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REVIEW

# SAFE PEDIATRIC GROUND AMBULANCE TRANSPORT: A SYSTEMATIC REVIEW

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## ABSTRACT

***Background***: Child injury or death in ambulance crashes may be preventable using proper restraints. This systematic review assesses aspects relevant to the proper use of pediatric restraints: EMS professionals' resources and training, knowledge, attitudes, and behaviors. It also identifies barriers to using restraints.
***Methods***: PubMed and Web of Science were searched using free-text search terms between 2000 and 2020. Inclusion criteria included human research, pediatric population, ambulance as the mode of transportation, peer-reviewed journals, and English full-texts. After initial screening and inclusion, a snowball methodology was used to identify potentially relevant articles. Two independent reviewers carried out the methodology.
***Results:*** The original search yielded 80 publications after de-duplication between databases, and two additional articles were identified independently of the search through snowball sampling. Four publications met inclusion criteria for final analysis. Two studies were survey-based among EMS personnel aiming to identify knowledge, behaviors, and barriers to child transport. One study used qualitative data collection through interviews with ambulance personnel. The final study was a combination of survey and observational data. Of note, there were no studies that evaluated an intervention.
***Conclusion:*** Based on this review, there is a lack of research in the realm of safe pediatric ambulance transport. There is a need for quality improvement studies to address the barriers that were identified by previous literature and to improve the overall safety and compliance of applying pediatric safety restraints during transportation to the hospital.

## INTRODUCTION

Unintentional injuries, including motor vehicle accidents, are the leading cause of death among children in the United States, and many of these deaths are preventable (Heron, 2019). One motor vehicle that is often overlooked is the ground ambulance.

Traffic-related fatalities are 2.5 to 4.8 times higher for those operating emergency vehicles compared to all other occupations (Maguire, 2002). In the U.S., approximately 1.6 million pediatric patients ages 0-13 are transported to the hospital using ground ambulances annually, representing 13% of all EMS transports (National Association of State Emergency Medical Services Officials, 2020, Shah 2008). According to 20 years of data analysis by the National Highway Traffic Safety Administration (NHTSA), there are about 4,500 traffic crashes involving ambulances per year, with 34% of those resulting in injury (National Highway Traffic Safety Administration, 2014). Although no published data shows how many ambulance crashes involve pediatric patients, it can be inferred using the previously stated estimates that approximately 600 ambulance crashes could involve pediatric patients each year.

A key feature of ambulances that make them particularly dangerous to children in a crash is the ambulance stretcher, designed for an adult patient and incompatible with child transport without additional equipment. To address this limitation, the National Highway Traffic Safety Association has issued best-practice recommendations, providing options that address different scenarios for pediatric patients (U.S. Department of Transportation, 2012). Based on these recommendations, the first choice should be a pediatric device fitted onto the stretcher; such devices are for children ranging from 4 to 100 lbs depending on the brand (U.S. Department of Transportation, 2012, National Association of State Emergency Medical Services Officials, 2012). However, small children (i.e., under 40 lbs) can safely be transported via their convertible car seat when installed appropriately onto the stretcher; this recommendation does not apply to rear-facing only car seats (U.S. Department of Health and Human Services Health Resources and Services Administration, undated). When a car seat is unavailable or not indicated (i.e., children weighing between 40 and 100 lbs.), there is a high potential for that child to be ejected from the four-point adult harness of the stretcher in a crash. In these cases, a special pediatric restraint is indicated that minimizes dead space between the stretcher straps and the child, as well as providing a fifth strap between the legs for additional security that is essential for pediatric patients.

There is no national, universally adopted standard for safe pediatric transport in U.S. ground ambulances. In 1999, the Emergency Medical Services for Children program issued preliminary guidance on pediatric transport, as proper pediatric restraint systems had yet to be developed (U.S. Department of Health and Human Services Health Resources and Services Administration, undated). Then, in 2012, NHTSA issued Best-Practice recommendations for pediatric ground ambulance transport, indicating scenarios under which pediatric restraints or car seats should be used (U.S. Department of Transportation, 2012). However, despite this guidance, only 21 states require a pediatric-specific safe transport device to be carried on ambulances (National Association of State Emergency Medical Services Officials, 2020).

Our first objective was to systematically assess the literature pertaining to EMS knowledge, attitudes, and behaviors regarding pediatric restraints in the absence of the universal adoption of a pediatric device requirement for patients. Our second objective was to identify barriers to transporting pediatric patients through the proper use of pediatric restraints and evidence-based interventions to address these barriers. This study aims to identify the gap in research on safe ambulance transport for pediatric patients.

## METHODS

### Search methods

A search strategy was devised in consultation with a medical librarian to identify literature regarding child restraints in ground ambulances. PubMed and Web of Science Core Collection were searched. The search was initially built in PubMed using a combination of Medical Subject Headings [MeSH] and keyword terms for child restraints, patient transportation, and traffic accidents. Boolean logic and truncation were employed to return a comprehensive set of relevant results.

The search was then translated for the Web of Science Core Collection database. Web of Science does not use subject headings, so the search was conducted using the topic search, which only searches title, abstract, and author keywords. Both searches were limited to English, with publication dates between 2000-2020. This timeframe was chosen based on changes to the guideline and regulatory landscape occurring in the mid-1990s and early 2000s that emphasized the importance of a child's age and size when determining the proper restraint (Bae, 2014). The final searches can be found in Table 1.

The searches were run on March 31, 2021. The results were uploaded to Excel for screening purposes. Additional references were identified from the full text articles that met inclusion criteria through the snowballing method in which citing articles were screened for possible inclusion.

| PubMed | Web of Science |
|---|---|
| (((“Seat Belts”[Mesh]) OR “Child Restraint Systems”[Mesh] OR seat belt* OR child safety seat* OR child restraint*) AND (((“Ambulances”[Mesh]) OR “Transportation of Patients”[Mesh]) OR “Emergency Medical Technicians”[Mesh] OR ambulance* OR patient transportation OR EMTS OR emergency medical technician* OR paramedic*)) AND (“Accidents, Traffic”[Mesh] OR traffic accident* OR traffic crash* OR traffic collision* OR injury prevention) | (seat belt* OR child* restraint* OR child safety seat*) AND (ambulance* OR patient transport* OR emts OR emergency medical technician* OR paramedic*) AND (traffic accident* OR traffic crash* OR traffic collision* OR spinal immobilization) |

***Table 1*** – Final search terms.

### Review process

Screening was conducted independently by two reviewers first at the title/abstract level and then at the full text level in April 2021. Conflicts were resolved by a third reviewer with discussion. The inclusion and exclusion criteria can be found in Table 2. The search methodology is summarized in a PRISMA diagram (see Figure 1).

#### *Coding*

Once the list of included papers was finalized, two reviewers, one with a Ph.D. in health

| Inclusion | Exclusion |
|---|---|
| Pediatric population (<18 years old) | Not a pediatric population |
| Human research | Not human research |
| Ambulance transportation | Not ground ambulances |
| English language | Not safe transport |
| | Published before 2000 |

***Table 2*** – Inclusion and exclusion criteria applied during the review process.

services research and one with professional experience as an EMT and current MD/MPH candidate, independently coded the articles and reached a consensus where disagreements arose. The reviewers noted the methods employed to address each article's pediatric restraint research objectives. The reviewers also identified the topical focus of each article. If applicable, they assessed the extent to which EMS professionals indicated they properly employ pediatric safe transport practices by tracking the safe transport outcomes in each article. To identify factors that affected the uptake of pediatric restraints in ground ambulances, the study team adapted the Consolidated Framework for Implementation Research (CFIR), a well-established framework to examine the implementation of guidelines and recommendations within health systems (Damschroder, 2009). The CFIR framework includes the individual, organizational ("inner setting"), and societal ("outer setting") characteristics that may affect implementation. The study team chose the following main themes as relevant to safe pediatric transport in ground ambulances:

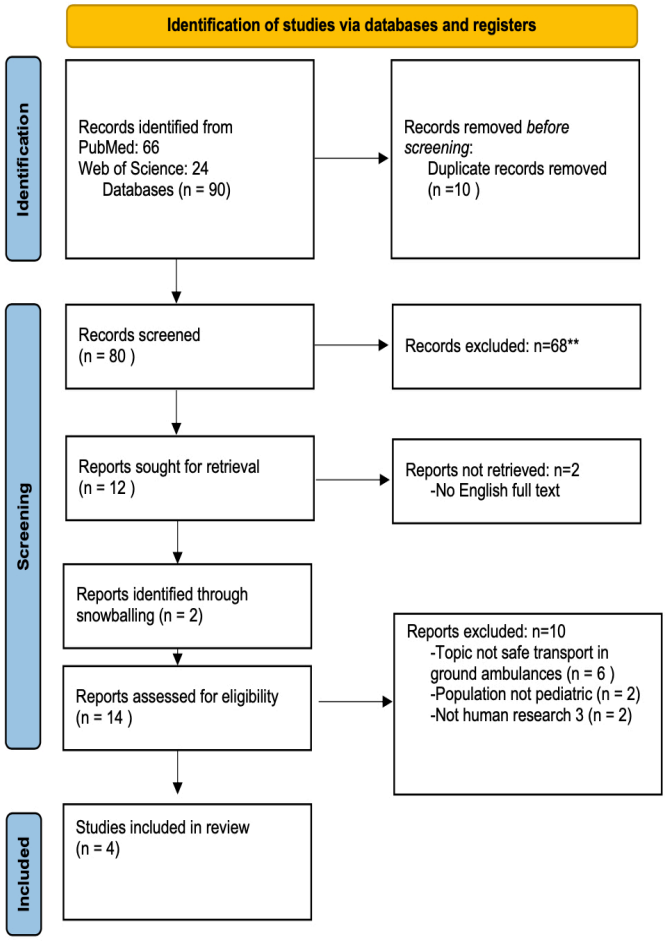


***Figure 1*** – PRISMA diagram details the databases searched, abstracts screened, and full-texts reviewed; four publications were included for final analysis.
**see Appendix for reasoning.

- Regulatory incentives: the article contextualizes the findings in terms of organization or governmental regulations [CFIR = Outer setting – External and Policy Incentives]
- Patient volume: the article describes the role of pediatric patient volume or demand for EMS [CFIR = Outer setting – Patient Needs]
- Culture: the article describes prevailing norms and values as they pertain to safe transport [CFIR = Inner setting – Culture]
- Resources: the article describes the training/education/time/devices available to

professionals [CFIR = Inner Setting – Readiness for Implementation – Available Resources]
- Knowledge and Beliefs: the article describes EMS professionals' knowledge and beliefs regarding safe transport [CFIR = Characteristics of Individuals – Knowledge & Beliefs about the Intervention]
- Self-efficacy: the article describes EMS professionals' belief in their ability to carry out safe transport [CFIR = Characteristics of Individuals – Self-efficacy]
- Crash experiences: the article describes EMS professionals' personal experiences with crashes [CFIR = Characteristics of Individuals – Other Personal Attributes]
- Interventions: the article describes and/or tests a pediatric safe transport intervention [CFIR = Intervention Characteristics]

Finally, the reviewers independently examined each article for the presence and evaluation of interventions to improve the use of appropriate pediatric transport methods in ground ambulances. Each article was assigned a ranking to each of the previously-mentioned themes to assess their extent and strength of their focus. A single minus sign ("-") indicated no mention of the theme. Positive signs were used to grade the strength of the presence of the theme: "+" for limited, "++" for moderate, and "+++" for the strongest presence. Reviewers then met and, where rankings differed, came to final consensus on a ranking.

**RESULTS**

The initial search yielded 80 publications following de-duplication between databases. Following title and abstract review, 12 articles were identified for full-text review, which yielded two articles for inclusion. Reviewers then examined articles that cited the two initially-included articles and identified two additional articles for inclusion. In total, four publications met inclusion criteria for final analysis.

Studies differed in terms of their methods. Johnson et al. (2006) used a written survey from 302 EMS providers, with a return rate of 67.7%. O'Neil et al. (2014) utilized a child passenger safety technician to observe transports and survey EMS providers; 40 children were observed, and 63 EMS personnel were surveyed. Oberg et al. (2015) held twelve semi-structured interviews with individuals staffing the ambulances, including three EMTs, four registered nurses, and five prehospital emergency nurses; this study originated in Sweden and was the only study included not taking place in the USA. Lastly, Fidacaro et al. (2018) utilized an online survey of EMS providers resulting in 114 responses, a 60% response rate.

In contrast, there was close alignment regarding the foci of the four studies. All four articles focused on safe child transportation. Safe provider transport, including seatbelts in the front and/or back of the ambulance, was also a self-reported focus included in Johnson et al. (2006) and O'Neil et al. (2014). Any safe transport outcome, including quantitative data related to the correctness of restraint use and the correct choice of restraint, was reported in three of the four articles. O'Neil et al. (2014) was the only article to report a quantitative safe transport outcome: the percentage of correct/appropriate EMS transport in pediatric devices. The extent to which EMS transported a child in a

car seat was reported in both Johnson et al. (2006) and O'Neil et al. (2014). Johnson et al. (2006), O'Neil et al. (2014), and Fidacaro et al. (2020) included outcomes related to the EMS transportation of children inappropriately, such as placing the child on a parent's lap. EMS seatbelt usage was reported by Johnson et al. (2006) and O'Neil et al. (2014). Lastly, Johnson et al. (2006) was the only article to include outcomes related to private vehicle habits of EMS personnel.

Based on the study foci, included studies examined barriers and facilitators that may affect the uptake of safe pediatric transport within ground ambulances. The CFIR framework constructs and their inclusion in the study are summarized in Table 3 (n=4). Overall, the studies mainly focused on the individual characteristics of those imple-

| **Article Description** | | | **CFIR: Outer Setting** | | **CFIR: Inner Setting** | | **CFIR: Individual** | | | **CFIR: Intervention** |
|---|---|---|---|---|---|---|---|---|---|---|
| Author (Year) | Title | Methods | Regulatory Incentives | Patient Volume | Culture | Resources | Knowledge and Beliefs | Self-Efficacy | Crash Experiences | Intervention Tested |
| **Johnson *et al.* (2006)** | Child and Provider Restraints in Ambulances: Knowledge, Opinions, and Behaviors of Emergency Medical Services Providers | Survey | + | + | + | ++ | +++ | ++ | + | – |
| **O'Neil *et al.* (2014)** | Ambulance Transport of Noncritical Children: EMS Providers' Knowledge, Opinions, and Practice | Survey, Observation | + | + | + | ++ | +++ | ++ | – | – |
| **Oberg *et al.* (2015)** | The EMS Personnel's perception of the transportation of young children | Interview | + | – | + | – | – | +++ | – | – |
| **Fidacaro *et al.* (2018)** | Pediatric Transport Practices Among Prehospital Providers | Survey | + | + | – | ++ | +++ | +++ | – | – |

***Table 3*** – Analysis of included publications (n=4).
Key: "-": not mentioned, "+": present but limited, "++": moderately present, "+++": strongly present

menting safe transport and less on organizational and societal characteristics that may affect implementation. Notably, knowledge and beliefs were examined in depth by three of the four studies. Self-efficacy—referring to EMS professionals' confidence in their ability to transport pediatric patients safely—was the next most-examined theme within the individual construct. The regulatory incentives were very weakly included in all four studies. The recurring issues throughout the studies include the general lack of training or comfortability in installing pediatric restraints. The basis of knowledge was also inconsistent and indicates that EMS providers face challenges when deciding which

method of pediatric restraint to use. There is a general disconnect between perceived knowledge and the application of knowledge when presented with scenarios involving pediatric patients of varying acuity. Although the barriers to safe pediatric transport have been identified in the research, including low frequency of pediatric calls, lack of training, and the emotional and social factors present during a call, there has been no intervention to improve or address these barriers. None of the studies evaluated an intervention to improve the adoption of or adherence to pediatric safe transport guidelines or recommendations.

## DISCUSSION

In summary, the included articles focused most strongly on assessing provider challenges at the individual level: the knowledge, beliefs, and self-efficacy barriers to safe pediatric patient transportation in EMS. This was expected considering the self-reported survey method that was used in three of four of the studies. The outer setting, consisting of regulatory incentives and patient needs (i.e., pediatric patient volume), was reported in very little detail. This corresponds to the need for more data reporting pediatric call volume and involvement in ambulance crashes. Most notably, this systematic review found no pre/post-implementation studies in the literature that address the knowledge, use, and barriers related to pediatric restraints in ground ambulances for pediatric patients.

Many factors could contribute to pediatric patient safety challenges in ambulances, including low call volume, EMS provider experience, heightened emotional environment, and preparedness for the proper equipment to safely transport pediatric patients. This literature review demonstrates a great need for more unified standards for transporting pediatric patients. Both federal and state standards can be considered for expansion. With only 21 states currently requiring pediatric transport equipment to be installed on the ambulance, action at both the federal and state levels to encourage and adopt policies requiring this equipment should be among the early steps in improving the safety of pediatric patients riding in ambulances. The next step would be allocating funding for equipment and training to complement these requirements.

At the state level, there is a need for regulatory guidelines, policies, or recommendations, with the understanding that differences may emerge depending on region, patient volume, and resources. State requirements for certification and recertification of EMS licensure are an opportunity to ensure that pediatric transportation is taught and tested. For example, the New York State recertification requirements for the EMT-Basic and EMT-Paramedic levels include 1 hour of safe transportation of pediatric patients (New York State Department of Health, 2020). In comparison, the state of Indiana accepts the recertification standards as per the National Continued Competency Program (NCCP), which requires 0.5 hours of safe pediatric transport to be documented in the continuing education of an EMT (Distance CME, 2022). Agency-specific requirements and in-service, hands-on training can further support this knowledge. Lastly, there is a significant role that hospitals and other receiving facilities can play in the quality improvement and development of recommendations or policies.

While considering the need for further policy and recommendations, it is essential to

recognize the gap between the goal and the reality of what EMS personnel face in the pre-hospital setting. For example, ambulance safety risks should be addressed when formulating new guidelines. EMS personnel are known to be at much greater risk of mortality due to the nature of their job. A recent study showed that the crash rate when transporting a patient without lights and sirens was 7.0 per 100,000 transports and increased to 16.5 per 100,000 transports when using lights and sirens (Watanabe, 2017). The national occupational-related mortality average per 100,000 workers is 5.0. However, the risk of occupational-related mortality to EMS personnel is much greater (12.7 per 100,000) (Maguire, 2002). This number exceeds that of other first responders, including police and firefighters. Exploring these barriers and addressing how best to overcome safety challenges for passengers and EMS personnel is an avenue for future research.

Some limitations exist in this study. The search strategy and terms were unlikely to capture every article published on safe transportation fully. It is possible that searching additional databases would have captured more relevant articles. Grey literature was not searched, and it is possible that articles in languages other than English may be relevant. Studies that did not explicitly mention the restraint of children could have been missed. The snowball method was used to capture additional articles and minimize the potential for missed articles. Another limitation of this study is the subjectivity of the reviewing process in determining the presence and strength of the selected constructs and themes. Two independent reviewers determined the extent to which each theme was present, and discrepancies were discussed to come to conclusions; however, the subjectivity of this review remains a limitation in the qualitative analysis.

## CONCLUSION

In conclusion, there is an extensive research gap in the realm of safe pediatric patient ambulance transport. First, there is a need for data collection to define patient volume and the significance of the issue. Second, federal or state policy should be set to ensure the safety of pediatric patients riding in ground ambulances. Ambulance design and safety in the patient compartment, including the security of the pediatric patient, ought to be the responsibility of organizations guiding the practice of Emergency Medical Services nationally. Finally, there is a need for quality improvement studies to address the barriers identified by previous literature and improve the overall safety and compliance of using pediatric safety restraints during patient transportation to the hospital.

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## APPENDIX

| Exclusion Reason | Excluded (n=68) |
|---|---|
| Not safe transport | 32 |
| Not ambulance transportation | 29 |
| Not pediatric | 4 |
| Not peer-reviewed | 3 |

***Appendix*** – Excluded articles from original search with reasoning.