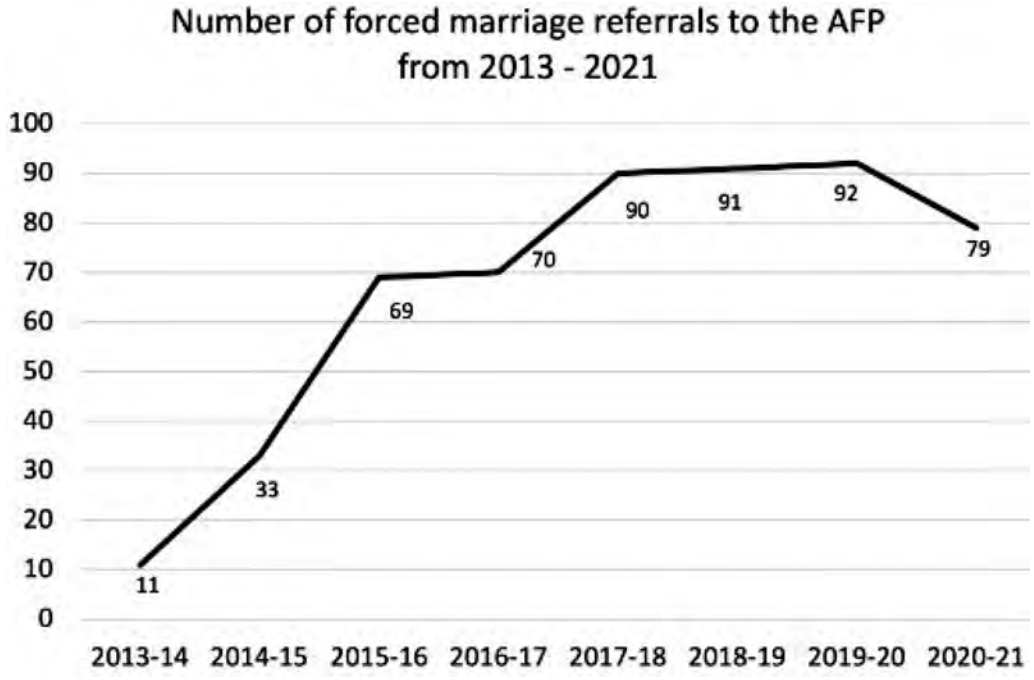

Figure 2. Forced marriages referred to Australia Federal Police (Simmons & Wong, 2021).

Human trafficking, especially in first-world countries, is prominently associated with the trafficking of women for sexual exploitation (Putt, 2007). The United Nations traffick-

ing citation index (UN, 2023) confirms this for Australia. Within Australia, these women originate from Thailand and, to a lesser extent, China, South Korea, and Malaysia. Disturbingly, children globally are also trafficked for sexual servitude, constituting approximately 25% of trafficked individuals (Whittington, 2022). Human trafficking has surpassed illegal arms sales worldwide, with projections indicating that persons trafficked for sexual servitude will soon outnumber those for trafficked drugs (Edwards, 2022).

Research suggests that criminal groups engaged in human trafficking in Australia are relatively small and discreet, occasionally posing as family units, making the crime challenging to identify during regular daily activities (Donnelly et al., 2019; Langhorn, 2018; USFA, 2018). Paramedic awareness training programs could utilize specific demographic information to create an increased suspicion index when encountering cases meeting these relevant parameters. Skills taught should include soft skills and techniques on how to communicate and ask gentle, nonjudgmental questions and how to evaluate and listen carefully so to understand if the victim's responses are in the context of possible human trafficking (USFA, 2018).

The seamless sharing of information between countries and agencies is deemed crucial to improving the prosecution of traffickers and protecting victims (Putt, 2007). Therefore, the system that information is passed on by paramedics to relevant authorities may play a pivotal role in prosecuting offenders and ensuring the safety of victims, underlining the importance of cohesive interagency interoperability (NPIA, 2009).

Despite the development of the "Look a little deeper" Human Trafficking awareness training package by the AFP, it remains unclear whether Australian Ambulance services have adopted this program. This package was offered to the Queensland ambulance service which refused to adopt the training as it was not a priority. The training package imparts information on the warning signs of human trafficking to first responders, relevant government organizations, state/territory police, universities, and non-government organizations (AFP, 2021).

Due to the increasing prevalence of forced marriage resulting from significant demographical changes, there is a need for further awareness within Australia (ACIC, 2017). Human trafficking is especially challenging to identify, and this article emphasises the need for paramedic awareness and training on the signs and impacts of forced marriage.

Risks and Reporting Systems

Concern is raised about the moral obligation of reporting crimes, patient confidentiality, loss of trust in ambulance services, and personal risk to paramedics. This issue was raised in Canada when "Bill 46, the Gunshot and Stab Wounds Mandatory Disclosure Act" proposed mandatory reporting of gunshot and stab wounds (Simons, 2009).

This article does not advocate for paramedics to transition into the role of front-line law enforcement officers. However, as a recognised profession, Australian paramedics bear the responsibility to report criminal activities, and the ignorance of signs indicating illegal conduct is not a valid defense against non-reporting. Certain professions, including paramedicine in Australia, are mandated to report observations as part of their job responsibilities, with variations in reporting requirements across different jurisdictions (see below) (Falkiner et al., 2017).

Duty	Branch of Law	Duty-Bearer	Examples
Specific duty to report knowledge or belief about a child sexual offence	Criminal law	All adults	Ireland; South Africa; France; Victoria (Australia); New South Wales (Australia)
General duty to report serious criminal offences, implicitly including child sexual offences	Criminal law	All adults	USA
Duty to protect a child from the risk of sexual abuse by another person in a child and youth-serving organization	Criminal law	Managers or those in positions of authority in child and youth-serving organizations	New Zealand; Victoria (Australia); New South Wales (Australia)
Duty to report knowledge and reasonable suspicion or reasonable belief that a child has been or is being sexually abused (sometimes extending to risk of abuse)	Child protection law - "Mandatory reporting laws"	Members of designated professional groups, commonly including those in education, childcare, health, and law enforcement	Dozens of nationas across developed and developing economies
Duty to report known and alleged cases of child sexual abuse within organizational settings to an independent external oversight body	Child proteciton law / Civil law / Reportable conduct schemes	Managers in child and youth-serving organizations	New South Wales; Victoria; Australian Capital Territory (Australia)
Duty to report where one knows or ought to know a child has been or is being sexually abused	Civil law - Torts - Negligence - Duty of care	A person in a professional relationship with a child of sufficiently close nature that the person owes the child a legal duty of care	USA; Canada; UK; Australia; New Zealand
Duty to report known and suspected cases of child sexual abuse	Occupational policy	Professional or pratitioner in an occupation having such a policy	USA; Canada; UK; Australia; New Zealand

Table 1. Legal duties to report child sexual abuse (Falkiner et al., 2017).

Forced marriage is gender-based violence that leaves young girls and women vulnerable to a life of misery. Australian law looks at forced marriage as a form of family violence and a version of modern slavery (Simmons & Wong, 2021). As it can be summarized that paramedics' core roles are to reduce pain, reduce suffering, and save lives, it may be possible to breach these roles by not reporting human trafficking. Laws that protect children and vulnerable people are generally well supported by communities. Research from India endorsed reporting by general practitioners on violations against children as a golden rule (Moirangthem et al., 2015).

The research acknowledges the risks associated with reporting crimes, as it may harm victims or the reporters. The potential backlash from dangerous criminals enforces the need for a highly secure and stringent anonymous reporting system, although the operational details of such a system falls beyond the scope of this paper, necessitating input from content experts in law enforcement. An anonymous, robust, user-friendly reporting system would instil confidence in paramedics to report illicit activities without fear of reprisal (Falkiner et al., 2017; Papp et al., 2019).

There are other professions such as teaching that have mandatory reporting requirements and are exposed to the public like paramedics. To safeguard these professionals, it is important that a reporting system has a robust responsive capacity as an integral part of this system (Falkiner et al., 2017).

LIMITATIONS

The scoping review is limited by primarily relying on publicly available information and excluding proprietary data. The results may not fully represent awareness programs

within Australian ambulance services. The study calls for more focused research, including formal interviews with current Australian paramedics.

CONCLUSION

In conclusion, this paper proposes that paramedics could contribute significantly to identifying and reporting human trafficking. (Awerbuch et al., 2020).

It is important to note that additional comprehensive research is necessary to validate the hypothesis presented. The proposition suggests that with appropriate awareness training (Awerbuch et al., 2020) and a user-friendly anonymous reporting system, paramedics could potentially contribute to identifying criminal activities, and help reduce suffering and address this heinous crime effectively.

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CONCEPTS

A LITERATURE SUPPORTED MODEL FOR IMPLEMENTING EFFECTIVE USE OF SIMULATION AND DEBRIEFING IN PARAMEDIC EDUCATION

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ABSTRACT

The purpose of this paper is to provide a literature supported pathway to incorporating effective simulated learning experiences (SLE) into paramedic precertification courses. The literature is sparse on simulation incorporation into paramedic programs; however, it demonstrates extensive benefit in medicine and nursing. Paramedic educators have access to simulation equipment, yet seldom use it for more than skills development. Studies show that effective simulation can lead to improved patient care, outcomes, and safety, but requires ongoing faculty development, especially in the area of debriefing. Learning the structure and purpose of debriefing and committing to practicing the skill is crucial to unpacking meaning from a SLE. This paper describes the reasons for implementing SLEs into paramedic precertification courses, suggests a comprehensive model for faculty development, describes a debriefing method for immersive SLEs, and provides guidance for ongoing simulation professional development.

INTRODUCTION

Simulations implemented in a medical education environment create a realistic scene that allows learners to engage similar to how they would during an actual event. Simulation based education (SBE) and simulated learning experiences (SLE) are increasingly important to medical education across all provider levels (Issenberg et al, 2005; Nehring & Lashley 2010; Cook et al, 2013). SLEs provide experiential learning opportunities that research indicates are optimally implemented early in learning before clinical encounters. SLEs reduce risk to patients while allowing for the creation of myriad clinically relevant encounters (Mills et al, 2015). Despite this broad recommendation of SBE, McKenna, et al (2015) found that while access to simulation equipment and resources among paramedic programs approached 100%, use of programmable high-fidelity simulators and live simulated patient actors was only reported in 71% and 66% of programs, respectively.

The SUPER study (2015) concluded that training and support in use of simulation technology were the greatest impediment to SBE. Increasing access to initial and ongoing faculty development in the use of simulation creates communities of practice and increases confidence in the use simulation (Palaganas et al, 2014; Zigmont et al, 2014). Faculty development, for the purposes of this paper is defined according to Centra, as a "range of activities that institutions use to renew or assist faculty in their roles" (1979). These activities can include workshops, conventions, courses, series of seminars, and individualized feedback (Cheng et al, 2015). Faculty members across medical disciplines often report feeling unprepared to deliver SBE, particularly in debriefing (Zigmont et al, 2014; Cheng et al, 2015; Eppich & Cheng, 2015; Jeffries, 2008), highlighting the importance of initial and ongoing faculty development.

Cheng, et al, define debriefing as a "discussion between two or more individuals in which aspects of a performance are explored and analyzed with the aim of gaining insights that impact the quality of future clinical practice" (2016). It is the portion of the SLE for facilitator-guided reflection of the simulation while unpacking objectives. This discussion allows learners to translate the simulated experience and apply it to clinical practice (Rudolph et al, 2006; Cheng et al, 2016; Meyer et al, 2011; Boyle et al, 2007). This paper seeks to describe the need for debriefing in precertification paramedic education, while establishing an outline for faculty development for simulation best practices and recommends the debriefing with good judgment (Rudolph et al, 2006) model for paramedic educators.

TEACHING CRITICAL CARE MEDICINE

With limited research available regarding simulation education in paramedic courses, a reasonable proxy was needed. Teaching medical students critical care medicine offers a reasonable parallel to paramedicine work levels, clinical reasoning, decision making, and responsibility. Beal et al provides a comprehensive literature review of articles that discussed training in acute care specialties including "critical care, intensive care, anesthetics, emergency medicine, trauma, or prehospital care" (Beal et al, 2107, p.105).

The authors concluded that the addition of high-fidelity simulation involving the use of high-fidelity manikins and standardized patients into the curriculum correlated to a 50.0 percentile gain in competency for the high-fidelity simulation over 12 studies making it significantly more effective than other teaching methods collectively. The percentile change was calculated using Z Scores and found to be an increase of 49.8 percentiles, meaning a 50th percentile student from the simulation group would be in the 99.8th percentile if in the control group comprised of those learners who did not have simulation in the curriculum. Therefore, considering the average time of two hours to implement simulation is worth the investment with such a high percentile gain (Beal et al, 2107) and further indicates that simulation is effective at addressing objectives related to performance outcomes.

Employing high-fidelity simulation in the context of performance-based objectives will yield the greatest gains in critical care medical students. It is also clear that simulation should be used as an adjunct not replacement to other teaching methods (Beal et al, 2017). Considering this, and that prehospital care was at least considered for inclusion in the article's analyses, careful integration of high-fidelity simulation and standard-

ized patient methodology into the paramedic curriculum should yield similar results in paramedic courses than didactic teaching alone. Since this study focuses on preclinical learning objectives, placing simulation in the preclinical phase of paramedicine courses would yield optimal results.

Mills, et al (2015) determined that the placement of SLE prior to clinical placements (CP) resulted in more learning gains than the reverse. Two groups naturally formed through students' self-selection into one of the two groups and producing sufficient randomization and homogenous groups, n=85, (Mills et al, 2015). The SLE was standardized, administered by the same instructors, and compulsory for all students as a part of their regular education. Uncontrolled variables included the CP instructors and complexity or volume of actual clinical encounters for the groups, consistent with typical ambulance work. One group had simulation experience prior a clinical experience (Sim-Clin), and the other group (Clin-Sim) had real-world CP followed by the same SLE. Assessment scores for the Sim-Clin group were reported to be higher than those of the Clin-Sim group by a statistically significant margin indicating more sustained learning and a faster ascent to competency.

Mills et al (2015) illustrate that there is an optimal place for simulation in the paramedic curriculum, and Beal et al (2017) conclude that critical care medicine can be taught effectively using simulation. The authors both highlight the necessity of developing faculty capable of teaching with simulation effectively.

Making the Argument for Faculty Development

Preclinical nursing programs have increasingly used simulation to supplant clinical hours due to increasing difficulty obtaining clinical experiences for their learners. Some paramedic programs face the similar challenges; there is no guarantee learners will see critical patients requiring critical thinking during field clinical experiences on the ambulance. McKenna, et al, (2015) evaluated the access to, comfort in using, and availability of simulation equipment and found that paramedic educators have extensive access to myriad simulation equipment, including 31% of programs that have access to equipment and never use it. Most programs (66%) indicated never using simulation to replace field hours, and 77% of respondents never replace field internship hours with simulation. Therefore, these programs exclusively rely upon ambulance apprenticeship and patient encounters in emergency departments to supply all the clinical learning, despite mounting evidence that paramedic programs are facing similar challenges as nursing counterparts.

Paramedic education lacks simulation implementation in an environment that appears to be flush with access to a variety of simulation resources with the broadest disparity being 71% of programs using high-fidelity manikins despite 91% of programs having access (McKenna et al, 2015). Use of some simulation equipment is intuitive; however, high-fidelity manikins require training on the user interface and manikin functionality; only 48% of programs indicated adequate training (McKenna et al, 2015). Additionally, only 13 programs reported an in-house expert was available to train faculty and 23% of programs had simulation support personnel available during the courses (McKenna et al, 2015). Based on these data, with a majority of paramedic programs lacking simula-

tion expertise, training, and support, it can be inferred that paramedic educators would greatly benefit from enhanced training on the simulation equipment.

With most programs having access to simulation modalities and only a fraction implementing it, McKenna et al (2015) found that debriefing training is needed, with 45% of the users citing lack of debriefing training as a barrier to implementing simulation. This is coupled with only 24% of the core faculty stating they have received "a lot" of training on debriefing. Although 67% of programs identify that training in running simulation events and scenario writing are the barriers to using simulation, these are pre-event barriers which could artificially lower the number of programs reporting a need for training in debriefing because, if you do not know how to run the manikin for a scenario, you would not recognize the need to debrief it. The training deficit in debriefing is critical since faculty need to know more than just how to turn on the equipment, but what to do with it after the scenario has been carried out.

Faculty Development Framework

Peterson, et al (2017) describes a faculty development plan that includes best practices in simulation design, implementation, and debriefing SLEs across the entire simulation community at the University of Alabama at Birmingham (UAB) and the rationale behind their tiered approach to faculty development while including certification as a simulation educator. The educators at UAB began with explaining why this was needed and proceeded to develop a tiered approach to faculty development that addresses varied faculty need while creating uniform, scaffolded learning processes rooted in best practices in simulation education.

Effective simulation educators can vary their approach to different situations within a simulation or debriefing while consistently employing best practice recommendations. The authors recommend a tiered approach where faculty who are new to simulation can be coached while developing their skills, irrespective of clinical knowledge or experience level (Peterson, et al 2017). Faculty are allowed to implement the newly acquired teaching methods with regular observation and feedback and consequently grow in their simulation skills at their own pace. Experienced faculty can enter the development model at different points based on prior simulation experience, so they can move from competent to expert at a comfortable pace.

The different facets in UAB's faculty development program include observation, didactic presentations, interactive learning experiences, practice, expert feedback, mentoring, and networking. Progression through the facets requires the faculty to continuously work at improving themselves in all areas. Regardless of how long the faculty works in simulation, observation and feedback is continuous, and as junior, inexperienced simulation faculty become senior, they give more feedback but still receive feedback. This creates a culture of growth, development, and mutual support among simulation educators and formal and informal learning opportunities builds a high functioning community of simulation practice.

Faculty development requires attention to the detailed needs of the faculty member, as well as a safe environment for the faculty to grow and develop their skills. The UAB model considers the varied aspects of simulation education and considers the needs of the adult learner. Further, it is enhanced with a rigorous program that is not time sensi-

tive allowing faculty to learn at their own pace, acquiring skills over time. This process leads to an effective community of practice in simulation education and capable faculty which can be able to be applied to paramedic instructors' simulation development, particularly using peer feedback.

Peer Feedback and Growth of the Debriefer

Cheng, et al (2015), explore the impact of faculty development of novice debriefers to not only feel supported in the use of simulation, but also to develop self-confidence in debriefing. There are several debriefing models, each with its own niche for optimal use, but all tend to fall into one of two broader debriefing categories; revealing learner frames to effect broader learning; or plus/delta style discussions where favorable actions are reinforced, and others are identified and changed going forward. Learning objectives for the simulation, learner type and level, and time available to debrief, determine the ideal debriefing model (Cheng, et al, 2015). Mastering one debriefing technique while ignoring others may result in using a suboptimal technique for the current learning situation. Therefore, equipping the educator with multiple debriefing techniques is beneficial.

A cornerstone in adult learning theory states that learners need immediate relevance and practicality (Cheng, 2105) in the experiential learning. Additionally, learners in a debriefing course seek peer feedback alongside expert feedback to help develop the community of debriefers. Therefore, the authors assert that combining repetitive practice with guided expert and peer feedback during, but especially after, a debriefing course is essential to master debriefing skills. Standardization of the delivered feedback is critical to maximizing its effectiveness.

The Debriefing Assessment for Simulation in Healthcare (DASH) and the Objective Structured Assessment of Debriefing (OSAD) are widely accepted, validated tools available to assess and provide feedback to a debriefer of any experience level (Cheng et al, 2015). The DASH evaluates six elements of debriefing, each scored on a 7-point criterion referenced, behaviorally anchored scale. The OSAD evaluates 8 elements on a 5-point scale with anchors at the 1-, 3-, and 5-point positions. Both show good inter-rater reliability, and content and concurrent validity in studies of experts and first-time users. The tools look at how the facilitator leveraged debriefing events to strengthen learning and meet both scenario objectives and learner objectives.

Since no one piece of information can be learned, meaningfully practiced, and masterfully implemented in one setting, debriefing education needs to be refined over time, employing Kolb's concepts of experiential learning of feedback suggestions. With both tools anchored, either can be used for guided reflection or to show skill improvement in an experiential learning cycle promoting programmatic debriefing quality. This method illuminates a pathway to success at the pace of the individual learner which is influenced only by the experience that the faculty member brings with them (Peterson et al, 2017; Cheng et al, 2019). Such skills may include small group facilitation, effective communication and negotiation skills, or a capacity to synthesize events in complex situations they inherently apply to debriefings.

Peer feedback is a collegial and collaborative aspect of educator development that can foster a community of practice, augment competency for the feedback provider and receiver while ameliorating weaknesses and supporting successes (Rudolph et al, 2006;

Cheng et al, 2019). As more educators use these or similar rater systems, they will understand what is expected of them self-evaluate debriefings and individualize their development. The DASH has a version designed for instructors to rate themselves either with an immediate after-action review or watching themselves on a recording. Self-reflection paired with expert or peer feedback can provide magnify debriefing prowess (Rudolph et al, 2006).

In recognizing the development of debriefing as a skill developed over time, and that not every new educator needs to begin the development continuum at the same point, debriefers can be supported in their budding expertise. Transitioning from instructor led pedagogy to learner centered education represents a categorical shift in the outcomes related simulation education and the ability of the learner to apply their experiences to the clinical environment (Rudolph et al, 2006).

Shifting from Instructor-Centered Teaching to Learner-Centered Teaching

Debriefing can be constructed in a learner-centered manner or in an instructor-centered manner. Instructor-centered teaching is where the instructor makes knowledge deposits into their learners. The instructor is the unilateral holder and disseminator of the content, and the passive unquestioning learners absorb, memorize, and regurgitate that knowledge. While it allows for the fastest delivery of information, it results in shorter retention times than its counterpart (Cheng et al, 2016). Conversely, learner-centered teaching is a constructivist method where learners take an active role in the learning process and the instructor is a facilitator of the learning. The instructor has objectives to meet, however, the learner may bring up topics they wish discuss generated from the scenario. This creates more motivated learners who have ownership over their learning, leading to longer retention time.

Cheng, et al (2016) make the argument for the value of establishing debriefings as a largely learner-centered event and identify several variables to consider when implementing learner-centered debriefings including amount of time available to teach and the knowledge and experience of the learners. When time is limited for debriefing, instructor-centered teaching is preferred because it allows the instructor to maximize the material covered. This applies when time is running short during debriefing or in the clinical environment when patients are present. When dedicated sufficient debriefing time exists, a learner-centered approach is preferred allowing learners to contextualize the learning to the clinical setting. Learners with little background or experience may benefit from more instructor-centered pedagogy since those learners will be less inclined to engage in discussion-style learning, whereas learners with base knowledge will be more likely to engage in a discussion to modify their frames of reference and implement new practices to an existing repertoire. Experienced learners may enrich the learning of others participating in the experience during a well-constructed and facilitated debriefing.

Each of the three phases of a debriefing – reactions phase, analysis phase, and summary phase – incorporate learner-centered teaching concepts. The reactions phase invites learners to share their feelings and perspectives on the SLE and allows time for the learners to process and share perspectives, frames, and learner-developed objectives, thus activating learning. The analysis phase begins with the instructor setting a loose

agenda for the discussion to follow. Much of the time in a debriefing is spent in this phase unpacking objectives and is where learner-centered approaches often provide the most benefit. During the summary phase, the learners are given a chance to express in their own terms what part of the experience resonated most with them and allows the instructor to evaluate the learning that has taken place. The instructor should refrain from summarizing, describing, or stating what should have been learned during the encounter, focusing rather on the learners' self-reflection as a crucial step in formative assessment.

The goal should be to incorporate learner-centered teaching styles into debriefings of SLEs but Cheng, et al, (2106) concede that it is not always practical or possible to have purely learner-centered experiences with time and learning knowledge base variables. They recognize that a good debriefing starts with a good pre-briefing which sets the stage for learner-centered teaching because it contains important components designed to establish ground rules for the experience, encourage participation and active learning, and establishes the safe learning environment where even failure is an acceptable and encouraged option.

Setting the Stage with Pre-Briefing

Rudolph, Raemer, and Simon (2014) explain the pre-briefing is the time when the simulation faculty set the stage, literally and figuratively, for the learners. The pre-briefing: describes the setting in which students will interact with the simulated patient (manikin or SP), provide the learning objectives, and discuss how the observations made during the SLE will be used. The "safe container" (Rudolph, et al, 2014, p.339) is a context in which learners are free to expand their comfort zone and make mistakes in a psychologically safe environment throughout the simulated experience, respecting the learners for putting their professional identities on display to be evaluated and discussed.

Explicitly recognizing the importance of learner psychological safety and taking steps to actively reduce the feelings of stress the learner will feel from peers, instructors, and supervisors observing and evaluating them has a nurturing effect on the learner. They become willing to practice at the edge of their comfort level and to talk about areas of potential improvement. This safe learning environment allows learners to face negative feelings associated with failure and mistakes and set aside the notion that participation in the simulation will expose their ineptitudes or weaknesses as part of a growth model rather than a punitive one.

To create and maintain the psychologically safe environment throughout the simulation, learners should be assured of complete confidentiality and understand the way the experience will impact them after it is over. Simulations can be used used as a formative assessment; a summative assessment receiving a grade; or can be high stakes, possibly meaning the difference between receiving or keeping a certification, license, or job. Higher stakes mean the learner may see the simulation as a threat to their identity rather than a way to improve and gain knowledge. After securing confidentiality, share the objectives needed to facilitate full engagement in the scenario.

Psychological safety of the learner extends to understanding the physical environment in which the scenario will take place. Despite best efforts, material differences between the simulated environment and the real clinical setting will always exist; deliberately

allowing time for the learner to view the available medications, for example, or practice with the medical equipment and instruments available to the during the encounter will enhance learner comfort in the space. This helps ensure learners stay engaged in the simulation and reduces the chances they cite the physical fidelity as a reason for any subpar performances. This begins "establishing a fiction contract," (Rudolph, et al, p.341) which essentially establishes a mutual understanding between faculty and participant that the situation is not real, and that care was taken to accurately mimic reality while acknowledging its departures from reality. The participants also agree they will engage in the simulation as if everything they encounter is real, to the degree possible. This serves to increase the learner's focus on the objectives rather than gaps in fidelity.

Finally, psychological safety is affirmed with the establishment of the Basic Assumption which states: We believe that everyone participating in activities [at this institution] are intelligent, capable, care about doing their best, and want to improve (Rudolph et al, 2014). Learners seeing and hearing this prior to starting a simulation will be more likely to be comforted knowing the instructor understands they will not be perfect, and that they are present to become better, fostering a growth mindset for all involved, empowering learners to ultimately succeed.

Establishing a safe harbor for putting into practice new knowledge, techniques, or skills is an essential element to creating a successful experience that can lead to a rich debriefing that provides transferable learning. The safe container, established at the outset, will allow the debriefing team to delve deep into learners' frames and points of view with deeply probing questions and meaningful reflection. And throughout, they will know they will be treated in a professionally courteous manner, even in the event things do not go as well as they hoped or wanted.

Debriefing with Good Judgment

Rudolph, et al, (2006) provide a framework for model debriefings they called "Debriefing with Good Judgment" (DGJ). Reflection on action, whether in the clinical or simulated setting, demands critical, yet supportive, facilitation. With the Basic Assumption as a foundation, actions are believed to result from the well-intentioned, rational attempt at the best solution. These frames – or schemata, mental models, etc. – tend to be grounded in experience, cultural upbringing, educational level, and perception of the situation and lead to an action and subsequent observable result. The results can have a favorable outcome, a neutral outcome, or a harmful outcome.

The link between frames, actions, and results is very strong; an individual perceives the situation; determines and executes a course of action; and reviews, interprets, and reacts to the ensuing results, beginning the cycle anew (Rudolph et al, 2006). Focusing only on the action that brought about the result is known as single loop learning. This directly and concretely fixes the action – and result – for that singular specific situation but may not lead to extrapolation to other similar situations, only able to apply their experience to the next identical situation. This does not, however, address the thought process that led to the action. A skilled facilitator will focus the conversation on uncovering the learners' frames that led to the action. Since the learners' frames are not typically vocalized during a scenario, explicitly reflecting upon the frames during a debriefing will lead to changes in the incorrect action – or maintenance and expansion of the appropriate ac-

tion – and subsequently a change in outcome. Creating a new way of thinking – a new frame –has the potential to be applied across a broader range of situations beyond the one being debriefed.

In a nonjudgmental debriefing, facilitators get the participants to identify the successful and unsuccessful aspects of a simulation, generally with little specific guidance as in, "what areas do you think could be improved?" However, often the facilitator has withheld a point of view held, leading learners to guess the "right" response in what Rudolph et al (2006) call "Guess What I am Thinking" questions. The judgmental model has the advantage of getting right to the point and highlighting what went well or went poorly, or right or wrong, without considering what led to the events and often lacks any level of discussion as judged purely from the perspective of the facilitator. Adult learners shut out those facilitators who present a correct, finite answer to all situations. Evaluation of these two methods leads the authors to suggest a method they call Good Judgment.

DGJ, instead, follows a three-step approach where the instructor leads a discussion, and all participants are invited to share in the development of new frames. Of critical importance here, is advocacy for the learner followed by a genuinely curious inquiry about the learners' frames regarding a specific moment or event in the simulated experience. First, the facilitator identifies the moment they would like to discuss and shares the perception, thoughts or reaction to the event including how it differs or synergizes with the observed moment up for discussion. At this point, the learner knows exactly what is being discussed and what the view their instructor has on the situation. The facilitator then asks the participant(s) involved to share what their thoughts were at that moment in the scenario in a facilitative, non-condescending fashion, deliberately revealing their frame. In such a healthy exchange, the learner can be vulnerable knowing the discussion's goal is purely to become better providers, rather than punitive for mistakes. Context can then be applied to the entire situation, and, with the help of the facilitator, deep meaning and transferability can be developed. This is the optimal way for adult learners to maximize an experience while making it transferable to actual clinical practices.

DISCUSSION

Implementation of SLE into a precertification paramedic program is the first, if not most crucial, step. This paper should serve as the basis for further research and into simulation usage in programs who have simulation equipment available and access to simulation expertise in their institutions. Furthermore, the creation of a community of practice at the local and national levels would further support needed growth and development of EMS instructors related to best practices in SBE.

There are many simulation associations and EMS organizations that are working to improve the quality of simulation methodology and activities in EMS education. Much research is needed and this author encourages EMS instructors to consider research opportunities in healthcare simulation as an EMS educational methodology. This would include reaching out to those organizations to determine what existing research opportunities and priorities exist, or how additional research questions can be identified and answered.

Further research needed includes, but is not limited to, lessons learned from and outcomes associated with the creation of local communities of simulator educator practice;

educator attitude shifts toward SBE correlated to student performance; demonstration of change in time to competency, proficiency, or mastery of procedural skills after robust implementation of simulation; changes in student self-reported confidence in clinical internships after simulation experiences; and, changes in perceived student stress during clinical internships after simulation experiences. These research opportunities could be qualitative or quantitative in nature, depending on the topic, and would further support the professional development needed for EMS instructors for optimal experiential learning adjunctive to didactics and clinical internships.

CONCLUSION

The very nature of a paramedic's job lends itself to optimal preparation for and experience in critical, stressful situations. Implementation of SLE with effective debriefing in paramedic programs can close the gap between what the clinical experiences and internships can deliver, and the knowledge needed to be an independent paramedic. Optimal implementation of SBE requires paramedic faculty to be skilled in best practices of simulation education, especially around debriefing. Exposing learner frames and reinforcing those frames or restructuring them for improved performance is challenging to avoid learner dissonance and defensiveness. Training in techniques of debriefing should begin with initial training followed with ongoing, routine peer support and feedback with proven mechanisms such as the DASH or OSAD to develop paramedic educators agile in SBE.

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Volume 16, Issue 8, August 2024

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LITERATURE SURVEILLANCE

PARAMEDICINE LITERATURE SEARCH: JUNE-AUGUST 2024

SECTION EDITORS: Shaughn Maxwell, Psy.M., EMT-P*[1]; Brenda M. Morrissey, DPA, FP-C, FACPE[2]*

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To help paramedicine professionals to keep abreast of the literature in our discipline, the Paramedicine Literature Search provides the results of a standardized search of the PubMed database. This search results will include articles from journals that many paramedicine professionals may already be familiar with. The search strategy is also designed to include articles in journals they may not be commonly monitoring, such an article about ambulance care for cancer patients that appeared in an oncology journal.

The formatting of the Paramedicine Literature Search allows the reader to scan the titles of articles and click into the article link, when provided, for additional details.

The authors have made a diligent effort in designing of the search strategy to balance sensitivity (i.e., getting all relevant articles in paramedicine) with the specificity (i.e., excluding articles not relevant to paramedicine). The balance is imperfect. As a result, it should be noted that the results do not include every relevant article and includes some non-relevant articles.

The search strategy is filtered to only include articles published in a time frame listed below. This will include articles with electronic and print publication dates in that date range. Some of the publication dates may fall outside of this range due to how the article metadata was indexed by the publisher.

The following results were obtained on October 2, 2024 from the PubMed website (https://pubmed.ncbi.nlm.nih.gov) using the following search terms and Boolean logic:

"paramedic"[Text Word] OR "paramedics"[Text Word] OR "prehospital"[Text Word] OR "pre-hospital"[Text Word] OR "emergency medical technician"[Text Word] OR "emergency medical technicians"[Text Word] OR "Ambulance"[Text Word] OR "emergency medical services"[Text Word] OR "fire-rescue"[Text Word] OR "fire-rescue"[Text Word]

Search Filter: Publication range of June 1, 2024 to August 31, 2024.

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International Journal of Paramedicine

Published by the National EMS Management Association (USA)

GUIDELINES FOR AUTHORS

The *International Journal of Paramedicine* (*IJOP*) is a forum for scholarly contributions and state-of-the-art research relevant to patient care and the growth and advancement of paramedicine, including the areas of paramedic leadership, management, education, operations, culture, professional and clinical practice. The *IJOP* encourages exploration of paramedicine from diverse theoretical and practical views from all disciplines, including business and economics; the natural, basic, and applied sciences; and the humanities, social sciences, and arts. Priority will be given to submissions that use sound theoretical or conceptual frameworks, strong methodological design, and relevance to the international paramedic community. All methodologies such as quantitative, qualitative, mixed methods, and knowledge syntheses will be considered.

NEMSMA is a longtime collaborator with National Association of EMS Physicians in support of *Prehospital Emergency Care*. In continuation of that relationship, IJOP and PEC have established a collaborative relationship that will the facilitate the exchange of submissions in certain circumstances based in part on which journal may be the best fit for a particular manuscript.

GENERAL GUIDELINES AND NOTES

- The *IJOP* only publishes material in English. Please use Academic English.
- The *IJOP* accepts submissions in the following categories:
  - Case Studies (2,000 words)
  - Concepts (3,000 words)
  - Correspondence / Commentary (1,000 words)
  - Education (3,000 words)
  - Empirical Investigations / Original Research (4,500 words)
  - Methodology (2,000 words)
  - Quality Improvement Project Reports (3,000 words)
  - Reviews / Synthesis (4,000 words)
  - Special Reports (2,000 words)
  - Toolbox (1,500 words)

The word limits noted above are guidelines for the various submission types. Authors are encouraged to adhere to these guidelines and to be concise in their submissions.

- Merriam-Webster's Collegiate Dictionary (11th ed.) should be consulted for spelling.
- Contributions that explore non-clinical topics such as leadership, operations, education, professional practice, and the culture of paramedicine are strongly encouraged.
- Based on the international scope of the *IJOP*, contributions should provide a degree of generalizability and transferability to global settings and should have relevance to the *IJOP's* broad readership.
- *IJOP* discourages multiple publications derived from a single study.
- All original research submissions must have received approval from an Institutional Research Board (IRB) or Research Ethics Board (REB).
- Once a submission has been assessed for suitability by the editorial team, it will undergo a double-blind peer-review by independent, anonymized reviewers.

As part of the submission process, authors will be required to confirm that their submission complies with all of the items below. Submissions may be returned that do not adhere to these guidelines:

- The submission cannot be previously published or in the submission process of another publication (or an explanation has been provided in a cover letter to the Editor).
- The Author and Funding File and the Main Submission File are both in Microsoft Word document file format.
- An ICMJE Form for Disclosure of Potential Conflicts of Interest is submitted for each author.
- All illustrations, figures, and tables should be placed within the text at the appropriate points AND submitted as separate files in a high resolution format.
- Supplemental media files (e.g., spreadsheets, slides, audio or video files) may be included for reader access. The file should be hosted by the authors unless other arrangements have been made with the Editors.
- Where available, URLs for each reference have been provided.
- The text is double-spaced in a 12-point font.
- Page numbers and line numbering are used for the 'Main Submission File'
- The text adheres to the stylistic and bibliographic requirements outlined.
- Authors are strongly encouraged to follow any EQUATOR (Enhancing the QUAlity and Transparency Of health Research) Guidelines that apply to their type of submission. These include, but are not limited to:
    - Randomized trials
        - CONSORT and its extensions
            - https://www.equator-network.org/reporting-guidelines/consort/
    - Observational studies
        - STROBE and its extensions
            - https://www.equator-network.org/reporting-guidelines/strobe/
    - Systematic reviews
    - PRISMA and its extensions
        - https://www.equator-network.org/reporting-guidelines/prisma/
    - Study protocols
        - SPIRIT and the PRISMA-P extension
            - https://www.equator-network.org/reporting-guidelines/spirit-2013-statement-defining-standard-protocol-items-for-clinical-trials/
    - Diagnostic/prognostic studies
        - STARD and the TRIPOD extension
            - https://www.equator-network.org/reporting-guidelines/stard/
    - Case reports
        - CARE and its extensions
            - https://www.equator-network.org/reporting-guidelines/care/
    - Clinical practice guidelines
        - AGREE and the RIGHT extension
            - https://www.equator-network.org/reporting-guidelines/care/
    - Qualitative research
        - SRQR and the COREQ extension
            - https://www.equator-network.org/reporting-guidelines/srqr/

- Animal pre-clinical studies
  - ARRIVE
    - https://www.equator-network.org/reporting-guidelines/improving-bioscience-research-reporting-the-arrive-guidelines-for-reporting-animal-research/
- Quality improvement studies
  - SQUIRE and its extensions
    - https://www.equator-network.org/reporting-guidelines/squire/
- Economic evaluations
  - CHEERS
    - https://www.equator-network.org/reporting-guidelines/cheers/

Note that there is a section in EQUATOR with guidelines specific to emergency medicine that may also be applicable to studies in paramedicine.

SUBMISSION FILES

The following describes the 'standard' submission files that should be uploaded via the *Journal* submission website for each manuscript. Please refer to the specific submission guidelines for each submission category for more specific instructions that may apply.

Author and Funding Information File

Author Information

- All authors of a manuscript should provide their full name with up to four post-nominals and up to two organizational affiliations and titles – exactly as they should appear in the publication.
- The email of all authors should also be included.
- If available, please include ORCiDs (http://orcid.org) numbers for each author.
- You also include social media handles (e.g., Facebook, Twitter, LinkedIn) for each author.
- Please ensure that everyone who meets the International Committee of Medical Journal Editors (ICMJE) requirements for authorship is included as an author (http://www.icmje.org/recommendations/browse/roles-and-responsibilities/defining-the-role-of-authors-and-contributors.html).
- If an author changes their affiliation during the peer-review process, the new affiliation information can be given to the Editorial Team and will be handled as any other manuscript revision. Please note that no changes to affiliation can be made after the pre-publication galleys of the manuscript have been accepted for final publication.
- Identify one author as the corresponding author. They will be shown as such when the article is published and will be the point of contact between the editorial team and the authors.
- If the work presented in the manuscript was presented at conference or published in abstract form, identify the name of the event, location, format, and date of presentation.
- Acknowledgements, where applicable, can be provided. Brevity is strongly encouraged.

Funding Information

- Please provide the details for any funding that supported the submitted work, to include all details required by your funding and grant-awarding bodies. The following template sentences are suggested:
  - For single agency grants: This work was supported by the [Funding Agency] under Grant [number xxxx].
  - For multiple agency grants: This work was supported by the [Funding Agency #1] under Grant [number xxxx]; [Funding Agency #2] under Grant [number xxxx]; and [Funding Agency #3] under Grant [number xxxx].
  - If a funding source was not involved, please confirm with a statement such as, "External funding was not used to support this work."

Main Submission File

To provide a high level of objectivity in the peer-review process *IJOP* uses a double blind process. The identities of the authors and their institutions are not revealed to the reviewers and the identifies of the reviewers are not revealed to the authors.

Due to the double blind review process, information about the authors and their institutions should not appear anywhere in the main submission file. This should include removal of identifying information in the 'properties' of the Microsoft Word (.doc or .docx) files that are submitted.

Please do not use extensive formatting of the document. Use single spaces between sentences. Separate paragraphs with a carriage return. Do not indent the first line paragraphs with tabs or added spaces.

Unless stated otherwise in the directions for a specific manuscript category, all submissions should include the following elements in the following order as a single document file, called the Main Document File.

Title

- Provide the suggested title for the published article. Please note that the title used for publication is subject to editorial team approval.

Abstract, Keywords, Disclosures / Conflicts, Presentations, and Acknowledgements

- Unless exempted or described differently in the directions for a specific submission category, abstracts MUST be limited to 300 words or less, including the section headers (e.g., Problem, Methods, etc.). Use structured abstracts when possible.
- Unless exempted or described differently in the directions for a specific submission category, this page will also include between three (3) and six (6) keywords or short phrases that will be used for title and search engine optimization. Keywords of paramedicine, EMS, and emergency medical services will be added by default and will not count towards the keyword count requirements.
- State any disclosures or conflicts for each author. This will be in addition to completion of the ICMJE Disclosure Forms for each author as described below. If the are no conlficts, please state 'none.'

Primary Manuscript Body

- The primary body of the manuscript will come next in the main submission file. The composition of the primary body of the manuscript may vary with the category of the manuscript. Refer to specific manuscript category descriptions for details.
- The manuscript should use a minimum of formatting. If there are multiple levels of heading and sub-headings, please indicate the heading level by placing (H1) directly after the heading text for the top level heading, H2 for sub-headings, H3 for sub-sub headings, etc.
- Tables should be used to summarize large amounts of information rather than writing it out as a narrative. Tables may be created within the word processor or inserted from another program (e.g., Excel). If another program is used to create the table, please include the original source file as a supplementation media file submission. All tables should be inserted into this primary manuscript body file. They must be labelled sequentially, and referred to in the text. Table captions must include the table number and a name for the table at a minimum. Additional descriptive text may be added to the caption as needed to complement the reference to the table in the main body of the paper.
- Figures shall be inserted directly into the text at the appropriate position. These may be lower resolution images to simply show their correct placement. Figures must be labelled sequentially and referred to in the text. Figure captions must be included with the figure number and a name for the figure at a minimum. Additional descriptive text may be added to the caption as needed to complement the reference to the figure in the main body of the paper. In addition to including figures in the text, submit each figure as a supplemental media files in high resolution PDF, .jpeg, .tiff, or .png file formats, with a 300dpi minimum resolution.

References

- Where applicable, the references for the manuscript come next. Use endnotes rather than footnotes. The APA style in-text reference marks and in endnotes must be used.
- In each endnote reference, include hyperlink whenever possible to the referenced document. A DOI hyperlink is preferred, which will have a format of https://doi.org/XXXXX. If a DOI is not available, provide a link to the source journal, publisher website or similar source.
- Authors are responsible for the accuracy of all references, links and in text citations.

Appendices

- Where applicable, any appendices to the manuscript are inserted next.

ICMJE Forms for Disclosure of Potential Conflicts of Interest

- One form per author should be submitted.
- The form is available at: https://icmje.org/disclosure-of-interest/

Supplemental Media Files

- If the submission includes any supplemental tables or figures, they would be each be uploaded individually for inclusion at the end of the article.

- For speadsheets used to generate tables, upload them as individual files and clearly indicate which table they are associated with.
- If there are any supplemental media files (e.g., spreadsheets, slide decks, audio or video files), provide links to where readers can access them. They must be readily accessible without passwords or other restrictions.

GUIDELINES FOR CATEGORY-SPECIFIC SUBMISSIONS

Case Reports (≤2,000 words)

- These manuscripts share the experience of unusual clinical presentations, circumstances, or treatment approaches. Case reports should be structured as described in the Consensus-based Clinical Case Reporting Guideline (CARE; https://www.equator-network.org/reporting-guidelines/care/).

Concepts (≤3,000 words)

- These papers present a specific management or clinical concept, idea, or theory – and describes its practical application. If the paper presents a new concept, it may also suggest research, improvement projects, or pilot implementations of its application. Along with other standard submission file elements, the primary manuscript body pages file for Concept papers should contain:
  - Introduction - The introduction should describe the problem, issue, or circumstance that the concept is intended to address. Where applicable, address the current literature that demonstrates a gap and any pertinent background information.
  - Concept Description – Provide a description of the concept and how it can be applied. Where applicable, provide sufficient detail and clarity of any methods or procedures and the setting and population to which the concept applies.
  - Discussion - Authors are encouraged to include a critical review of related research and a fulsome discussion that highlights how the concept contributes to the field of paramedicine. Address any limitations of the concept.

Dialogues (≤1,000 words)

- The Dialogues section will publish comments and questions from readers related to previously published articles. Along with other standard submission file elements, the primary manuscript body pages file for correspondence should include:
  - Subject Paper Information - Provide the title, name of the first author, and the *IJOP* issue for the paper that is the subject of the correspondence.
  - The narrative of the correspondence.

Editorials (≤2,000 words)

- Editorials are a venue for the expression of opinion and perspective on topics relevant to the paramedicine community. They should make clear point(s) in a concise manner with a scholarly approach and tone. They should not be used for the presentation of data, findings, or research that has not been previously published.

Educational Methods and Processes (≤3,000 words)

- These submissions explore a specific educational process, approach, or method. The paper should also discuss any issues to consider in its practical application.

Along with other standard submission file elements, the primary manuscript body pages file for Education papers should contain:

- Introduction - The introduction should describe the problem, issue, or circumstance that the educational process, approach, or method is intended to address. Where applicable, address the current literature that demonstrates a gap and any pertinent background information.
- Description – Provide a description of the educational process, approach, or method and how it can be applied. Where applicable, provide sufficient detail and clarity of any methods or procedures and the setting and population to which the process, approach or method applies.
- Discussion - Authors are encouraged to include a critical review of related research and a fulsome discussion that highlights how the concept contributes to the field of paramedicine. Address any limitations of the concept.

Empirical Investigations / Original Research (≤4,500 words)

- The submission of manuscripts for empirical investigations / original research may be clinical or non-clinical. Several of the EQUATOR guidelines, described previously, may apply to any given study in this category. Please apply them as appropriate to your particular investigation.
- Authors may provide, or editors may suggest, that some information be provided as a supplemental file so that the main paper remains concise. The supplemental content may include data sets, images, video clips, and in-depth details on methodology. Along with other standard submission file elements, the primary manuscript body pages file for empirical investigations / original research should include elements as called for in the applicable EQUATOR guidelines.
- NEMSMA is a longtime collaborator with National Association of EMS Physicians in support of *Prehospital Emergency Care (PEC)*. In continuation of that relationship, *IJOP* and *PEC* have established a collaborative relationship that exchanges manuscripts in certain circumstances. Empirical investigations on clinical topics may be forwarded to *PEC* for their initial consideration with author consent.

Methodology (≤2,000 words)

- This category of submissions provides deep explorations of methods used or may be used in research studies or improvement projects. These methods should be novel in some way that makes them of significant interest in their own right, separate from the studies in which they are utilized. These papers can also provide a more detailed description of the methods than would otherwise be appropriate in the primary research or improvement project manuscript. The primary paper's methods section may direct readers to a methodology paper in this category for more detailed descriptions of the methods it utilized.
- Along with other standard submission file elements, the primary manuscript body pages file for Methodology papers should contain appropriate elements from the EQUATOR guidelines, as described for empirical investigations.

Quality Improvement Project Reports (≤3,000 words)

- *IJOP* acknowledges the importance of quality improvement activities to optimize EMS system performance and patient outcomes and welcomes manuscripts describing quality improvement projects.

- United States regulations do not require quality improvement activities to have Institutional Review Board (IRB) or Research Ethics Board (REB) approval. The distinction between manuscripts requiring or not requiring IRB/REB approval may be subtle. Manuscripts not requiring approval will generally be those which do not apply clinical treatments or diagnostic methods that have not been previsouly established in the literature. A manuscript that explores different ways to implement a clinical treatment or diagnostic method may not require approval.
- The *IJOP* shall reject manuscripts that appear to have framed an activity as quality improvement to circumvent research compliance, conduct, or reporting standards.
- Authors may contact the editorial office if they are uncertain whether their work should be submitted as a quality improvement or a research manuscript. If there any dounbdt, authors are encouraged to submit QI projects to an IRB is to obtain their independent judgement of the need for IRB oversight.
- Quality improvement project reports should adhere to the Standards for Quality Improvement Reporting Excellence (SQUIRE) guidelines (http://www.squire-statement.org). With permission of the Editorial Team, authors may submit manuscripts that use other generally accepted improvement project frameworks (e.g., IHI Model for Improvement; DMAIC).
- In general, quality improvement project reports should describe the process being examined; the process change(s) that were tested; the baseline process performance level; the methods used for conducting process tests and evaluating the results; the results, including the post-intervention performance levels; any confounding variables and balancing measures; and the process change iterations as applicable.
- The manuscript discussions and conclusions should highlight what the external audience can learn from the reported experience, not just the activity's internal success or failure.
- Authors may provide, or editors may suggest, that some information be provided as a supplemental file so that the main paper remains concise. The supplemental content may include data sets, images, video clips, and in-depth details on methodology.

Reviews / Synthesis (≤4,000 words)

- *IJOP* invites the submission of reviews of all types, including those with and those without meta-analytic components. In addition to the guidelines for original research provided elsewhere in these guidelines, any submissions in this category should be consistent with the Prisma 2020 guidelines for reporting systematic reviews https://www.equator-network.org/reporting-guidelines/prisma/.

Toolbox (≤3000 words)

- These submissions will explain a tool or technique and describe its practical use. Where applicable, the articles may include a supplemental file or link that contains the tool and a data file where the reader may try out the tool.
- Along with other standard submission file elements, the primary manuscript body pages file for Toolbox papers should contain:

- Introduction - The manuscript shall include an introduction that provides an overview of the type(s) of projects that the tool or technique could be used for or the specifics of the project that it was actually used in.
- Description of the Tool / Technique – As the central focus on the paper, this section shall provide in an in-depth examination of the tool or technique and its mechanics. Describe how the tool or technique should be applied in context of a clinical, operational, or administrative setting.
- Discussion – Discuss the underlying rationale for the tool or technique and why it may be favored over other options.
- Provide a critique of related methods. Also include discussion of any limitations of the tool or technique.
- Exercise – Where applicable, describe how to use the tool or technique in conjunction with a sample data set or scenario.

Special Reports

- This submission category will be used for articles of a scholarly nature that do not fit into one of the other *IJOP* submission categories. Authors are encouraged to use the guidelines described in this document that seem to be most applicable to their Special Report, but consultation with the Editorial Team before manuscript submission is strongly encouraged.