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Minerva Anestesiologica 2021 January;87(1):4-6
DOI: 10.23736/S0375-9393.20.15283-0

EDITORIAL

Moving past Mallampati: airway ultrasound in predicting difficult face mask ventilation

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Airway management is a fundamental skill in the practice of clinicians working in acute care settings, including the operating theater, Emergency Room, and Critical Care Unit. A delay or failure to properly provide adequate ventilation, oxygenation, and ultimately a secure airway, carries a high degree of morbidity and mortality. Nevertheless, the predictive value of routine bedside airway examination is poor and reliable prognostication of the difficult airway remains a problem.[1, 2] Historically, bedside physical exam assessment has been the mainstay in airway evaluation and difficult mask ventilation (DMV) prognostication. However, the evidence for its ability to accurately predict difficult airway management (defined as DMV, difficult laryngoscopy, and difficult or failed endotracheal tube placement) is lacking. In a recent Cochrane review, the sensitivity and diagnostic accuracy of several routinely used bedside screening tests, including the Mallampati Score, Wilson Risk Score, thyromental and sternomental distances, mouth opening distance, and upper lip bite tests, were all evaluated. Based on 133 studies involving over 800,000 participants, all of these tests despite being widely recommended in societal guidelines, failed to accurately predict a difficult airway, leading clinicians to be faced with an unanticipated difficult airway.[1, 2]

The ability to specifically predict DMV is an especially important element of an airway evaluation. In situations of unexpected difficult laryngoscopy and/or failed endotracheal tube placement, adequate mask ventilation is lifesaving by allowing sufficient time to maintain oxygenation, obtain assistance, and gather emergency airway equipment including what may be needed for a surgical airway. In the operating theater context, successful mask ventilation and oxygenation may also provide a bridge to patients' recovery to spontaneous ventilation and the ability to convert to an awake intubation technique. Recent advancements in technology, portability, and affordability of ultrasound devices have made it possible to expand its role beyond the Unit of Radiology and Echocardiography Laboratory. Point of care ultrasound (POCUS), defined as a goal-oriented focused examination performed and interpreted by the treating physician at the patient's bedside, is a quick, non-invasive, reproducible, and inexpensive assessment tool. It is used not just for the rapid diagnosis of various medical conditions, but also for a real-time dynamic monitoring of the interventions and response to treatment. Moreover, it can be safely applied to a wide variety of patient populations and is currently considered a primary non-invasive adjunct to the conventional clinical assessment.[3]

Over the last decade there has been mounting evidence for the value of ultrasound use in the bedside evaluation of upper airway anatomy.[4-9] Airway ultrasound has the potential to be utilized for tracheal size measurements, confirmation of endotracheal tube location, endobronchial place-

ments, and localization of the cricothyroid membrane and tracheal rings for emergency airway access. Additionally, it could assist in the performance of laryngeal nerve blocks, assessment of vocal cord and diaphragmatic dysfunction, diagnosis of postextubation stridor, confirmation of laryngeal mask position, and even with the diagnosis of obstructive sleep apnea. Recently, ultrasound assessment of relevant anatomical structures of the anterior neck and measurement of the soft tissue thickness at the different levels of the neck was found to have a reasonable correlation with several aspects of difficult airway management. However, its ability to reliably predict an unanticipated difficult airway management is yet to be determined.[4-9]

To this end, Bianchini *et al.*[10] recently completed a prospective observational trial which enrolled 230 abdominal surgery patients over one-year interval between 2017-18. Exclusion criteria included predicted difficult intubation. Using a standardized preoperative ultrasound airway protocol, the authors evaluated a variety of airway anatomy determinants (hyomental distance, tongue base thickness, soft tissue thickness anterior to hyoid, thyro-hyoid distance, soft tissue thickness anterior to epiglottis, to arytenoids, and to vocal cord commissure). Secondarily, the authors evaluated a variety of other clinical patient characteristics as to their predictive ability with regard to DMV. Using binomial logistic regression, only tongue base thickness during head extension in both non-paralyzed patients (P=0.001) and paralyzed patients (P=0.02) differed in terms of DMV *versus* non-DMV. Using receiver operating characteristic analyses, of the aforementioned ultrasound measurement in non-paralyzed patients, a cut-off value of tongue base thickness with head extension >50 mm (area under curve [AUC]=0.75; P<0.01) was found to be predictive of DMV (sensitivity 85% and specificity 60%). In paralyzed patients, tongue base thickness during head extension with a cut-off value of 50 mm was also predictive of DMV (AUC=0.77; P<0.01) (sensitivity 75% and specificity 61%). Their findings were validated in both elderly and obese patients.[10] The authors should be commended on their sound statistical methodology. Though statistically sound, one critique would be that though the authors used a 5-point scale for describing pre- and intra-operative ventilation (0= easy, 1= slightly difficult, 2= moderate difficult, 3= very difficult, and 4= impossible mask ventilation) there is the question of reproducibility and interobserver error depending on how easy their scoring scheme is for others to use and how well other clinicians would agree about how to similarly score mask ventilation quality.

The publication by Bianchini *et al.* has quite the propitious timing in the context of the current COVID-19 pandemic. Firstly, all clinicians treating COVID-19 infected patients are at risk of becoming infected themselves and tracheal intubation is a high-risk procedure due to exposure of potentially high-viral load airway secretions. Hence, any preparatory actions that mitigate against infectious-particle exposure are important in terms of maintaining the health and safety of clinicians. Regardless of the acute care context, an accurate, reliable, and rapid airway assessment has become especially important during the current pandemic as even minimal delays in providing optimal respiratory support can be detrimental to patient outcome. As compared to conventional airway assessment techniques, airway ultrasound offers the advantage of permitting COVID-infected patients to remain masked and/or not having to remove any supplemental oxygen delivery devices to assess their airway. A recent set of UK consensus guidelines on airway management in COVID-19 patients explicitly recommends that individuals involved in the airway management of COVID-infected patients engage in careful and thorough pre-intubation airway management planning in order to: 1) ensure all needed airway equipment is at bedside prior to beginning intubation activities; 2) to secure a given airway as rapidly as possible; and 3) to minimize the number of intubation attempts.[11] Using the findings related to airway ultrasound presented by Bianchini *et al.* will help mitigate viral transmission to the members of the health care team by permitting appropriate planning and preparation for anticipated challenging airway management cases.

In summary, building on a variety of historical physical examination methods used for airway

assessment, the commendable work by Bianchini *et al.*[10] provides increased insight into predictors of DMV and ultimately to safer and superior airway management overall. Analogous to the ubiquitous use of echocardiography for cardiac evaluation, it is foreseeable that once a critical mass of literature accumulates, airway ultrasound may too become central to airway evaluation prior to intubation. Bianchini *et al.*'s work has particular importance in the current pandemic era in terms of minimizing potential exposure to those clinicians involved in airway management and also may lead to improved patient outcomes by possibly obviating the risks associated with DMV. Future research should build on the findings of Bianchini *et al.* and would ideally be a broader direct comparison between novel ultrasound airway techniques as compared to the current conventional methods.

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Conflicts of interest.—The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Authors' contributions.—Lev Deriy and Neal Gerstein have given substantial contributions to manuscript conception, writing, editing and revision. All authors read and approved the final version of the manuscript.

Comment on: Bianchini A, Nardozi L, Nardi E, Scuppa MF. Airways ultrasound in predicting difficult face mask ventilation. Minerva Anestesiol 2021;87:26-34. DOI: 10.23736/S0375-9393.20.14455-9.

History.—Manuscript accepted: November 19, 2020. - Manuscript received: October 13, 2020.

(*Cite this article as:* Deriy L, Gerstein NS. Moving past Mallampati: airway ultrasound in predicting difficult face mask ventilation. Minerva Anestesiol 2021;87:4-6. DOI: 10.23736/S0375-9393.20.15283-0)