

Transtacheal jet ventilation in the ‘can’t intubate can’t oxygenate’ emergency: a systematic review

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Abstract

Background: Transtacheal jet ventilation (TTJV) is recommended in several airway guidelines as a potentially life-saving procedure during the ‘Can’t Intubate Can’t Oxygenate’ (CICO) emergency. Some studies have questioned its effectiveness.

Methods: Our goal was to determine the complication rates of TTJV in the CICO emergency compared with the emergency setting where CICO is not described (non-CICO emergency) or elective surgical setting. Several databases of published and unpublished literature were searched systematically for studies describing TTJV in human subjects. Complications were categorized as device failure, barotrauma (including subcutaneous emphysema), and miscellaneous. Device failure was defined by the inability to place and/or use the TTJV device, not patient survival.

Results: Forty-four studies (428 procedures) met the inclusion criteria. Four studies included both emergency and elective procedures. Thirty studies described 132 emergency TTJV procedures; 90 were CICO emergencies. Eighteen studies described 296 elective TTJV procedures. Device failure occurred in 42% of CICO emergency vs 0% of non-CICO emergency ($P<0.001$) and 0.3% of elective procedures ($P<0.001$). Barotrauma occurred in 32% of CICO emergency vs 7% of non-CICO emergency ($P<0.001$) and 8% of elective procedures ($P<0.001$). The total number of procedures with any complication was 51% of CICO emergency vs 7% of non-CICO emergency ($P<0.001$) and 8% of elective procedures ($P<0.001$). Several reports described TTJV-related subcutaneous emphysema hampering subsequent attempts at surgical airway or tracheal intubation.

Conclusions: TTJV is associated with a high risk of device failure and barotrauma in the CICO emergency. Guidelines and recommendations supporting the use of TTJV in CICO should be reconsidered.

Key words: airway management; emergencies; respiration, artificial

Transtracheal jet ventilation (TTJV) is the introduction of pressurized oxygen usually through a narrow-bore cannula cricothyroidotomy. 'Narrow-bore cannula' has been variously defined as $<4\text{ mm}^1$ (10 gauge), or $<2\text{ mm}^2$ (14 gauge). While TTJV is sometimes used during elective head and neck procedures, it has also been advocated as a rescue procedure during emergency airway management. Current Difficult Airway Society (DAS) guidelines recommend scalpel cricothyroidotomy as the favored technique in the 'Can't Intubate, Can't Oxygenate' (CICO) scenario. Notwithstanding, TTJV through a narrow-bore cannula cricothyroidotomy is also included in the DAS CICO recommendations, but limited to clinicians experienced with this technique in their routine clinical practice.¹ This recommendation is similar to the Canadian guidelines.³ The DAS paediatric CICO guidelines include TTJV as an option in children one to eight yr old.⁴ The ASA has published difficult airway guidelines over three decades⁵⁻⁷ and includes TTJV as an option during a CICO emergency. TTJV for the CICO emergency is advocated in Australia⁸ and is mentioned as an option in airway guidelines from Germany⁹ and Italy.¹⁰

Some studies have suggested a high incidence of failure and barotrauma with the use of TTJV.^{2 11} The National Audit Project 4² reported 12 failures in the 19 attempts at narrow-bore cannula cricothyroidotomy with jet ventilation. In a review of airway-related malpractice claims that had reached legal settlement and were registered in the Anaesthesia Closed Claims Project,¹¹ Peterson reported that of the nine TTJV procedures performed during CICO emergencies, eight were complicated by barotrauma and all had poor outcomes.

Despite its inclusion in many published airway guidelines to manage the CICO emergency, the benefit of TTJV is unclear. Given this uncertainty we performed a systematic review of its use in clinical practice. Our primary goal was to determine the complication rates of TTJV use in the CICO emergency setting and compare them with the complication rates of those occurring in the emergency setting, where CICO is not described (the non-CICO emergency) and the elective surgical settings. Complications were categorized as device (thus technique) failure, occurrence of barotrauma including subcutaneous emphysema, or miscellaneous (e.g., cardiovascular collapse or bleeding). Device failure was defined by the inability to place and/or use the TTJV device and not by patient survival.

Methods

This study was registered with the International Prospective Register of Systematic Reviews February 16, 2015 (Registration #CRD42015016605) and conducted following the Preferred Reporting Items for Systematic review and Meta-Analysis (PRISMA) statement.¹²

Search strategy

We searched the following databases: Medline (1946 - March 2016), EMBASE (1974-March 2016), Cochrane Database of Systematic Reviews, ACP Journal Club, Database of Abstracts of Reviews of Effects, Cochrane Central Register of Controlled Trials, Cochrane Methodology Register, Health Technology Assessment, and the NHS Economic Evaluation Database. Searches were conducted on March 10th 2015 and repeated on August 28th, December 17th 2015, and March 30th 2016.

Search strategies were constructed separately for each source, based on the search interface and a balance of search sensitivity and specificity. The keywords 'transtracheal', 'trans-tracheal',

'cricothyrotomy', and 'cricothyroidotomy' were used for the Cochrane suite of databases and the unpublished literature searches. The keywords 'airway management', 'oxygenat*', and 'ventilat*' were added to the Medline and EMBASE search strategies, along with the subject headings 'airway management' (MeSH) and 'respiration control' (EMTREE) in order to increase search specificity in these databases. The Cochrane and unpublished literature search strategy mirrored the Medline/EMBASE search strategy as closely as possible, by capturing the transtracheal/cricothyrotomy aspect without further limiting the search results. The Cochrane/unpublished literature search strategy has greater sensitivity than the Medline/EMBASE search strategy, without sacrificing the original design and intent for this systematic review. The full search strategies can be found in Appendix 1. Bibliographies from narrative reviews were hand searched for further potential articles.

Unpublished literature

The unpublished literature was searched in the conference abstracts indexed by EMBASE from 1974 to March 2016 (which included the International Anaesthesia Research Society conference abstracts), and through the conference websites, conference journals or personal communication with conference organizers (see Acknowledgements Section) of the inaugural 2015 World Airway Management Meeting, ASA (2000-March 2016), the Canadian Anesthesiologists' Society (2007-March 2016), the Society for Airway Management (2005; 2007-March 2016) and the Difficult Airway Society (2012-2014). Although the last ten yr of society abstracts were requested from these societies, only certain yr were available. The Anaesthesia Closed Claims Project was also searched by written data request to the project administrator. Clinical leaders in the field of airway management were also contacted for abstracts from the above-listed meetings, further documented patients that may not have appeared in either published or unpublished scientific sources, or for clarification of details regarding their publications (see Acknowledgement Section).

Study selection

Independently and in duplicate, two authors reviewed all abstracts. A third author arbitrated disagreements. We included any study that reported at least one human subject of any age undergoing elective or emergency TTJV. As this systematic review is focused on TTJV use in clinical practice, animal, cadaver, mannequin, and lung-modeling studies were excluded. Animal models were excluded because their differing laryngeal and sub-laryngeal anatomy could impact success and complications of TTJV, in both simulated CICO and non-CICO scenarios, compared with humans. Cadaver studies, in both simulated CICO and non-CICO scenarios, were also excluded as many of our study parameters (e.g., occurrence of barotrauma, cardiovascular collapse or bleeding) would not be apparent in such a model. Also excluded were studies examining high-frequency jet ventilation, as this technique is not part of any published airway guideline. Articles were limited to those published in English or French.

Data extraction

We abstracted the following data from the included studies: emergency or elective TTJV, patient characteristics, catheter type, ventilation device and strategy, oxygen-driving pressure and complications. Emergency TTJV was further subdivided

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