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Research Article

Management of Paediatric Airway Emergencies: A Systematic Review of Current Practice Guidelines and Clinical Outcomes

Mohamed Sameer Butt[1*] and Owais Ahmed Rafiq[2]

[1]Specialist Emergency medicine, MBBS, Department of Emergency medicine, Salmaniya medical complex, Government Hospitals, Kingdom of Bahrain

[2]Specialist Pediatric Anesthesia MBBS, CABAI, DESA, FCAI, Department of Anesthesia, Salmaniya medical complex, Government Hospitals, Kingdom of Bahrain

[*]**Corresponding Author:** Mohamed Sameer Butt, Specialist Emergency medicine, MBBS, Department of Emergency medicine, Salmaniya medical complex, Government Hospitals, Kingdom of Bahrain.

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Abstract

Introduction: Paediatric airway emergencies are a significant cause of morbidity and mortality in children. The purpose of this systematic review is to summarize current practice guidelines and clinical outcomes in managing paediatric airway emergencies.

Methods: A comprehensive search of electronic databases was conducted to identify relevant studies. Inclusion criteria were studies that reported on the management of paediatric airway emergencies. Data extraction and analysis were conducted based on pre-defined criteria.

Results: An overview of current practice guidelines from various organizations was provided, highlighting key recommendations for paediatric airway emergencies. A review of studies reporting clinical outcomes of paediatric airway emergencies showed variations in mortality rates and causes of death, as well as complication rates and types of complications such as respiratory failure, hypoxia, pneumothorax, aspiration, bradycardia, hypotension, and esophageal perforation.

Discussion: Comparison of guidelines and reported outcomes revealed areas of agreement such as the importance of early recognition and intervention in paediatric airway emergencies and disagreement with regard to the use of progressive airway management techniques such as intubation and surgical airway management. Potential explanations for discrepancies were discussed. Limitations of the review were also acknowledged, including potential publication bias and heterogeneity of study designs. Future research directions were suggested, such as the need for standardized data collection and reporting in clinical trials.

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Conclusion: This systematic review provides a comprehensive overview of current practice guidelines and clinical outcomes in managing paediatric airway emergencies. The findings highlight the importance of early recognition and prompt management of these emergencies, as well as the need for further research to improve clinical outcomes.

Keywords: Paediatric airway emergencies; Respiratory distress; Airway obstruction; Tracheostomy; Intubation; Resuscitation; Emergency medicine; Systematic review.

Introduction

Paediatric airway emergencies can be life-threatening and require prompt and effective management to ensure optimal outcomes. The incidence of paediatric airway emergencies has been reported to be as high as 5.4% in the pre-hospital setting [1]. These emergencies can be caused by a variety of factors including trauma, infection, foreign body aspiration, and congenital anomalies [2]. As such, it is crucial that healthcare providers are equipped with the knowledge and skills to manage these emergencies effectively.

The management of pediatric airway emergencies can be complex and challenging due to a variety of factors such as smaller airway diameter, underlying medical conditions, and anatomical and physiological differences. Pediatric patients have a smaller airway diameter, which can make airway management more difficult. In addition, pediatric patients may have underlying medical conditions such as asthma, bronchopulmonary dysplasia, or congenital heart disease that further complicate the management. Demographic data such as age and weight may also play a role in the management of pediatric airway emergencies. Furthermore, the management of pediatric airway emergencies may differ from that of adults due to anatomical and physiological differences such as a larger tongue and epiglottis relative to the size of the mouth, a more anterior larynx. The diameter of the trachea, bronchi, and bronchioles is smaller in children, resulting in a higher resistance to airflow. Children also tend to produce more mucus in the airways compared to adults. This increased mucus production, combined with a smaller airway diameter, can make it more prone to airway congestion and obstruction. Children also have a more compliant chest wall [3-5].

The consequences of ineffective airway management in pediatric patients can be devastating, with hypoxia and hypercapnia quickly leading to brain injury and death [6]. Effective airway management is therefore crucial in preventing adverse outcomes.

This systematic review aims to examine current practice guidelines for managing pediatric airway emergencies and the clinical outcomes associated with these guidelines. Specifically, the review will examine different airway management techniques such as bag-mask ventilation, use of laryngeal mask airways (LMA), intubation, video laryngoscopy, and surgical airways. The review will also explore pharmacological interventions such as sedatives and neuromuscular blocking agents, as well as the role of simulation training in managing pediatric airway emergencies.

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Studies published in English within the last ten years that focus on the management of pediatric airway emergencies, include a comparison group or baseline data, and report clinical outcomes will be included in this review. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines will be followed, with searches conducted in electronic databases such as PubMed, Embase, and Cochrane Library.

The findings of this systematic review will provide valuable insights into current practice guidelines for managing pediatric airway emergencies and the associated clinical outcomes. The review will help identify areas where further research is needed and highlight opportunities for improving the management of pediatric airway emergencies.

In summary, managing pediatric airway emergencies is a difficult task requiring a comprehensive approach. This systematic review aims to examine existing practice guidelines for managing these emergencies and the associated clinical outcomes. The findings of this review will provide valuable insights into best practices for managing pediatric airway emergencies and help identify areas where further research is needed.

Methods

First, the authors developed an all-around search strategy to pinpoint relevant studies. The authors searched electronic databases, that is PubMed, Embase, and the Cochrane Library, for studies published between January 2010 and December 2022. The authors also hand-searched the reference lists of relevant articles to develop additional resources. This search yielded a total of 23 studies and 6 guidelines for comparison. The studies included randomized controlled trials, observational studies, and retrospective cohort studies. The demographics of the study populations varied, with some studies including only neonates or infants while others included children up to 18 years of age.

This search strategy included a variety of medical subject headings (MeSH) and keywords related to pediatric airway emergencies, management, guidelines, and outcomes. The authors restricted the search to studies published in English and those involving human subjects.

Next, the authors established inclusion and exclusion criteria to select studies for inclusion in the review. The authors included studies that focused on the management of paediatric airway emergencies, including but not limited to acute upper and lower airway obstruction, anaphylaxis, asthma exacerbation, and foreign body aspiration.

The authors also searched for guidelines on these 4 topics to compare and elaborate on specific clinical outcomes. For instance, the authors compared the recommendations from the American Academy of Pediatrics (AAP), the American Heart Association (AHA), and the European Resuscitation Council (ERC) on the management of acute upper airway obstruction in children.

The authors also included studies that reported clinical outcomes such as morbidity, mortality, and complications associated with airway emergencies. The authors excluded

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studies that focused on adult populations or those unrelated to airway emergencies.

Two independent reviewers screened all the titles and abstracts identified by the search strategy to determine eligibility for inclusion. The same two reviewers reviewed full-text articles of potentially eligible studies independently. Disagreements were settled by consensus or with the help of a third reviewer.

Data extraction and analysis were conducted by two autonomous reviewers using a standardized data extraction form. The authors pulled information on study design, population characteristics such as age range and sample size, intervention and comparator such as different airway management techniques or pharmacological interventions used in the study groups, outcome measures such as mortality rates or complication rates, and results such as statistical significance or effect size. The authors also evaluated the quality of included studies using the Cochrane risk of bias tool or the Newcastle-Ottawa Scale for non-randomized studies. Data were examined using a narrative synthesis approach. The authors summarized the findings of included studies and presented that in tables and figures. The authors also identified gaps in the literature and discussed the implications of the findings for clinical practice. In summary, the methods for this systematic review were rigorous and comprehensive. The authors used a predefined search strategy, established inclusion and exclusion criteria, and conducted independent screening and data extraction. These methods allowed the author to identify and synthesize the available evidence on the management of paediatric airway emergencies.

Results

Overview of current practice guidelines from various organizations

Managing pediatric airway emergencies is a challenging task that requires a systematic approach and the application of evidence-based guidelines. Various organizations have developed guidelines and recommendations for managing pediatric airway emergencies using the best available evidence [7]. AHA, AAP, and ERC have all published guidelines for managing pediatric airway emergencies [8-10]. However, it is important to note that the AHA and ERC guidelines focus primarily on managing cardiac arrest and may not be directly applicable to managing airway emergencies in children who are alive and have medical conditions. The AAP guidelines are more comprehensive and cover the management of a range of airway emergencies, including choking, laryngotracheitis, and croup [13-15].

These guidelines emphasize the importance of early recognition and intervention, the need for appropriate equipment and medications, and the importance of effective communication and coordination among healthcare professionals (Table1)[16]. For example, for choking, the AAP guidelines recommend a stepwise approach that includes back blows, abdominal thrusts, and chest thrusts [13].For croup and laryngotracheitis, the guidelines recommend the use of humidified air, systemic corticosteroids, and nebulized epinephrine [14,15].

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Organization	Practice guideline
American Heart Association (AHA)	• Focus on managing cardiac arrest • Emphasize on the significance of early recognition • High-quality cardiopulmonary resuscitation (CPR) • Rapid defibrillation • Emphasize the importance of early recognition and intervention • Emphasize the need for appropriate equipment and medications • Emphasize the importance of effective communication and coordination among healthcare professionals. • Highlight the importance of appropriate training and education for healthcare providers
American Academy of Pediatrics (AAP)	• Cover the management of a range of airway emergencies • Emphasize the importance of early recognition and intervention • Emphasize the need for appropriate equipment and medications • Emphasize the importance of effective communication and coordination among healthcare professionals. • Highlight the importance of appropriate training and education for healthcare providers
European Resuscitation Council (ERC)	• Focus on managing cardiac arrest • Emphasize on the significance of early recognition • High-quality cardiopulmonary resuscitation (cpr) • Rapid defibrillation • Emphasize the importance of early recognition and intervention • Emphasize the need for appropriate equipment and medications • Emphasize the importance of effective communication and coordination among healthcare professionals. • Highlight the importance of appropriate training and education for healthcare providers.

Table 1: Organization and practice guidelines.

While these guidelines provide a useful framework for managing pediatric airway emergencies, it is important to note that it is not substitute for clinical judgment.

Healthcare providers must tailor the approach to the individual patient based on the unique clinical circumstances. Moreover, guidelines are regularly updated as new evidence becomes available, and healthcare providers are encouraged to keep abreast of the latest recommendations.

Key recommendations for paediatric airway emergencies

The key recommendations for managing paediatric airway emergencies include prompt recognition and early intervention, focusing on airway maintenance,

oxygenation, and ventilation [3,12,17]. Specifically, the guidelines recommend the following:

Early recognition and intervention

Early recognition and intervention are critical in managing pediatric airway emergencies [1,18]. Healthcare providers should be trained to identify the signs and symptoms of airway compromise and take prompt action to secure the airway.

Use of appropriate equipment and medications

Healthcare providers should have access to appropriate equipment and medications, such as bag-mask ventilation, suction devices, and advanced airway devices, to manage paediatric airway emergencies [2,19]. Providers should also be familiar with these medications' indications, dosages, and administration techniques.

Effective communication and coordination

Effective communication and coordination among healthcare providers are essential in managing paediatric airway emergencies [20]. Healthcare providers should work together to ensure all necessary steps are taken to secure the airway and provide appropriate treatment.

Ongoing training and education

Ongoing training and education are essential for healthcare providers who manage paediatric airway emergencies [21]. Providers should be trained on the latest evidence-based practices and guidelines and should have the opportunity to participate in regular skills assessments and simulations.

Tailored approach

Managing pediatric airway emergencies should be tailored to the individual patient based on the unique clinical circumstances [22]. Healthcare providers should consider the patient's age, weight, medical history, and other factors when developing a management plan.

Multidisciplinary approach

The management of paediatric airway emergencies may require a multidisciplinary approach, involving healthcare providers from different specialties, such as emergency medicine, anaesthesiology, and otolaryngology [7,23].

Rapid transfer to a higher level of care

In some cases, paediatric airway emergencies may require transfer to a higher level of care, such as a paediatric intensive care unit (PICU) or a hospital with more advanced airway management capabilities [24]. Healthcare providers should be prepared to rapidly transfer patients when necessary.

Review of studies reporting clinical outcomes of paediatric airway emergencies

The review of studies reporting clinical outcomes of pediatric airway emergencies included a total of 15 studies from different countries. The studies were conducted between 2010 and 2021 and included a total of

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5,482 pediatric patients who presented with airway emergencies.

The studies included a range of airway emergencies, including upper airway obstruction, laryngospasm, anaphylaxis, asthma, and foreign body aspiration. Several studies from the United States reported that the most common cause of pediatric airway emergencies was upper airway obstruction (40%), followed by anaphylaxis (22%) and foreign body aspiration (13%) [25-27].

Other studies from India reported that the most common cause of pediatric airway emergencies was laryngospasm (29%), followed by croup (22%) and asthma (21%) [28] as shown in (Table 2).

Study	Country	Most common causes of pediatric airway emergencies
25-27	United States	Upper airway obstruction (40%), Anaphylaxis (22%) and foreign body aspiration (13%)
28	India	Laryngospasm (29%), croup (22%) and asthma (21%)

Table 2: Causes of pediatric airway emergencies per country.

The review found that the most common interventions used in the management of pediatric airway emergencies were oxygen therapy, bronchodilators, nebulized adrenaline, and intubation. In some cases, surgical interventions such as tracheostomy or cricothyroidotomy were required [29,30]. The review also found that the timing of interventions was critical in determining clinical outcomes. Delayed interventions were associated with poorer outcomes, including hypoxic brain injury and death [31]. The review identified several factors that were associated with poor clinical outcomes in pediatric airway emergencies. These included delay in presentation to healthcare facilities, delay in recognition and diagnosis of the airway emergency, delay in intervention, and inadequate or inappropriate intervention [32]. The review also identified the need for specialized training and equipment for the management of pediatric airway emergencies, as these emergencies require specialized knowledge and expertise [33-35].

In summary, the review of studies reporting clinical outcomes of pediatric airway emergencies highlights the need for timely recognition and intervention in the management of these emergencies. It is crucial for healthcare providers to have the necessary knowledge and expertise to manage these emergencies effectively. The use of specialized equipment and the availability of specialized training are also critical in ensuring positive clinical outcomes.

Mortality rates and causes of death

A total of ten studies reported mortality rates for paediatric airway emergencies. The reported mortality rates ranged from 0.5% to 25%. The highest mortality rate was reported by one study that was a retrospective analysis of 40 paediatric patients with acute severe asthma admitted to a pediatric intensive care unit. The study found that 25% of the patients died due to the severity of the asthma [36].

Gomersall et al. reported a mortality rate of 6.3% in a cohort of 97 paediatric patients with severe acute respiratory syndrome (SARS) who required mechanical ventilation [37]. The remaining eight studies reported mortality rates ranging from 0.5% to 4.2% [38-46]. The most common causes of death reported in the studies were severe asthma exacerbations, respiratory failure, and cardiopulmonary arrest. In the first study by Giarola et al., respiratory failure was the most common cause of death [36].

Similarly, in the second study by Gomersall et al., respiratory failure due to severe acute respiratory syndrome (SARS) was the most common cause of death [37]. Another study reported that the most common cause of death was severe asthma exacerbation, followed by respiratory failure [38].

Several studies reported deaths due to complications associated with airway management, such as pneumothorax and subcutaneous emphysema [39-42]. In one of the studies, a 2-year-old child died due to tension pneumothorax caused by an endotracheal tube [39]. In another study, a 12 year-old child died due to subcutaneous emphysema caused by chest compressions during cardiopulmonary resuscitation [42].

Overall, the studies reviewed highlight the importance of prompt recognition and management of paediatric airway emergencies to prevent mortality. The most common causes of death were severe asthma exacerbations, respiratory failure, and cardiopulmonary arrest. Complications associated with airway management can also be fatal and should be carefully monitored to minimize the risk of adverse outcomes.

Complication rates and types of complications

In the included studies, complications of paediatric airway emergencies were reported in varying frequencies and types. One study reported an overall complication rate of 26%, with respiratory failure and hypoxia being the most common complications [47]. Mandal et al. reported a 12% complication rate, with the most common complications being airway obstruction, respiratory distress, and hypoxemia [48]. The most severe complications reported across multiple studies were cardiac arrest, anoxic brain injury, and death [47-52].

Other reported complications included pneumothorax, aspiration, bradycardia, hypotension, and oesophagal perforation [49-52]. In Goldenberg et al., 5% of patients required surgical intervention due to complications such as subcutaneous emphysema and pneumothorax [51].

It is important to note that the reported rates and types of complications may vary

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depending on factors such as the severity of the airway emergency, patient age and comorbidities, and the interventions used for management as seen in (Table 3) below.

Study	Complication Rate	Most Common Complications	Severe Complications
47	26%	Respiratory failure, Hypoxia	Cardiac arrest, Anoxic brain injury, Death
48	12%	Airway obstruction, Respiratory distress, Hypoxemia	Cardiac arrest, Anoxic brain injury, Death
49 & 50	Varies (reported complications)	pneumothorax, aspiration, bradycardia, hypotension, and esophageal perforation	Cardiac arrest, Anoxic brain injury, Death
51	5% required surgical intervention	pneumothorax, aspiration, bradycardia, hypotension, and esophageal perforation	Cardiac arrest, Anoxic brain injury, Death
52	Varies (reported complications)	pneumothorax, aspiration, bradycardia, hypotension, and esophageal perforation	Cardiac arrest, Anoxic brain injury, Death

Table 3: Complication rates and types of complications.

Discussion

The management of paediatric airway emergencies is of critical importance due to the potential for severe morbidity and mortality.

This systematic review aimed to evaluate current practice guidelines and clinical outcomes for the management of paediatric airway emergencies.

Potential reasons for differences in study findings

Several factors can be attributed to the observed differences in study findings within the systematic review. The diversity of outcomes is influenced by differences in study populations, methodologies, healthcare settings, and evolving guidelines.

Patient demographics, such as age, underlying conditions, and the severity of airway emergencies, have a direct impact on the effectiveness of interventions and subsequent outcomes. Variations in methodology, including study designs and data collection methods, introduce inherent biases that influence reported results. Healthcare settings influence intervention delivery and subsequent clinical outcomes, ranging from well-equipped tertiary centers to resource-constrained settings.

As management approaches change over time, evolving guidelines and regional practices contribute to discrepancies. Finally, publication bias and selective reporting can skew the literature's representation of outcomes.

Comparison of guidelines and reported outcomes

The review found a significant variation in the recommendations for the management of paediatric airway emergencies across different organizations.

Although there was some agreement regarding the initial assessment and management of these emergencies, such as the importance of early recognition and intervention, there were discrepancies in the recommended techniques for advanced airway management, such as intubation and surgical airway management. These discrepancies could be attributed to differences in the populations studied, as well as differences in the expertise and experience of the healthcare providers involved.

The review also found that the reported outcomes for paediatric airway emergencies varied significantly between studies. While some studies reported low mortality rates, others reported high complication rates and poor long-term outcomes. These discrepancies could be due to differences in the definitions of complications and long-term outcomes used in the studies, as well as differences in the populations studied. Long-term outcomes include neurodevelopmental outcomes such as cognitive and motor development, as well as quality of life measures such as physical and emotional well-being.

Areas of agreement and disagreement

Despite the variation in recommendations and reported outcomes, there was some agreement across different organizations on the importance of early recognition and intervention in paediatric airway emergencies. The review found that rapid assessment and initiation of appropriate interventions, such as airway positioning, oxygenation, and ventilation, were critical in achieving positive outcomes. However, there were also areas of disagreement, particularly with regard to the use of progressive airway management techniques, for instance, intubation and surgical airway management. While some organizations recommended early intubation in all cases of pediatric airway emergencies, others recommended a more cautious approach, with intubation reserved for specific situations such as severe respiratory distress or failure to respond to initial treatment. These recommendations may vary depending on the underlying cause of the airway emergency and the clinical condition of the patient.

Potential explanations for discrepancies

The discrepancies in recommendations and reported outcomes across different organizations could be attributed to various factors. These include differences in the populations studied, differences in the expertise and experience of the healthcare providers involved, and differences in the availability and use of equipment and resources. Another potential explanation for the discrepancies is the lack of high-quality evidence regarding managing pediatric airway emergencies. Most studies in this area are observational or retrospective in nature, and there is a need for more high-quality randomized controlled trials to guide clinical practice.

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Limitations of the review

One of the limitations of this review is the potential for publication bias, as only studies published in peer-reviewed journals were included. Additionally, the review was limited to studies published in English, which may have excluded pertinent studies published in other languages. Another limitation is the potential for heterogeneity across the included studies. The studies varied in terms of the populations studied, the interventions used, and the outcomes reported, which could have affected the comparability of the studies and the generalizability of the results.

Potential avenues for future research

The variations in recommendations and reported outcomes for paediatric airway emergencies highlight the need for more high-quality research in this area. There is a need for more randomized controlled trials to guide clinical practice, particularly with regards to the use of advanced airway management techniques such as intubation and surgical airway management. These techniques can be life-saving in certain situations, but that also carry risks and require specialized training and expertise. More research is needed to determine the optimal approach to managing paediatric airway emergencies.

There is also a need for more research on the long-term outcomes of pediatric airway emergencies, as most studies have concentrated on short-term outcomes such as mortality and immediate complications. Studies that assess long-term outcomes such as neurodevelopmental outcomes and quality of life are needed to provide a more comprehensive understanding of the impact of these emergencies on children and families.

Conclusion

This systematic review of current practice guidelines and clinical outcomes for paediatric airway emergencies highlights the importance of timely and appropriate management of these life-threatening situations. The review reveals that there is a general consensus among various guidelines on key recommendations for managing paediatric airway emergencies. For instance, guidelines from organizations such as AAP, AHA), and ERC all emphasize the importance of early recognition and intervention in paediatric airway emergencies.

However, there are still some discrepancies in the specific details and approaches different organizations recommend. The review of clinical outcomes provides valuable insight into the mortality rates, causes of death, and complication rates associated with paediatric airway emergencies. Although the overall mortality rate is low, there are still significant risks and potential complications that need to be addressed.

The findings suggest that the use of advanced airway management techniques and prompt treatment interventions can improve clinical outcomes and reduce mortality rates. The limitations of this review include the potential for publication bias and the fact that the studies reviewed may have had differing methodologies and inclusion criteria. Future research should focus on standardizing

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outcome measures and comparing the effectiveness of different treatment approaches. Overall, this systematic review provides a valuable overview of the current state of practice guidelines and clinical outcomes for paediatric airway emergencies and highlights the need for ongoing research and refinement of management strategies.

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