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Higher pre-hospital anaesthesia case volumes result in lower mortality rates: implications for mass casualty care

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Summary

Senior physicians with a higher pre-hospital anaesthesia case volume have higher first-pass tracheal intubation success rates, shorter on-site times, and lower patient mortality rates than physicians with lower case volumes. A senior physician's skill set includes the basics of management of airway and breathing (ventilating and oxygenating the patient), circulation, disability (anaesthesia), and environment (especially maintaining core temperature). Technical rescue skills may be required to care for patients requiring pre-hospital airway management especially in hazardous environments, such as road traffic accidents, chemical incidents, terror attacks or warfare, and natural disasters. Additional important tactical skills in mass casualty situations include patient triage, prioritising, allocating resources, and making transport decisions.

Keywords: airway management; anaesthesia; anaesthesiologist; emergency medical services; mass casualty incidents; tracheal intubation; videolaryngoscopy

In this issue of the *British Journal of Anaesthesia*, Saviluoto and colleagues¹ present a retrospective registry-based cohort study of the association between the pre-hospital anaesthesia case volume of helicopter emergency medical services (HEMS) physicians and mortality. Physicians were divided into three groups according to the case volume of pre-hospital anaesthesia in the year preceding the airway management of a given patient. Twelve physicians treated more than 36 cases in the preceding year (511 patients), 56 physicians treated 13–36 cases in the preceding year (2033 patients), and 88

physicians treated 12 cases or fewer in the preceding year (2274 patients).

On-scene time was significantly shorter for the physicians with higher case volumes (median time: 28 min for physicians with >36 cases, 32 min for physicians with 13–36 cases, and 32 min for physicians with ≤12 cases). First-pass success rate was significantly higher for physicians with higher case volumes (98%, 93%, and 90%, respectively) and mortality was lower (25%, 29%, and 36%, respectively). Overall, 30-day mortality was 32% (n=1469). In the multivariate logistic regression analysis, the pre-hospital anaesthesia case volume of the preceding year was inversely correlated with 30-day mortality. The authors suggest that physicians with higher pre-hospital

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anaesthesia case volumes are faster and more efficient. They therefore have higher first-pass success and shorter on-site times. Shorter pre-hospital times improve outcomes in patients with cardiac arrest, myocardial infarction, stroke, and trauma.^{2,3} On-site, tactical decisions are necessary to expedite patient care and transport to the most appropriate hospital.⁴ This is even more critical in mass casualty care.⁵

The study had several weaknesses. The groups differed in age and vital signs; however, the difference in mortality persisted after controlling for age. First-pass tracheal intubation success was better for physicians with higher case volumes, but most of the difference might be explained by the fact that physicians with higher case volumes used neuromuscular block more often. Higher case volumes may be associated with better care of the ABCDEs (airway, breathing, circulation, disability, and exposure) of trauma care in addition to better airway management. Physicians with higher case volumes used mechanical ventilation more frequently. This may have improved outcomes of patients with traumatic brain injury. Other potential contributing factors to better outcomes may have included early detection and treatment of pneumothorax, use of pelvic binders, administration of tranexamic acid in patients with multiple trauma and hypertonic saline in patients with intracranial hypertension, and optimisation of transport decisions. The study did not report data regarding in-hospital anaesthesia case volumes and clinical experience of the in-hospital physicians, such as years of experience and numbers of tracheal intubations. The study did not report differences in outcomes between junior and senior physicians or between anaesthesiologists and non-anaesthesiologists. Also, the authors did not report the experience of the teams and the services involved in pre-hospital patient care.

Another study of HEMS reported that pre-hospital exposure to critical care was distributed unevenly amongst physicians, with some having limited exposure. Low rates of HEMS patient contacts may have been associated with increased mortality rates.⁶ Because the study by Saviluoto and colleagues¹ was retrospective, pre-hospital anaesthesia case volumes can only be correlated with rates of first-pass success, on-site times, and mortality. Causation cannot be inferred. Prospective studies would be necessary to confirm the findings of this study.

Finally, the role of videolaryngoscopy was not addressed in this study.⁶ After the introduction of supraglottic airway devices in the mid 1980s, the introduction of videolaryngoscopy in the mid-2000s was the next major game changer in modern airway management.^{7,8} A systematic review comparing videolaryngoscopy with direct laryngoscopy including 64 studies, with a total of 7044 adult patients, reported several benefits of videolaryngoscopy, including a better view of the glottis, fewer failed intubations in normal and in anticipated difficult airways, and lower incidence of postoperative hoarseness and laryngeal or airway trauma.⁹ Some EMS systems, emergency departments, anaesthesia services, and ICUs switched completely to videolaryngoscopy to improve clinical performance, human factors (situational awareness and teamwork), and teaching.^{10,11} In the German S1 guideline for pre-hospital airway management, videolaryngoscopes are recommended as the default devices in pre-hospital anaesthesia.¹² The effectiveness of tracheal intubation may vary with the type of videolaryngoscope.¹³ Devices used in emergencies should be the same ones that are regularly used in daily clinical practice.¹⁴ It would have been useful to know whether videolaryngoscopy was used in the study by Saviluoto and colleagues,¹ and, if so, by which physicians, and when

videolaryngoscopy was introduced. This is relevant, because use of videolaryngoscopy may improve outcomes, including on-scene times and first-pass success rates.¹⁵

The study had several strengths. It was conducted nationwide and included most, if not all, cases of pre-hospital anaesthesia by helicopter-based physicians in Finland between January 1, 2013 and August 31, 2019. Nationwide reporting of consecutive cases reduced reporting bias. Moreover, the large number of patients allowed in-depth data analysis and formulation of robust conclusions. The study included pre-hospital and in-hospital data. Other studies of HEMS systems have lacked in-hospital data to help estimate the benefit of pre-hospital measures on patient outcomes.¹⁶

Airway management in mass casualty incidents

There is no single best airway management technique during mass casualty incidents. Airway management in a given emergency medical services (EMS) system should be based on the skill levels of the medical personnel, available equipment, and local conditions, including rescue vehicles, transport times, and pre-hospital and in-hospital resources.¹² The study of Saviluoto and colleagues¹ was conducted in a HEMS system, with physicians highly skilled in airway management. Physician-based EMS systems operate mainly in continental Europe. Findings from physician-based HEMS systems cannot be extrapolated to other regions, where potentially fewer skilled medical personnel, including nurses and paramedics, perform airway management.¹⁷ Quality indicators for advanced pre-hospital airway management have been reported based on a modified nominal group consensus approach, and include number of cases and first attempt success for tracheal intubation.¹⁸

Tracheal intubation is the gold standard for airway management in emergency medicine. Tracheal intubation protects against aspiration, enables efficient ventilation, and allows reliable end-tidal carbon dioxide (ETCO₂) monitoring. Worldwide, studies have reported varying tracheal intubation success and outcome rates. One reason for the variation may be the different skill levels of the medical personnel, from senior anaesthetists to junior paramedics.^{12,19} Other reasons may be variations in the use of neuromuscular block and differences in medical and traumatic conditions of patients included in the studies. In severe traumatic brain injury (Glasgow Coma Scale <9), advanced pre-hospital airway management should be performed only by sufficiently skilled medical personnel.^{20,21} The value of pre-hospital airway management is not well established in situations such as chest trauma, multiple trauma, and intoxication. Guidelines for pre-hospital tracheal intubation recommend use of neuromuscular block for experienced physicians to increase first-pass and overall success rates.²² For less experienced medical personnel, oxygenation should be optimised with oxygen supplementation and one should consider using bag-valve mask ventilation or a supraglottic airway only.²³ Less experienced medical personnel may be inclined to avoid use of neuromuscular blockers, leading to failure to secure the airway.

In a mass casualty incident tracheal intubation may not be possible, even in a physician-based EMS system. In a mass casualty incident, such as a terrorist attack, a natural or human-caused disaster, or mass toxicological event, there may be relatively fewer skilled medical personnel on site with less

sophisticated equipment than in an incident with a single victim.²⁴ In a mass casualty incident the goal is to provide the greatest benefits to the most patients.²⁵ The first step is to triage all patients according to the urgency of airway management. Some patients may require urgent or non-urgent airway management.²⁶ Tracheal intubation to prevent airway obstruction can be one of the most effective life-saving interventions in a mass casualty incident.²⁷ Other patients may not require airway management because they are ventilating and oxygenating sufficiently on their own. Still others are beyond help and will not benefit from airway management.

The second step is to provide additional oxygenation, which may or may not precede further airway management. A sufficiently skilled team with appropriate equipment should provide advanced airway management.²⁶ The use of checklists and regular team training may further improve the success rate of pre-hospital airway management.²⁸ Adequate experience of the personnel performing airway management and the assisting team members is crucial for success. Second-generation supraglottic airway devices may be more effective than tracheal intubation to manage the airway until definitive airway control can be achieved.²⁹ Once an advanced airway has been inserted properly, adequate ventilation must be maintained. In a mass casualty incident, a single ventilator may be used to support as many as four patients.³⁰ Good outcomes will also depend on safe, timely transport to appropriate hospitals.

Studies on outcomes of airway management during mass casualty incidents have only rarely been published in the medical literature. More reports can be found in the lay literature. Mass casualty incidents involving asphyxiation from causes such as inhaled toxins,³¹ avalanches,²⁴ and submersion³² may have had better outcomes with improved triage, administration of oxygen,³³ or just basic airway management such as opening the airway, maintaining a patent airway, and administering antidotes to noxious agents³¹ or treatment of symptoms.³⁴

What is the take home message?

Senior physicians with a higher case volume of pre-hospital anaesthesia have higher first-pass success rates with tracheal intubation and shorter on-site times. Their patients have lower mortality rates. Videolaryngoscopy may further improve pre-hospital airway management. Airway management techniques should be adapted to the skill levels in each EMS system. In mass casualty care, physicians should have broad skill sets. They should have clinical skills with mastery of the ABCDEs, technical rescue skills for emergencies in hazardous environments, and tactical skills to triage patients, to prioritise resource allocation, and to direct transports to appropriate hospitals. RCTs are required to assess whether the higher pre-hospital case volume of the physician and the assisting staff result in lower mortality rates. If so, this would suggest limiting medical staff at EMS and HEMS bases to provide better airway management during normal and mass casualty incidents.

Authors' contributions

Drafting of the manuscript: PP

Editing and critical revision of the manuscript: all authors.

The authors agreed to the final version of the manuscript.

Declarations of interest

The authors do not have any conflict of interest regarding the content of this article.

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Improving mass casualty planning in low resource settings: Médecins Sans Frontières and International Committee of the Red Cross perspective

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