Editorial Comment To The Article: Mishaps With Endotracheal Tube Exchangers In ICU: Two Case Reports And Review Of The Literature

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Abstract

Editorial response to the article written and published in Vol 4:Nates, J. L. & Berner, D. K. Mishaps With Endotracheal Tube Exchangers In ICU: Two Case Reports And Review Of The Literature. The Internet Journal of Anesthesiology 2001 Vol5N1Link to article: Joseph L. Nates & Donna Berner: Mishaps With Endotracheal Tube Exchangers In ICU: Two Case Reports And Review Of The Literature: The Internet Journal of Anesthesiology. 2001; Volume 5, Number 1.

I read with interest and enthusiasm the recently published article that reviewed mishaps with endotracheal tube exchanger in the ICU setting. Despite the relatively common need to exchange an ETT in the OR, PACU and ICU from single lumen tube to a double lumen tube or vice versa, nasal-to-oral and vice versa, the request for a larger luminal size ETT and the ETT which becomes occluded or malfunctions, the anesthesia literature has a relatively paucity of research related to this clinical airway procedure. Dr. Nates and Mr. Berner noted this and commented that despite the wide spread use of airway exchange catheters (AEC), studies supporting their use are scarce with only a few recently published reports shedding much needed light on the subject by highlighting the complications associated with ETT exchange. They reported two cases of ETT exchange in the ICU that resulted in esophageal placement of the new (replacement) ETT. In their discussion of the two “mishaps”, they point out the potential of losing the airway despite the use of an AEC which is incorporated precisely with the goal of maintain access to the airway. Their concern with the AEC and its potential of wandering outside of the ETT via the Murphy eye is certainly a clinical caveat that we each should be aware. The ETT is prone, though its thermolability, manipulation, age, the temperature of both the patient and any delivered gases, and its position within the oropharynx and hypopharynx, to attain an angle or bend at almost any point from its tip to the more proximal portion at the level of the lips. This bend or angulation subsequently may alter the path the AEC follows, thus increasing the likelihood that the AEC will exit via the Murphy eye.

Dr. Nates and Mr. Berger investigated this elegantly with passing the AEC via the damaged ETT (pictorially shown in the article) and repeatedly demonstrated the detour the AEC followed, thus exiting via the Murphy eye. A misguided AEC, which is obviously being passed blindly, must be heeded by the airway clinician as a potential problem and thus, vigilance for dealing with a lost airway or other critical mishap must be maintained. They hypothesized that the tip of the ETT had most likely been located between the vocal cords when the AEC was passed through the ETT. It was then threaded through the Murphy eye out of the trachea into the esophagus, they further rationalized that the presence of the ETT tip at the level of the glottis explained why they were able to ventilate with the AEC in position. Another possibility of how the AEC entered the esophagus was offered by the authors: the ETT bent out of the trachea and was “railroaded” into the esophagus due to forceful coiling of the AEC during passing of the ETT.

Another relevant point the authors made to minimize the risk of their mishap included the use of a larger diameter AEC which would be “too large”, thus much less likely to pass through the Murphy eye. Moreover, the authors should be applauded for emphasizing, as all airway managers should know, the AEC should be handled with caution; the rate of failure seems to be higher than expected depending on the type of AEC, the particular technique incorporated and the experience of the operator. Furthermore, the airway manager

should be aware of the major as well as minor complications that may accompany the exchange of an ETT. Finally, the two most astute suggestions made by the authors, which would hold true for any airway procedure, related to the airway manager developing a primary plan that is accompanied by a backup plan (or algorithm) which is complimented by immediate access to advanced airway equipment.

Furthermore, I applaud and respect any medical care professional who is willing to share their “failures”, “mishaps” or “complications” with the readership. To share one's own experiences, favorable or unfavorable, in order to teach and educate our colleagues is commendable. The description of the mishaps in this case report should remind us that, while the concept of using an AEC is relatively simple, the clinician who fails to incorporate certain key components in their evaluation of a patient being readied for an ETT exchange might actually promote the likelihood of potentially life-threatening critical events. Therefore, to continue with the educational initiative began by Dr. Nates and Mr. Berner, I must make some additional comments concerning the AEC and exchanging an ETT.

The authors opened their discussion section with the statement, “ETT exchange is a simple procedure, and it does not seem to require special training”. This certainly does not gel well with their concluding statement, which underscores the complexities and potential for complications that may occur during an exchange. I am a firm believer that ETT exchange is a simple concept but it is not a simple procedure. It is a procedure which may be plagued by airway and hemodynamic complications, some major and some minor, yet enough potential of complications of catastrophic proportions that the exchange should not be left to the less experienced. Even in the most experienced hands, an ETT exchange can tame even the cockiest airway manager and provide a very humbling and stress-filled encounter. This “stressful” experience can exist in the absence of the patient not suffer any particular mishap or critical event. I would also add that “special training” is required for an exchange. It is the lack of experience or special training that may lead to failure to properly assess the patient, failure to formulate a primary and backup plan for the procedure, and failure to have immediate access to advanced airway equipment in the event of difficulty passing the new ETT or any other unforeseen airway problem.

The authors stated that the “damaged” or “defective” ETT (case 1) was examined carefully. They did not state exactly what part of the involved ETT was damaged or defective. However, they went on to state (and illustrate with photographs) that when the AEC was threaded through the ETT, the AEC exited the ETT via the Murphy eye on every attempt. Moreover, exiting the Murphy eye was also shown with an Eschman catheter (the readership should be aware that the Eschman catheter should not be used in the capacity as a tube exchanger). They commented on the pliability and softness of the ETT that may have contributed to a bend or angulation in the tip that allowed the Murphy eye to lie in the path of the incoming AEC. They surmised that the ETT tip was most likely situated at the level of the vocal cords when the exchange was performed; hence the exiting AEC had more direct access to entering the esophagus.

Several clinical caveats must be shared with the readership so to more clearly explain what possibly or more likely took place with these two exchanges. First of all, I presume the authors did a rapid but thorough examination of both the patient and the medical record to gleam any useful information that may have assisted them in planning the exchange. Nonetheless, it should be pointed out that neither of these cases were true emergencies; hence the airway manager had time to fully evaluate the patient and the record. Reviewing the previous airway encounter is tremendously important and can provide very useful details concerning the airway at the time the initial intubation was performed. The available description, of course, is reliant on the documentation by the previous airway manager, which may or may not be accurate, adequate, legible or informative. Any information gathered may be like the printed newspaper edition on your front doorstep, “old” as you review it, since the ICU patient may experience ongoing alterations in the airway status due to volume management, any intervening trauma to the airway, capillary leak syndromes, drug reactions and other potentially airway altering conditions which coexist in the ICU patient. The airway manager, therefore, must obtain “real-time” patient information so to better plan what the patients needs are, currently. It would be prudent that each patient who is to undergo an ETT exchange, whether elective, urgent or emergent, undergoes a comprehensive airway examination. The most important component of this airway evaluation would be a screening direct laryngoscopy. Direct viewing and assessment of the airway will reveal important information that may guide decision making for the exchange. Any single factor or any combination of factors

noted at laryngoscopy may be noted that may impede or limit the view of the periglottic structures. Armed with this real-time data, the clinician can formulate a plan based on their experience and skill plus the applicability of the clinically available methods of exchanging an ETT (direct laryngoscopy alone, a single AEC, fiberoptic bronchoscopic guidance, a “double technique” incorporating two AEC's or one AEC combined with fiberoptic guidance). Further, other options may include a decision to do nothing in the high risk patient who can be maintained with the current ETT, regroup when a more experienced team can attend the procedure, repair the ETT (if possible or feasible), recommend a surgical airway as a solution, or even extubate the patient, if applicable. I cannot overemphasize the importance of the screening laryngoscopy. The aforementioned airway risk assessment is equally imperative in determining if the patient should be taken to the confines of the operating room or the operating room environs should be recreated at the bedside before proceeding with the exchange.

The description of the two cases in the article does not mention such an airway assessment or examination (other than stating the airway was a Class I). By the description provided by the authors as to their speculation of what position the ETT held, a screening laryngoscopic evaluation would have provided invaluable data and the decision making tree may have been completely different from the course pursued. My personal experience with many similarly described clinical scenarios has been a “near or total extubation” of the larynx with the ETT cuff that lies between or above the vocal cords. Moreover, many of these cases consist of an ETT tip, which actually sits above the glottis, and the cuff is over inflated. Hence, the ETT is acting as an “LMA” or a “cuffed hypopharyngeal airway” (CHPA rather than the COPA, Mallinckrodt). This clinical entity is relatively common and its remedy must be entertained with care, so to avoid an airway disaster. For example, blind advancement of an ETT, which lies above the glottis, could lead to esophageal intubation, ETT kinking, laryngospasm or a lost airway. Likewise, passing an AEC may not be the best method of resolving the malposition unless the airway clinician is assured that the ETT tip is through the glottis. If the ETT cuff is over-inflated yet sealing the hypopharynx, it is very difficult to know what path an AEC may follow knowing the ETT's lumen and tip may not be adjacent to the glottic opening. This highlights the importance of performing a screening direct laryngoscopy. One very useful method of diagnosing and treating an ETT, which has or is suspected to have exited the glottis, is fiberoptic assessment and advancement. However, if confronted by a straightforward airway where the glottis can be easily seen around the ETT (once the ETT cuff is deflated), direct laryngoscopy and ETT advancement is certainly acceptable practice.

The author's contention that the ETT tip was between the vocal cords when the AEC was “threaded through the Murphy eye out of the trachea into the esophagus” requires further comment. First of all, if the ETT tip was between the glottis, then the Murphy eye located approximately 1 cm proximally, was above the vocal cords and not actually in the “trachea”. Thus, the description that the AEC followed a path through the Murphy eye ‘out of the trachea” is incorrect. It should have read, “the AEC exited the ETT and migrated posterior to the glottis and entered the esophagus”. Otherwise, the description suggests the AEC entered the subglottic area (trachea) and then reversed directions to exit the glottis in a cephalad direction and then turned caudad and then entered the esophagus. This is probably a highly unlikely clinical scenario. The Cook AEC used in these cases would be very unlikely to follow such a course given it semi-rigid character. More likely, this statement was improperly worded in the text but I must “call them as I read them”. For the AEC to exit through the Murphy eye and enter the esophagus (barring any undue force or aggressive maneuvering by the authors, which was not describe), the ETT's tip must have been not between or at the level of the vocal cords but actually above the glottis. In the more likely scenario, both of these patients' tracheas were actually extubated at the time of passing the AEC for the tube exchange. Again, a screen direct evaluation may have easily detected this malposition.

The other concern with this description is that if the AEC exited the Murphy eye, then upon removal of the defective ETT, it should have been noted by the clinician that the ETT was guided out of the patient over the AEC via the Murphy eye. This clinical detail was not described. Moreover, there would certainly have been some resistance of the ETT exiting via the Murphy eye as compared to the conventional route of removal through the much larger ETT lumen.

The author's choice of the relatively small 11F COOK AEC (OD=3.7mm) most certainly contributed to the mishaps described. The practice of ETT exchange in the ICU patient may be best served by the use of a larger catheter such the 19F COOK (OD 6.4mm) or 14F Cook (OD=4.7mm) which

is applicable in most adult situations when a 7.0 or larger ETT is exchanged. As noted by the authors, the larger AEC is too "wide" to exit via the Murphy eye plus the larger size affords a more stable conduit for advancing the ETT, especially since lateral movement or 'wobbling" of the ETT is minimized. The authors mentioned the limitation of using the larger catheter when confronted by a smaller ETT (i.e., nasal exchanges, i.e., size 6.0, 6.5 or 7.0 or a partial occluded ETT). A very useful alternative AEC for this situation may be the "medium" adult 14F by the same manufacturer. The use of the larger sized AEC must be incorporated cautiously when the airway clinician plans to deliver ventilation via high pressure. Since the risk of barotrauma rises considerably if air entry exceeds the ability to dissipate the air (pressure). Hand controlled jet ventilation with a relatively larger AEC combined with a relatively small ETT (7.0) may not allow adequate egress of gases if high pressure air delivery takes place when both are in the airway. ([1],[2])

The second postulated explanation of the etiology of the esophageal placement of the AEC offered by the authors was that the ETT bent out of the trachea and was forced into the esophagus when threading the AEC. Though I realize anything is possible when one deals with the airway, it is highly improbable that this took place. Firstly, if this statement is correctly phrased in the text, it is unlikely that the AEC would "force" the ETT out of the trachea and then into the esophagus. On the contrary, it may be the "new replacement ETT" that is passed over the AEC that may "railroad" the AEC and lead to its coiling in the hypopharynx. This author experienced this on multiple occasions with the less rigid Sheridan TTX medium and larger AEC. I do not have any reported "coiling" or "railroading" of the ETT in to the esophagus in over 180 exchanges with the three sizes of AEC manufactured by Cook Critical Care. Of these cases incorporating a Cook brand AEC, only two esophageal placements have been described, each following either improper technique by a less experienced practitioner or a difficult exchange which lead to the AEC's distal end moving too proximally and subsequently above the vocal cords. One particular problem, which may hamper an ETT exchange, is the presence of thick, sticky inspissated secretions, which may adhere to the AEC. This subsequently may lead to some difficulty with the removal of the old ETT, especially if the AEC is not held securely in position. If it is not held in its proper position, there is the likelihood that he AEC may be moved proximally and its tip may exit the glottis.

The authors repeated their concern about a risk of "bending" the ETT and displacing it into the pharynx when passing the AEC in the clinical situation when only a small portion of the ETT is in the trachea. They stated that the largest AEC (Cook 19F, OD=6.3mm) is too rigid and thus poses a higher risk of bending the ETT tip. This could then, theoretically, guide the AEC into the pharynx and then the esophagus. It is true that anything may occur, but the likelihood is nearly nonexistent if the ETT tip is below the vocal cords and the subsequent passing of the AEC is performed to the proper depth. There is no doubt that an AEC could be misguided into the pharynx if the ETT tip is above the vocal cords, as was probably the etiology in the two reported cases. Another important point to consider is the nature of storing the AEC on a difficult airway cart or tote bag. If the AEC is coiled or bent to allow easier storing, the airway clinician must be cognizant of the possible bend or curvature of the catheter when it is removed from its packaging. I have noted this problem with bending or coiling the catheter for storage in an emergency bag or in the draw of a difficult airway cart. All catheter sizes are prone but the smaller adult size (11F) appears to be most likely to bend.

The majority of these situations, however, may be avoided if the patient has been properly evaluated prior to commencing with the exchange (a screening direct laryngoscopy). An accurate determination of the ETT tip location should prompt the airway manager to pursue the assessment and repositioning of the ETT with fiberoptic guidance.

Two final comments: the authors mentioned the study by Loudermilk et al. and stated that they recommended the small adult AEC (11F) as a useful adjunct for airway management. ([3]) It must be pointed out that the study by Loudermilk et al. indeed, dealt with the use of the small adult sized AEC. However, its use was described in the extubation of the difficult airway, not for exchange of the ETT. Finally, Dr. Nates described the removed ETT from case #1 as "damaged" and "defective" but did not specifically identify the problem. However, in the photographic illustrations of the AEC passing through the Murphy eye, the supposedly "removed" ETT appears to have an intact and inflated cuff. Perhaps a new ETT was substituted for cleanliness, but if the pictured ETT is the original, the readership is lost in knowing what was damaged or defective. If this truly is the original ETT with an intact cuff, then I presume that the patient's glottis was extubated at

the time of the exchange. The presumption that the ETT is damaged or defective by virtue of the continued leak and multiple inflations of the cuff suggests the ETT was acting as a “laryngeal or pharyngeal mask airway”. However, since no description of an examination of the hypopharynx or glottis was provided in the text, the actual position of the ETT and the exact set of conditions that lead to the AEC entering the esophagus, remains unknown. Lacking any details pertaining to resistance for ETT removal over the AEC (suggesting the AEC was traversing the Murphy eye) and no mention of the old ETT being removed with the AEC through the Murphy eye, I would be hard pressed to accept this as the most plausible explanation for the esophageal intubation.

I strongly agree with the authors that despite the widespread use of the AEC for exchanging a tracheal tube, there is a paucity of literature available to educate those who must evaluate the patient, formulate primary and secondary strategies, and then execute the exchange. The approach to the evaluation and preparation of the patient, assembling conventional and advanced airway equipment, gathering needed personnel (nursing, respiratory therapy, additional anesthesiologists, a colleague capable of performing a surgical rescue airway) is far from simple: it is complex and each step has a purpose. Failure to execute any of these individual steps may jeopardize the ETT exchange. The Hartford Hospital exchange database (n=358 cases) suggests that each and every patient who undergoes an ETT exchange is potentially at risk for hypoxemia (overall rate for each method, 36%), hemodynamic alterations (bradycardia, 14%, cardiac arrest, 5%), esophageal intubation (14%, overall), airway injury and a “lost airway”. Overall, a rate of 3% for emergency surgical airway and in addition to several others “rescued” by accessory airway devices immediately available at the patient's bedside (LMA, Combitube, “bougie” type airway catheter, FOB). These complications are not trivial but are a sampling of what disaster can accompany an ETT exchange in the hands of experienced ICU anesthesiologists who are prepared with advanced airway equipment. Moreover, having a surgical colleague in attendance in the presumed high-risk cases (which seems like nearly all of them) is another fitting suggestion for airway planning strategy.

In conclusion, our specialty is at the forefront of dealing with the exchange of an ETT but to this point we have pretty much neglected it in the literature. I would encourage others to write and report their experience, favorable or otherwise, so to share with our colleagues the potential hazards which plague exchanging the ETT, not only in the ICU, but also in the PACU and the operating room.

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