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The Conflicting Paradigm of Ventilator Associated Conditions

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In this issue, Cocoros and colleagues present a retrospective, nested case-control study to identify factors associated with pediatric ventilator-associated conditions (VACs) in 6 hospitals (1). Recent definitions for VACs have been proposed in pediatrics, and VACs have been associated with mortality (2).

Retrospective chart review was performed to identify children who met the proposed definition of pediatric VAC: 2 days of stable or decreasing daily minimum FiO₂, followed by an increase in minimum daily FiO₂ of 0.25 for at least 2 days, or 2 days of stable or decreasing minimum mean airway pressure (MAP) followed by an increase in daily minimum MAP of 4 cmH₂O sustained for at least 2 days. VAC cases were matched with up to 4 control patients based on hospital, ICU type (CICU, PICU, NICU), age, congenital heart disease, and number of days of ventilation prior to the VAC diagnosis. A research coordinator blinded to whether the patient met VAC definitions extracted potential VAC risk factors from cases and control patients, concentrating on medications, blood products, and procedures in the two days before and including the day of the VAC diagnosis or index day for the control patients.

In general, patients who met VAC criteria were on higher ventilator support, were more likely to be on continuous sedation, receive neuromuscular blockade and blood products, and were less likely to have sedation interrupted or weaned at the time of VAC diagnosis as compared with controls. VAC patients were more likely to be immunosuppressed, treated with diuretics or stress ulcer prophylaxis, have a positive fluid balance, and be on ECMO as compared with controls. There were slight differences in NICU patients, but many of these variables retained significance in multivariable models.

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The authors conclude that use of neuromuscular blockade, positive fluid balance, blood products, and continuous sedation may be modifiable risk factors for pediatric VAC. Although this study shows an association between multiple factors and deterioration in oxygenation, limitations in the study methodology make it imperative that we do not jump to say that VACs can be prevented by focusing on these areas.

First, it is clear that patients who develop VACs are sicker than patients who don't develop VACs. They are on higher ventilator support, more likely to be immunosuppressed, and have higher degrees of chronic renal dysfunction. Although the authors attempted to adjust for co-morbidities and admission severity of illness, the PIM 2 score does not measure illness severity at the time of VAC diagnosis, which was on average 10 days after admission. It is unlikely that the physiologic derangement seen on ICU admission has relevance on predicting deterioration in oxygenation 10 days after ICU admission. All of the variables found to be associated with VAC are reflective of severity of illness and organ dysfunction (3). The authors did not adjust for these factors at the time of VAC diagnosis, which is important because clinicians are more likely to use neuromuscular blockade, transfusions, and maintain or increase sedation in patients with multiple organ dysfunction on high ventilator support. Most intensive care practitioners do not apply these therapies without reason, but this study does not control for the propensity to use these therapies (4). While reducing unnecessary use and decreasing institutional and practitioner variability in the application of these therapies may be important (4), we should not conclude from this study that this will reduce the incidence of VAC, as there are likely many unmeasured confounding factors.

Second, data from the 2 days prior to and the index day of the VAC were included in consideration of risk factors. Therefore, it is impossible for readers to know whether any of the identified risk factors were prescribed (neuromuscular blockade, blood products, and fluid administration) in response to the VAC on the index day. For example, an immunosuppressed patient with neutropenic enterocolitis has a bowel perforation, develops septic shock, and is transfused and fluid resuscitated. If that patient develops ARDS 6–12 hours later (FiO_2 and MAP are increased and meets criteria for VAC), they may be treated with neuromuscular blockade (5). These may be captured as VAC “risk factors” on the index day, but they are prescribed in response to the condition leading to the VAC. We must separate therapies that are indicated to treat an illness (for which the diagnosis of VAC is a marker, i.e. sepsis-induced ARDS), from potentially unnecessary therapies that may lead to a VAC.

This study highlights the conflicting paradigm of VAC diagnosis and its importance. The CDC criteria are intended to provide an objective assessment of complications of mechanical ventilation, enabling quality reporting and improvement. Unfortunately, it is difficult to discern preventable complications from surrogates for higher severity of illnesses. All of the above risk factors are risk factors for mortality in pediatric and adult critical care, and there is evidence that judicious use of these therapies (i.e. restrictive fluid and transfusion strategies, interruption of sedation) may benefit certain cohorts of ICU patients (6–8). However, these therapies are also life saving for the most critically ill patients – the sickest patients with the highest mortality risk are most likely to require these therapies. We

are left with a difficult conundrum: does an intermediary outcome intended to measure “complications” of mechanical ventilation that may simply be reflective of underlying disease severity add clarity to the complicated field of health care quality assessment? Use of definitions for surrogate measures of quality care, requires appropriate adjustment for “unmodifiable” patient specific risk factors and illness severity to ensure hospitals and providers caring for the most critically ill patients are not “punished” for higher VAC rates. VAC may be a surrogate for mortality, but it is unlikely that existing mortality based severity of illness scores assessed on ICU admission are adequately calibrated to capture this VAC risk. The effect of changing therapies to prevent VAC can only be determined after appropriate adjustment for patient specific factors that affect the likelihood of receiving that therapy, or of having a VAC.

Sincerely,

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