

Abstract

Background: Ventilator-associated pneumonia is a major cause of morbidity and mortality for patients in an intensive care unit. Once present, ventilator-associated pneumonia is known to increase the duration of mechanical ventilation, time in the intensive care unit, and length of hospital stay. Patients with acquired brain injury are commonly admitted to the intensive care unit and considered to be at a high risk for the development of respiratory complications such as ventilator-associated pneumonia, which could potentially impact on the intensive care unit costs and outcomes. Respiratory physiotherapy is often provided to prevent and/or treat ventilator-associated pneumonia in patients with acquired brain injury. The theoretical rationale of the respiratory physiotherapy is to improve airway clearance and enhance ventilation which may reduce the incidence of pulmonary infections and thus ventilator-associated pneumonia, and may in turn decrease the duration of mechanical ventilation, prevent the need for tracheostomy and hence result in reduced costs and shorter hospital stay. Although respiratory physiotherapy may be beneficial in reversing or preventing ventilator-associated pneumonia, to date there are no data concerning the effectiveness of respiratory physiotherapy in patients with acquired brain injury. Hence from an evidence-based perspective, at present there is no justification for the role of respiratory physiotherapy in the management of patients with acquired brain injury in the intensive care unit.

Aim: This two-part, prospective randomised controlled trial aimed to investigate the effect of regular prophylactic respiratory physiotherapy on the incidence of ventilator-associated pneumonia, duration of mechanical ventilation, and length of intensive care unit stay in adults with acquired brain injury, as compared to a control group (Part A). The second part of the study (Part B) randomised those subjects from Part A who developed a ventilator-associated pneumonia into a treatment or control group to establish if the provision of a regimen of regular respiratory physiotherapy influenced the outcome of ventilator-associated pneumonia. Additionally, this study also aimed to provide the first description of the financial costs of respiratory physiotherapy time in providing interventions to patients with acquired brain injury in the intensive care unit and investigated the cost effectiveness of respiratory physiotherapy interventions in decreasing the incidence of ventilator-associated pneumonia, duration of mechanical ventilation and length of intensive care unit stay.

Subjects: 144 adult patients with acquired brain injury admitted with a Glasgow Coma Scale of nine or less, requiring intracranial pressure monitoring, and invasive ventilatory support for greater than 24 hours, were randomised to a treatment group or a control group.

Methods: For subjects randomised to the treatment groups, the regimen of respiratory physiotherapy treatment was repeated six times per 24-hour period and continued until the subject was weaned from mechanical ventilatory support. Each respiratory physiotherapy

intervention of 30 minute duration comprised a regimen of positioning, manual hyperinflation and suctioning. In both Parts A and B, the control group received standard nursing and medical care but no respiratory physiotherapy interventions.

Results: Consent was obtained for 144 subjects, with 72 randomised for treatment in Part A. Part A groups were comparable with respect to demographic variables, with the exception of body mass index and gender distribution. Using intention to treat philosophy, there were no significant differences for incidence of ventilator-associated pneumonia [Treatment Group 14/72 (19.4%) vs. Control 19/72 (26.4%); $p = 0.32$], duration of mechanical ventilation (hr) [172.8 vs. 206.3]; $p = 0.18$], or length of intensive care unit stay (hr) [224.2 vs. 256.4; $p = 0.22$].

For subjects with acquired brain injury receiving this prophylactic regimen of respiratory physiotherapy in the intensive care unit, in an attempt to prevent ventilator-associated pneumonia, the cost of physiotherapy was \$487 per subject. Comparatively the intensive care unit mechanical ventilation bed day cost was \$33,380 per subject. The cost of Part A respiratory physiotherapy time for Treatment Group 1 was 1.7 per cent of the cost of subject's intensive care unit mechanical ventilation bed days.

Thirty-three subjects (22.9%) from Part A developed ventilator-associated pneumonia, and were transferred to Part B and re-randomised, 17 to the Treatment Group 3. Part B groups were comparable with respect to demographic variables. No significant differences were detected in the dependent variables for Part B of the study, with similar duration of mechanical ventilation (hr) [342.0 vs. 351.0]; $p = 0.89$], and length of ICU stay (hr) [384.7 vs. 397.9; $p = 0.84$] noted.

In those subjects with acquired brain injury in whom ventilator-associated pneumonia developed, the regimen of respiratory physiotherapy for the remaining duration of mechanical ventilation following diagnosis of ventilator-associated pneumonia costed an average of \$788. Comparatively the intensive care unit bed day cost for the period of mechanical ventilation was \$43,865. The cost of Part B respiratory physiotherapy time for Treatment Group 3 was 1.8 per cent of the cost of their intensive care unit mechanical ventilation bed days.

Subjects with a ventilator-associated pneumonia were significantly younger, were admitted with a lower Glasgow coma scale, and more likely to have been admitted with a chest injury than subjects without a ventilator-associated pneumonia. Duration of mechanical ventilation and length of intensive care unit stay were significantly increased in subjects with ventilator-associated pneumonia, but length of hospital stay was not significantly different. Significant differences in the costs of respiratory physiotherapy and intensive care unit mechanical ventilation bed day costs were evident between those subjects with ventilator-associated pneumonia as compared to those without ventilator-associated pneumonia. For subjects with ventilator-associated pneumonia, the respiratory physiotherapy time cost was \$1,029 per

subject, compared to \$510 for subjects without ventilator-associated pneumonia. The intensive care unit mechanical ventilation bed day cost for subjects with ventilator-associated pneumonia was \$61,092 per subject, and \$25,142 for those without a ventilator-associated pneumonia, giving an incremental health cost of \$35,950 per episode of ventilator-associated pneumonia. No significant differences were evident in the cost of respiratory physiotherapy as a per cent of the cost of their intensive care unit mechanical ventilation bed days, with findings of 1.4 per cent in those with ventilator-associated pneumonia and 1.1 per cent in those without ventilator-associated pneumonia.

Conclusion: Use of a regular prophylactic respiratory physiotherapy regimen comprising of positioning, manual hyperinflation and suctioning, in addition to routine medical and nursing care, did not appear to prevent ventilator-associated pneumonia, reduce length of ventilation or intensive care unit stay in adults with acquired brain injury. Furthermore, in those acquired brain injury subjects with ventilator-associated pneumonia, regular respiratory physiotherapy did not appear to expedite recovery in terms of reducing length of ventilation or intensive care unit stay.

It can be concluded from the findings of this study that the presence of ventilator-associated pneumonia has a significant influence on morbidity and costs in subjects with acquired brain injury. Whilst statistically significant results were not found with clinical variables, it is suggested that the provision of a prophylactic respiratory physiotherapy regimen costing \$487 per subject is a worthwhile investment in attempts to avoid the incremental health cost of \$35,950 per episode of ventilator-associated pneumonia. In subjects with ventilator-associated pneumonia it is concluded that the cost of respiratory physiotherapy would not appear to be justified in attempts to reduce the duration of mechanical ventilation.