Nilesh M. Mehta
Sanjiv Sharma
Peter C. Laussen

Unplanned extubation: securing the tool of our trade

Received: 22 June 2015
Accepted: 20 July 2015
Published online: 12 August 2015
© Springer-Verlag Berlin Heidelberg and ESICM 2015

N. M. Mehta
Division of Critical Care Medicine, Department of Anesthesiology,
Perioperative and Pain Medicine, Boston Children's Hospital,
Harvard University, Cambridge, USA

S. Sharma (✉)
Paediatric and Neonatal Intensive Care, Critical care and
Cardiorespiratory Division, Great Ormond Street Hospital for Sick
Children NHS Foundation Trust, London, UK
e-mail: sanjiv.sharma@gosh.nhs.uk

P. C. Laussen
Department of Critical Care Medicine, Hospital for Sick Children,
Department of Anaesthesia, University of Toronto, Toronto,
Canada

Securing a patent human airway by tracheotomy has been described in Egyptian tablets dating back to 3600 B.C. [1]. Airway access has undergone dramatic technological improvements, from heroic tracheotomy reports during diphtheria epidemics to the modern day non-surgically placed endotracheal tubes that allow invasive mechanical ventilation. Indeed, the field of pediatric critical care was founded on the need for prolonged assisted ventilation via an endotracheal tube following surgery. Prolonged hand ventilation quickly gave way to rapid developments in the types and modes of mechanical ventilation, which continues to this day. Throughout, the endotracheal tube (ETT) has remained our fundamental tool to facilitate prolonged mechanical ventilation. As an essential tool of our trade, it is therefore reasonable that the way we maintain the ETT to provide respiratory support is a valid metric of the quality of care we deliver. Unplanned extubations (UE) are associated with poor outcomes [2].

Hence, UE has become an important quality metric across critical care, one that can be benchmarked against other institutions. In their article published in *Intensive Care Medicine*, Kanthimathinathan et al. present data analyzed from a single-center database, including patient variables and unplanned extubation to the minute, entered longitudinally over a 14-year period [3]. A retrospective analysis of prospectively collected data and lack of a clear intervention are indeed limitations of this study. However, some quality metrics, such as UE, are difficult to study in a multicenter fashion because there is no established or agreed upon “bundle” for care and there is variation in patient populations and care systems. Therefore a large single center report such as this, with rigorously applied internal controls for data accuracy and verification, has merit.

One of the primary objectives of the study was to describe the rate of UE in their intensive care unit over time, and to establish a benchmark for this quality metric. To be comparable across the field, a metric must be well defined, measured accurately and reliably, and able to be trended over a period of time. In this paper, the authors reported 243 unplanned extubations across 31,564 days of intubation to give an incidence of 0.77 per 100 intubated days. While the frequency of UE has been commonly measured per 100 days of ventilation, the authors point out that this likely underestimates the frequency and propose measurement of the frequency in relation to minutes of ventilation. It is important to note the decrease in the frequency of UE over 14 years, from 1.38 to 0.53 per 100 intubated days. There did not appear to be any specific new interventions undertaken and there were no descriptions to how this information was used to drive quality improvement within their unit. Nevertheless, the simple act of collecting and reviewing the data is enough to keep this potential problem in the collective consciousness of the unit, improves situational awareness, such that care is taken without following a targeted

bundle or intervention. This is a good example of the Hawthorne effect. The current study suggests that an UE incidence of less than 0.6 per 100 ventilator days should be an achievable benchmark in alike intensive care units.

UE is a metric that is measurable and comparable between institutions. The authors pointed out that we might in fact underestimate the frequency by using ventilator days as the denominator. To some extent, the unit of time does not matter, provided we all understand the conventions by which the metric is derived. A review of the literature (Table 1) shows the wide range of metrics that UE is expressed as and the diversity in approach of studies from exploring contributing factors to examining consequences of UE. As suggested by Kanthimathinathan et al., calculating the UE rate per 24 h, rather than calendar days, would provide greater accuracy of the frequency of this event and make the benchmark more reliable. There is clearly more work to be done in this regard; however, as a benchmark, we need to maintain a consistent definition that is readily understandable and applicable across centers. Finally, an extremely important component of any preventable quality metric, such as UE, is understanding the systems of care that could contribute to or prevent the adverse event. These include numerous

patient, staff, and procedural related factors. For example, a discussion about ETT position and fixation, and about ventilation strategy and anticipated extubation, should be included as part of a daily patient risk assessment, and ward round checklists have been shown to ensure this is done with beneficial effects on UE rates [4]. Optimal sedation strategy could impact UE rates and must be carefully orchestrated in intubated patients [5]. It is important to determine whether a change in workflow could contribute to UE. The authors noted no difference in the time of day as being a risk for UE but there is no additional information regarding staff experience, complexity of patients, and unit workflow/turnover. It is also important to appreciate that this is a multidisciplinary discussion involving physicians, nurses, and respiratory therapists, and should also include discussion with anesthesiologists who may intubate the patients but use a different method of fixation. In the end, cultural change driven by leadership and supported by multidisciplinary commitment is perhaps the most important factor in improving quality of care in complex environments such as the PICU.

The ETT is an important tool of our trade. It enables management that differentiates our care. As clinicians we

Table 1 Unplanned extubation rates (UER) by publication (grouped according to the metric used)

References	Type of study	Year	Age group	UER	Notes
Vianna et al. [6]	Retrospective	2007	Adult	2 % of intubated patients	
Yeh et al. [7]	Questionnaire	2004	Adult	22.5 % of intubated patients	
Kapadia et al. [8]	Prospective observational	2014	Adult	0.22 % per bed endotracheal day	
Razavi et al. [9]	Prospective cohort controlled	2013	Pediatric	3.6 % per intubated bed patient day	Risk factors included age <2 years, agitation, increased saliva, increased duration of ventilation
Silva et al. [10]	Systematic review	2013	Neonates	0.14–5.3 per 100 intubation days	
Lucas da Silva et al. [11]	Systematic review	2010	Pediatric	0.11–2.27 per 100 intubation days	
Piva et al. [12]	Prospective observational	1995	Pediatric	2.7 per 100 intubations	
Bastos de Moura et al. [13]	Retrospective cohort	2011	Adult	0.21 % of mechanical ventilation days	Leading cause was failure of restraint associated with psychomotor agitation
Carvalho et al. [14]	Prospective observational	2010	Neonatal	5.34 per patient days ventilated	Correlation between number of patient-days ventilated and UER frequency
De Groot et al. [15]	Prospective case controlled	2009	Adult	0.4 % per ventilation day	
Gonzalez-Castro et al. [16]	Prospective observational	2014	Mixed	1.21 per 100 days of mechanical ventilation	UER increased mortality, length of stay, and ventilator-associated pneumonia
Bouza et al. [17]	Prospective cohort	2007	Adult	0.92 per 100 days of ventilation	Increased UER reduced mortality rate but increased days on mechanical ventilation
Herold et al. [18]	Prospective observational	2006	Adult	0.8 per 100 ventilation days	
Tanios et al. [19]	Prospective cohort controlled	2014	Adult	7.5 per 1000 days of mechanical ventilation	Continuous sedation is associated with lower rates of UER

need to take care of our tools and employ them in the safest and most efficient manner. If we accept that UE are preventable, which is an important starting point, then we can develop internal and external bundles and systems of care to limit the frequency of UE. While there are still questions to answer regarding the denominator, UE

remains a valid metric against which units can be compared. With appropriate standardization of the definition, benchmarking UE as a quality metric can help identify best practices around ETT maintenance and ultimately drive down its incidence globally.

References

1. Carroll CM, Pahor A (2001) The history of tracheotomy. *J Ir Coll Physicians Surg* 30(4):237–238
2. Roddy DJ, Spaeder MC, Pastor W, Stockwell DC, Klugman D (2015) Unplanned extubations in children: impact on hospital cost and length of stay. *Pediatr Crit Care Med* 16(6):572–575
3. Kanthimathinathan HK, Durwood A, Nyman A, Murdoch IA, Tibby S (2015) Unplanned extubation in a paediatric intensive care unit: prospective cohort study. *Intensive Care Med* 41(7):1299–1306. doi: [10.1007/s00134-015-3872-4](https://doi.org/10.1007/s00134-015-3872-4)
4. Sharma S, Peters MJ (2013) ‘Safety by DEFAULT’: introduction and impact of a paediatric ward round checklist. *Crit Care* 17(5):R232
5. Tanios M, Epstein S, Grzeskowiak M, Nguyen HM, Park H, Leo J (2014) Influence of sedation strategies on unplanned extubation in a mixed intensive care unit. *Am J Crit Care* 23(4):306–314
6. Vianna A, Rangel D, Alves A, Aguiar A, Adolphsson S, Bockorny B, Farias C, Chiarello AC (2007) Unplanned extubation in the intensive care unit: what are the consequences? *Crit Care* 11(Suppl 3):P66
7. Yeh SH, Lee LN, Tien-Hui H, Chiang M-C, Lin L-W (2004) Implications of nursing care in the occurrence and consequences of unplanned extubation in adult intensive care units. *Int J Nurs Stud* 41:255–262
8. Kapadia FN, Tekawade PC, Nath SS, Pachpute SS, Saverkar SS, Bhise RA, Chavan AC, Varghese SJ, Kantak VU, Kshirsagar RV, Neve VA, D’souza SO (2014) A prolonged observational study of tracheal tube displacements: benchmarking an incidence <0.5–1% in a medical-surgical adult intensive care unit. *Indian J Crit Care Med* 18(5):273–277
9. Razavi SS, Nejad RA, Mohajerani SA, Talebian M (2013) Tanaffos 12(3):11–16
10. Silva PS, Reis ME, Aguiar VE, Foneseca MC (2013) Unplanned extubation in the neonatal ICU: a systematic review, critical appraisal, and evidence-based recommendations. *Respir care* 58(7):1237–1245
11. Lucas da Silva PS, de Carvalho WB (2010) Unplanned extubation in pediatric critically ill patients: a systematic review and best practices recommendations. *Pediatr Crit Care Med* 2(11):287–294
12. Piva JP, Amantea S, Luchese S, Giugno K, Maia TR, Einloft L (1995) Accidental extubation in a pediatric intensive care unit. *J Pediatr Rio J* 2(71):72–76
13. Bastos de Moura E, Aires de Araujo Neto J, De Oliveira Maia M, Beserra Lima F, Fernandes Bomfim R (2011) Assessment of the impact of unplanned extubation on ICU patient outcome. *Crit Care* 15(Suppl 1):169
14. Carvalho FL, Mezzacappa MA, Calil R, Machado Had C (2010) Incidence and risk factors of accidental extubation in a neonatal intensive care unit. *J Pediatr Rio J* 3(86):189–195
15. De Groot R, Aarts LP, Arbous MS (2009) Risk factors for unplanned extubations in critically ill patients. *Crit Care* 13(Suppl 1):P23
16. Gonzalez-Castro A, Penasco Y, Bianco C, Gonzalez-Fernandez C, Dominguez MJ, Rodriguez-Borregan JC (2014) Unplanned extubation in ICU and the relevance of non-dependent patient variables in the quality of care. *Rev Calid Asist* 6(29):334–340
17. Bouza C, Garcia E, Diaz M, Segovia E, Rodriguez I (2007) Unplanned extubation in orally intubated medical patients in the intensive care unit: a prospective cohort study. *Heart Lung* 4(36):270–276
18. Herold I, Arbous S, Habraken M, van der Schaaf, Frank M, Van den Berg P (2006) *Crit Care* 10(Suppl 1):441
19. Tanios M, Epstein S, Grzeskowiak M, Nguyen HM, Park H, Leo J (2014) Influence of sedation strategies on unplanned extubation in a mixed intensive care unit. *Am J Crit Care* 23(4):306–314