Title: Paramedics perform non-invasive positive pressure ventilations poorly in trauma patients.
Name: Grace Buck (s5174579)
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References: Endnote

Clinical Scenario

Paramedics are dispatched Code 1 to a 45-year-old male involved in a single vehicle collision. On arrival, the patient is found unconscious in the driver's seat of a car that has hit a tree on the side of a road. Upon initial assessment, the patient has a respiratory rate of four breaths per minute (BPM) with oxygen saturations of 88% and a contusion on the right orbital area. The patient is then fully immobilised and wearing a soft cervical collar to maintain spinal precautions.

PICO (Population – Intervention - Comparison – Outcome) Question:

In out-of-hospital trauma patients requiring ventilatory support, are paramedics performing non-invasive positive pressure ventilation (NIPPV) through a bag-valve-mask (BVM) adequately in order to achieve optimal targets for individual ventilation parameters?

Rationale and Relevance

Within the out-of-hospital environment, airway management is a challenging task as it can be frequently impacted by facial trauma, obstruction, or limited access to either the patient or their airway (Thoeni et al., 2015). Hence, the incidence of airway management in difficult airways, is higher in the pre-hospital setting than the in-hospital setting (Thoeni et al., 2015). Particularly in trauma patients, BVM ventilations are a common skill as multiple severe injuries are often associated with poorer tissue oxygenation and overall increased risk of damage (Beckers et al., 2014). Out-of-hospital airway management performed by paramedics is a vital yet often challenging procedure that requires the proper technique in order to achieve optimal patient outcomes (Panchal et al., 2020). Successful ventilation requires a patent airway, correct patient positioning, and a sufficient seal in order to reduce leaks (Sall et al., 2018; Althunayyan et al., 2021). If performed well, ventilation improves oxygenation and carbon dioxide clearance as well as relieving respiratory distress (Althunayyan et al., 2021). However, poor, and irregular ventilations can lead to excessive airway pressure, gastric insufflation, regurgitation, pulmonary aspiration, hypercapnia, hypoxaemia, increased mortality, and morbidity as well as impaired Haemodynamics (Sall et al., 2018). This appraisal aims to evaluate paramedic performance in regard to ventilating trauma patients in the out-of-hospital setting in order to achieve optimal targets for improved patient outcome.

Search Strategy

The databases Medline and EMBASE were searched from January 2001 to September 2021 using the key terms of: ("paramedic performance" OR "paramedic evaluation" OR "simulation study" OR "performance evaluation") AND (ventilation OR "bag valve mask ventilation" OR "airway management") AND ("trauma patients" OR "traumatic arrests" OR trauma OR "trauma simulations"). Included articles discussed paramedic performance in relation to their ventilation strategy and efficacy within the out-of-hospital setting. Articles were excluded if they were not in English, were not specific to paramedics or the out-of-hospital environment, evaluated invasive ventilation alone, or were out of the specified date range.

Search Outcome

The search strategy identified 43 articles, in which 14 full-text articles satisfied the inclusion criteria for further evaluation. Figure 1 outlines this process.

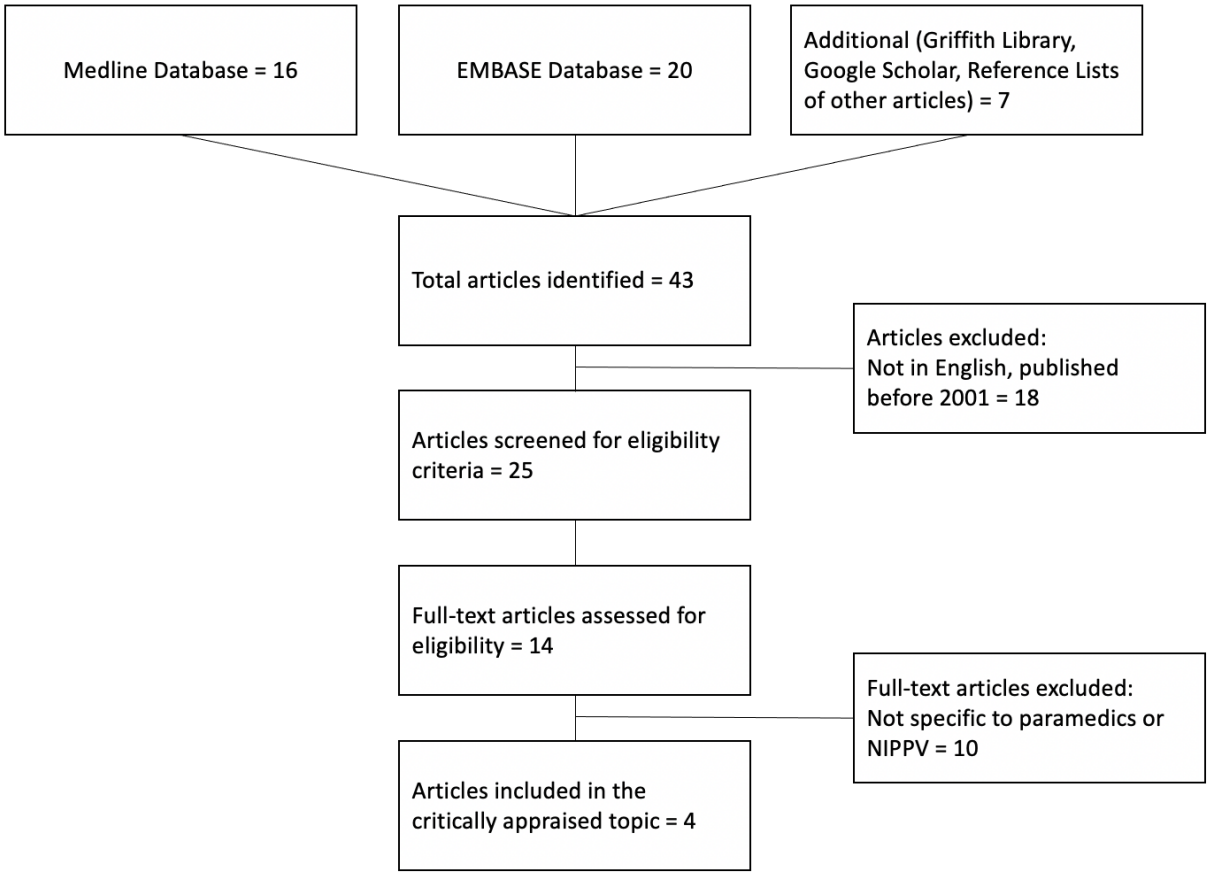

Figure 1. PRISMA diagram outlining the selection process.

Relevant Papers: 4

Author and Year	Study Design & Levels of Evidence (LOE) (Oxford)	Population (Sample and Characteristics)	Aim	Results	Strengths (+) and Limitations (-)
Panchal et al, 2015.	Observational Evaluation LOE = 2b	198 paramedics (Median age = 38) Inclusion criteria: currently certified paramedics and trained in basic and advanced life support,	To evaluate the approach to a difficult airway in a motor vehicle collision.	Only 14% of participants ventilated the patient at the correct rate of 10–12 breaths per minute (BPM) with adequate tidal volumes (TV) 50% of the paramedics had	(-) The manikin was used to generate a difficult airway, and thus this is limited to the context of simulation. (-) Reliance on video

				poor ventilations with inadequate TV. 78% of paramedics were found to be interrupting ventilations for greater than 30 seconds.	recording rather than real time assessment. (-) Study was conducted in one state in America, and thus cannot be generalised. (-) Risk of selection bias due to sample population being from one agency. (+) High fidelity scenario provided an accurate assessment of paramedic skills regarding a difficult airway. (+) Video recording allowed for review until the evaluator felt he had accurately observed and evaluated their performance.
Neth et al, 2020.	Blinded, prospective observational study LOE = 2b	106 EMS teams	Estimate the proportion of simulated adult resuscitation cases that meet guideline-based ventilation targets.	Only 3/106 simulations achieved the primary outcome by meeting all targets for ventilation rate, TV, and minute ventilation. Only a few simulations met the secondary outcomes of achieving resuscitation targets: ventilation rate	(-) A simulated environment may alter the performance of paramedics when compared to actual patient contact. (-) Guidelines do not provide a specific ventilation rate during resuscitation; therefore, the study chose a pre-specified target.

				26/106, TV 18/106, and minute ventilation 16/106. Ventilation rate was significantly lower for the BVM group.	(-) Study was based off a single, large, urban, fire-based EMS agency, which may not be generalisable across all prehospital systems. (+) Evaluators directly observed performance so they were not relying of video footage. (+) High fidelity manikins with dedicated simulation staff to create a realistic simulation.
Ocker et al, 2001	Bench Model LOE = 5	20 paramedics (Aged 21-38 years with more than 2 years' experience)	Assess what levels of lung and gastric tidal volumes paramedics achieve when employing ventilation with bag-valve-mask ventilation.	TV was significantly higher when using the laryngeal mask airway and Combitube compared to using the bag-valve-mask alone. Bag-valve-mask ventilation resulted in significant gastric inflation. Professional paramedics achieved excellent lung tidal volumes when using a laryngeal mask or the Combitube, but not when employing a	(-) It was impossible to simulate changing respiratory compliance that would be normally seen in CPR. (-) Did not allow for a manoeuvre of the manikin which would naturally prevent gastric inflation.

				bag-valve-mask.	
Lammers et al, 2012	Systematic evaluation (cross-sectional, observational) LOE = 2b	90 (45 crews - paramedics and EMS) 67% male and 33% female	Identify causes of errors during a simulated, prehospital paediatric emergency.	54% of crews did not use an oropharyngeal airway (OPA) with BVM ventilations during respiratory arrest, and some failed to achieve effective ventilations.	(-) Sample was only from one state. (-) The realism in a simulation is created by the equipment, simulator, and environment, meaning it can be limited. (-) Participants may have varying degrees of comfort and familiarity with simulations or these specific manikins. (+) The high-fidelity simulator that was used in this study provided feedback through physical and physiologic findings. (+) Reliability of measures of clinical performance were enhanced through various measures established by the authors.

Comments

The literature suggests that paramedics often perform ventilations poorly within trauma or cardiac arrest patients and fail to achieve optimal targets for ventilation parameters. Panchal et al. (2015) observed that in a trauma manikin simulation, only 14% of participants ventilated the patient at the correct rate of 10-12 BPM with an adequate tidal volume (TV). This evaluation also found that 78% of paramedics were interrupting their ventilations for greater than 30 seconds (Panchal et al, 2015). Ocker et al. (2001) possessed similar findings, TV was excellent when combined with invasive airway management techniques such as the laryngeal mask airway (LMA), yet, when BVM was employed alone, TV was significantly decreased.

This same study also found that incidence rates of gastric inflation were higher with bag-valve-mask ventilation that other airway management strategies (Ocker et al, 2001). In the study by Lammers et al. (2012), 54% of the crews did not utilise an oropharyngeal airway (OPA) and as a result, achieved poor and ineffective ventilations during a paediatric respiratory arrest.

The observational study by Neth et al. (2020) utilised primary and secondary ventilation parameters in order to evaluate paramedic performance. The primary outcome of the study was for simulations to meet all individual components of the ventilation criteria (TV, ventilation rate and minute ventilation); it was observed that only 3/106 simulations met this primary outcome (Neth et al, 2020). The secondary outcome was for cases to meet any of the individual components of the ventilation criteria, only a few simulations met this outcome: 26/106 for ventilation rate, 18/106 for TV, and 16/106 for minute ventilation (Neth et al, 2020).

Considerations

Literature displays that paramedic ventilations have proven to be poor in numerous studies evaluating the efficacy of their skills. As seen in the included studies, ventilations don't often meet the guidelines or optimal targets for TV, ventilation rate and minute ventilation. However, current literature is limited; the studies are often conducted outside of Australia limiting their generalisability, are non-specific to BVM ventilations, conducted in-hospital, involve various health practitioners other than paramedics, or are simulated studies which impacts realism. Thus, to mitigate the evident gaps in the literature, the addition of more recent, higher level, specific studies would allow for a deeper understanding and further knowledge on paramedic performance and patient outcome.

Clinical Bottom Line

Paramedics perform non-invasive positive pressure ventilation via a bag-valve-mask poorly in trauma patients, often missing optimal target ranges for successful and effective ventilations leading to adverse effects.

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