Elmer and Kahn *Critical Care* 2014, **18**:303
http://ccforum.com/content/18/1/303

CRITICAL CARE

JOURNAL CLUB CRITIQUE

Implementing evidence-based practice in the neuroscience intensive care unit

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University of Pittsburgh Department of Critical Care Medicine: Evidence-Based Medicine Journal Club, edited by Sachin Yende

Expanded abstract

Citation

Roquilly A, Cinotti R, Jaber S, Vourc'h M, Pengam F, Mahe PJ, Lakhal K, Demeure Dit Latte D, Rondeau N, Loutrel O, Paulus J, Rozec B, Blanloeil Y, Vibet MA, Sebille V, Feuillet F, Asehnoune K: **Implementation of an evidence-based extubation readiness bundle in 499 brain-injured patients - a before-after evaluation of a quality improvement project.** *Am J Respir Crit Care Med* 2013, **188:**958–966.

Background

Mechanical ventilation is associated with substantial morbidity in brain-injured patients. This study aimed to assess the effectiveness of an extubation readiness bundle to decrease duration of mechanical ventilation after brain injury.

Methods

Objective: To evaluate whether the implementation of an evidence-based care bundle can accelerate extubation readiness in brain-injured patients.
Design: Before/after observational study.
Setting: Two ICUs in one university hospital in France.
Subjects: Brain-injured patients ventilated >24 hours with an initial Glasgow Coma Scale score ≤12 and an acutely abnormal brain computerized tomography.
Intervention: One year of targeted education focused on a four-element treatment bundle consisting of lung protective ventilation, early enteral nutrition, standardization of antibiotherapy for hospital-acquired pneumonia and a systematic approach to extubation.
Measurements: Observational data were recorded prospectively during the pre- and post-intervention periods. The primary endpoint was the duration of mechanical ventilation. Secondary endpoints included ventilator-free days at 28 and 90 days, ICU and 90 day mortality, development of hospital acquired pneumonia or acute respiratory distress syndrome and unplanned or failed extubation.

Results

The study included 499 patients, 299 in the control phase and 200 in the intervention phase. Admission during the intervention phase was associated with lower mean tidal volume ($P < 0.01$), higher mean positive end-expiratory pressure levels ($P < 0.01$), and higher enteral intake in the first 7 days ($P = 0.01$). The mean duration of mechanical ventilation was 14.9 ± 11.7 days in the control phase and 12.6 ± 10.3 days in the intervention phase ($P = 0.02$). The hazard ratio (HR) for extubation was 1.28 (95% confidence interval (95% CI) 1.04 to 1.57; $P = 0.02$) in the intervention phase. The adjusted HR was 1.40 (95% CI 1.12 to 1.76, $P < 0.01$) in multivariate analysis and 1.34 (95% CI 1.03 to 1.74, $P = 0.02$) in a propensity score-adjusted analysis. ICU-free days at day 90 increased from 50 ± 33 in the control phase to 57 ± 29 in the intervention phase ($P < 0.01$). Mortality at day 90 was 28.4% in the control phase and 23.5% in the intervention phase ($P = 0.22$).

Limitations

The major limitations of this work are those inherent in a before-after observational study design. Additionally, the authors do not present a needs assessment to support the design of their quality improvement initiative.

Conclusions

Targeted education focused on an evidence-based extubation readiness bundle was associated with a reduction in the duration of ventilation in brain-injured patients.

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Commentary

Neurological diseases are a common cause of critical illness, accounting for approximately 7 to 10% of mechanically ventilated patients [1]. Mortality in these patients is generally higher than in patients with non-neurological disease, but varies substantially by the etiology of brain injury, with better outcomes seen in traumatic brain injury than in ischemic stroke and hemorrhage [2]. Regardless of etiology, brain-injured patients are at significant risk of developing healthcare-associated pneumonia, acute respiratory distress syndrome and undergoing prolonged mechanical ventilation, although it is unknown if these complications drive mortality or are epiphenomena of more severe brain injury [2-5].

In the ongoing effort to improve outcomes for these patients, Roquilly and colleagues report a quality improvement (QI) initiative to implement an evidence-based respiratory care bundle in two neuroscience ICUs at a single university medical center [6]. The goal of the initiative was to reduce the duration of mechanical ventilation in brain-injured patients by accelerating extubation readiness. The authors selected four strategies, supported by moderate- to high-quality evidence, on which to base their intervention: lung-protective ventilation, early enteral nutrition, optimization of antibiotic therapy for pneumonia, and protocolized early extubation. Bedside providers were trained on each aspect of this bundle, and the authors compare compliance and outcomes before and after the intervention. Compared with the pre-intervention period, compliance with most bundle elements improved after the intervention, and the mean duration of mechanical ventilation significantly decreased from 14.9 days to 12.6 days.

The impetus for this and many other QI initiatives lies in the fact that clinicians do not consistently use evidence-based practices [7,8]. Barriers to best practice implementation are often multifactorial, but may be grouped into three domains: knowledge (that is, clinicians are not aware of the evidence), attitudes (that is, clinicians are not in agreement with the evidence) and behavior (that is, clinicians face structural or organizational barriers to implementing the evidence) [7]. Performing a needs assessment to identify the barriers in a given situation is essential in order to ensure that a QI intervention targets the most relevant barriers [9]. Targeting the wrong barriers will limit the efficacy of an intervention. If, for example, alcohol-based hand sanitizers are not available in a given hospital, educating providers about their role in hand hygiene will likely not lead to practice change [8].

In this context, a limitation of this study is that the authors do not describe a detailed needs assessment. Instead, they developed an intervention that, although not described in detail, appears to be largely educational, potentially addressing both knowledge and attitudes. Although the intervention appears to have had some benefit, it is noteworthy that major quality gaps persisted even after the intervention. Overall bundle compliance remained only 21% and a majority of patients were still ventilated with tidal volumes above 8 ml/kg. Thus, it is likely that the intervention was not as effective as it could have been. Roquilly and colleagues do not report a needs assessment, which may explain why they focused on only knowledge and attitudes rather than behaviors, potentially reducing the overall impact of the intervention. Additionally, their ICUs may not experience the same challenges to evidence-based practice as the ICUs in this unit, and thus may not experience these same results.

Other limitations of this study include those inherent in before-after study designs. Before-after studies are among the most common study types in QI, yet several biases greatly limit their interpretation. First, patient outcomes tend to improve over time, regardless of any specific intervention. Second, unmeasured co-interventions may also improve outcomes, independent of the intervention under study. Third, the Hawthorne effect, whereby the act of observation improves performance of an observed behavior, may independently cause behavioral change [10]. The Hawthorne effect is powerful, and can be deliberately leveraged to affect outcomes, independent of a given intervention [11].

Fourth, a complex phenomenon termed 'regression to the mean' may lead to false inference that a QI intervention improved outcomes [12]. Regression to the mean occurs wherever there is inherent variability due to random fluctuations. If outcomes are randomly bad during a given intervention, they will 'regress towards the mean' (that is, get better) in the next observation period. In this study, we can assume that during some months the average duration of mechanical ventilation is longer, and in some it is shorter, even in the absence of an overall trend. Since QI interventions tend to be implemented during times of particularly poor performance, regression to the mean is probably a much more common explanation for positive QI studies than we typically recognize. One approach to identifying regression towards the mean is to look at the raw data trends over time. Indeed, in this study the raw data presented in the supplemental appendix are suggestive of this phenomenon.

Despite these limitations, this study provides important evidence that even simple educational interventions can still improve practice, particularly when baseline compliance is low. Yet the low rate of compliance with evidence-based practices both before and after the educational intervention highlights the need for ongoing implementation of QI initiatives, and the fact that, far from requiring perfection, improvements in patient outcomes can result from relatively modest practice changes.

Recommendations

QI interventions may be effectively used to increase compliance with evidence-based best practices and can improve patient outcomes. Performing a needs assessment prior to designing a QI initiative can help maximize efficacy by identifying the barriers most relevant in a given situation. Thoughtful interpretation of before-after studies requires careful consideration of the biases inherent in this methodology.

Abbreviations
CI: Confidence interval; HR: Hazard ratio; QI: Quality improvement.

Competing interests
The authors declare that they have no competing interests.

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Published: 21 February 2014

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doi:10.1186/cc13740
Cite this article as: Elmer and Kahn: **Implementing evidence-based practice in the neuroscience intensive care unit.** *Critical Care* 2014 **18**:303.