Manual vs mechanical ventilation in the prehospitally intubated adult patient with a traumatic brain injury

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Introduction

Worldwide, traumatic brain injuries (TBI) are a major cause of death and disability, affecting approximately 69 million people annually, including a significant burden of disease in Australia (1-6). Subsequent to the primary traumatic insult, a cascade of neuroinflammatory events take place contributing significantly to cerebral ischaemia (7, 8) and increased morbidity and mortality, termed the secondary insult (9).

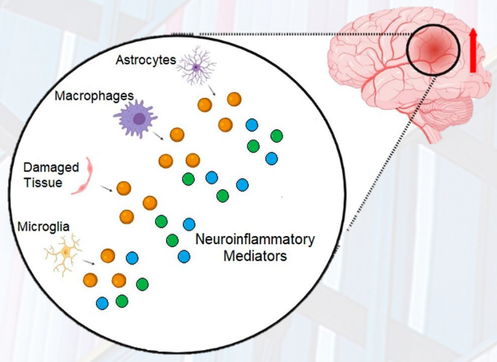

Figure 1: Neuroinflammatory cascade (10)

While hypoxia and hypotension are known to triple mortality rates (11), optimising cerebral blood flow by improving oxygenation and ventilation is crucial in reducing mortality (12). Although endotracheal intubation is considered the gold standard in the prehospital setting (13), there is a paucity of evidence to determine whether manual or mechanical ventilation is considered to be the superior modality.

The objective of this literature review is to compare manual (bag valve mask) versus mechanical ventilation through an endotracheal tube, with respect to morbidity and mortality in adult patients with a TBI in the prehospital setting.

Methods

A literature search was conducted on the 2nd of August 2022 using the medical electronic databases Ovid MEDLINE and CINAHL. MeSH headings and key terms included: prehospital, out of hospital, ambulance, emergency medical, service, technician, paramedic, bag valve mask, manual ventilation, BVM, resuscitation, mechanical ventilation, automatic ventilation, endotracheal, orotracheal, tracheal, intubation, ETT, ETI, tube, traumatic brain injury, TBI, head injury, HI, brain, head, cranial, skull, trauma, injury, fracture, damage, wound, and contusion. Relevant references and “Cited by” works were also included in the review.

Peer-reviewed primary articles between January 2002 and August 2022 were included if they involved adult patients who were prehospitally endotracheally intubated by paramedics. Articles were excluded if the patient had a medical emergency or other confounding prehospital injuries that may have impacted mortality rates, non-prehospital settings, systematic reviews +/- meta-analyses.

Results

There were 126 records located initially, reduced to 113 after duplicates were removed. A further 64 records were excluded after title and abstracts were screened. Of the 49 that remained, a further 41 met the exclusion criteria, leaving 8 articles for further analysis.

Discussion

This review revealed that both manual and mechanical ventilation had similar efficacies, as there were comparable rates of normocapnia. The distribution of hypercapnia and hypocapnia varied between studies, but paramedics were largely unable to ventilate intubated TBI patients safely, as evidenced by the majority of patients experiencing abnormal EtCO2 values (<35 mmHg or >45 mmHg).

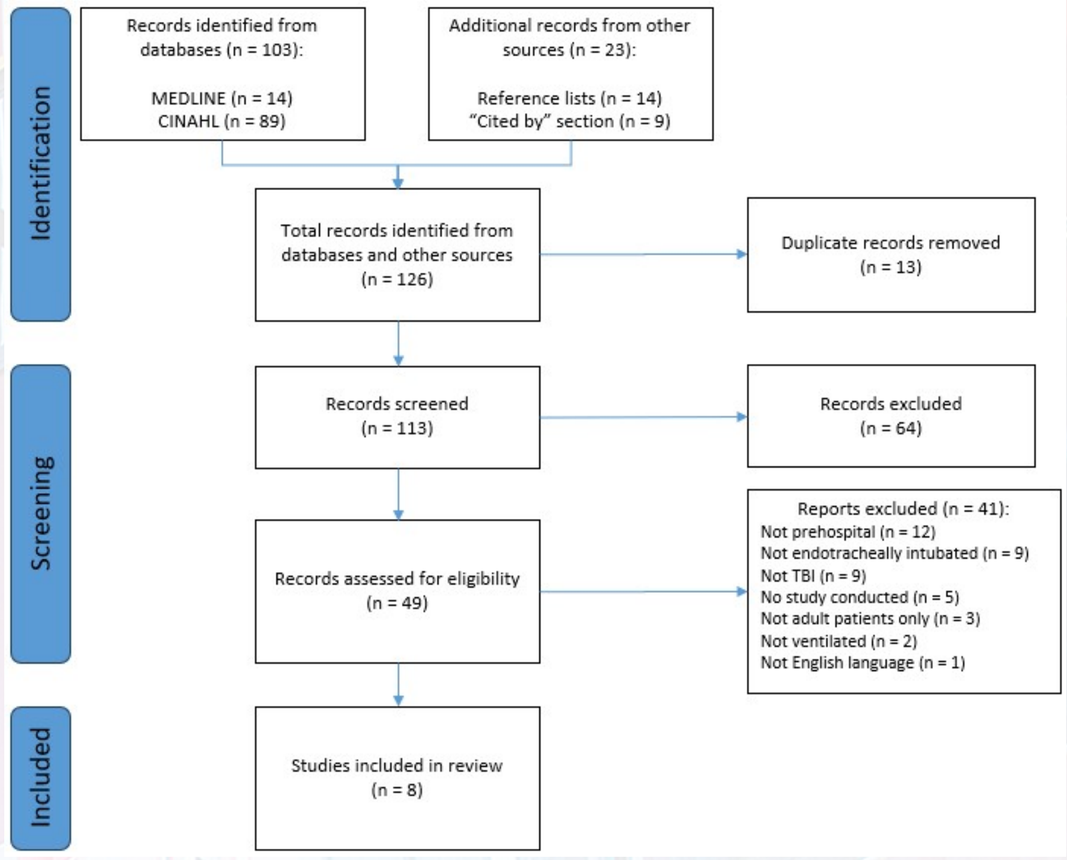

Figure 2: PRISMA Search Flow Diagram

Drawbacks of manual ventilation included clinician fatigue leading to variable tidal volumes and assisted ventilation rates, causing altered EtCO2 levels, intracranial pressure, and blood pressure (11). Additionally, cognitive overload and subsequent inability to perform other interventions, such as hyperosmolar fluid administration and capnography use (7, 12), were also identified as confounding factors.

Drawbacks of mechanical ventilation included complex configurations requiring upward of ten minutes to prepare, delaying time to therapy for patients (13). However, it was also noted that one of the benefits included having various settings which would allow for more precise treatment and consistent respiratory rates and tidal volumes (14).

Patients who are ventilated within the target EtCO2 ranges (35-45 mmHg) experience lower rates of morbidity and mortality (15). Although this review identified hypocapnia to be a negative factor in patient outcomes, hypercapnia was associated with significantly worse secondary brain injury (16-18). Thus, theory supports prehospital target EtCO2 values of 35-40 mmHg for improved patient outcomes, but randomised controlled trials are required to confirm this.

The existing body of evidence suggests that there was no significant difference in safety and efficacy between prehospital manual and mechanical in the endotracheally intubated adult TBI patient, with respect to morbidity and mortality rates. This review revealed contradictory, statistically non-significant findings, warranting further research in this field.

References

Please scan the QR code pictured to access the reference list.

Figure 3: Manual and mechanical ventilation through an ETT