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Exposure to reprocessed single-use tracheal suction catheter and ventilator-associated pneumonia risk: A preliminary, single unit–based, matched case-control study☆,☆☆

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ABSTRACT

Purpose: The reuse of reprocessed single-use suction catheter for suctioning an amount of tracheal secretion among orally intubated, mechanically ventilated patients, who are at risk of acquiring ventilator-associated pneumonia (VAP), has not been thoroughly investigated. This study aimed to examine the association between the repetitive use of reprocessed single-use suction catheter and VAP development.
Materials and methods: A preliminary, single unit–based investigation was designed as matched case-control study to extract data from hospital's existing 5-year VAP report and inpatients' clinical records. Cases were defined as patients, who developed VAP between December 2009 and October 2014. Controls were defined as patients, who had no evidence of VAP during study period. Six hundred eight controls were frequency matched to 152 cases in 4:1 ratio. Chart-extracted clinical data were stratified and included for conditional logistic regression analysis.
Results: Analysis showed a significant association between reprocessed single-use tracheal suction catheter exposure and VAP development [odds ratio (OR), 3.64; 95% confidence interval (CI), 2.47-5.35]. A statistically significant increase in VAP risk was found in male intubated patients (OR, 5.33; 95% CI, 1.22-23.3), who are older than 60 years (OR, 8.08; 95% CI, 1.47-44.3), had severe Glasgow Coma Scale scores (OR, 8.27; 95% CI, 1.83-37.3), and received mechanical ventilatory support for more than 96 hours (OR, 9.67; 95% CI, 1.98-47.1). In addition, a statistically significant increase in VAP risk was seen in intensive care unit, where reprocessed tracheal suction catheter changes were routinely provided (OR, 16.0; 95% CI, 2.40-106.7) and unsatisfactory hand hygiene percentage compliance was observed (OR, 8.40; 95% CI, 1.60-44.1). Ventilator-associated pneumonia proportion analysis revealed a higher number of unknown exogenous VAP among exposed cases compared to nonexposed case patients (32.2% vs 13.8%; OR, 2.31; 95% CI, 1.31-4.05; $P < .005$) that were mechanically ventilated for more than 96 hours (62.5% vs 25.7%; OR, 3.62; 95% CI, 2.40-5.46; $P < .0001$).
Conclusions: This current study suggests that exposure to reprocessed single-use tracheal suction catheter may predispose orally intubated, mechanically ventilated patients in developing VAP. Further research studies are recommended to validate these findings.
Implications for clinical nursing practice: The estimated VAP risk of this traditional-based practice is essential to provide strong basis for infection control measures to reduce, if not totally eliminate, VAP.

1. Introduction

Ventilator-associated pneumonia (VAP) is a pressing concern in intensive care units (ICUs) because of its significant impact on patient's morbidity and mortality [1] that is associated with prolonged hospital length of stay and high health care costs [2-4]. *Ventilator-associated pneumonia* is defined as a subtype of pneumonia that occurs up to 48 hours [5] after initiation of mechanical ventilation in patients who had

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no preexisting lung infection at the time of intubation [6,7]. Furthermore, this condition is associated with numerous risk factors that need to be evaluated. Identifying other potential risk factors is essential to improve the wide-range preventive measures against this most preventable type of health care–associated infection.

Recent and early evidence has identified various risk factors for VAP in ICU complex. These risk factors can be classified as host-related or patient-related, treatment-related, personnel-related, and device-related risk factors [8,9]. The association between these risk factors and VAP has been extensively investigated [8]. For instance, a substantial number of seminal studies have shown a positive association between patient- or host-related risk factors and VAP. These patient- or host-related risk factors include extreme age [10], male sex [11], decreased level of consciousness [12,13], patient's body positioning, and concurrent medical conditions including pre-existing pulmonary conditions [9,13,14], immunosuppression [8,9], and multiorgan system failure [10]. Others include bacterial contamination and subsequent aspiration of pooled secretions [9]. In addition, early research studies have reported an increased VAP risk associated with exposure to treatment-related risk factors. These include medications, number of intubation episodes, and prolonged mechanical ventilation [9,15,16]. Association between personnel-related risk factors and development of VAP has also been examined. Thus, failure to perform the standard universal precautions, such as hand washing and proper use of gloves and other protective equipment [9], can increase patient's risk in acquiring VAP.

In particular, device-related risk factors, such as endotracheal tube, ventilator circuits, nasogastric or orogastric tubes, and low intracuff pressures of less than 20 cm H_2O [9,17], are recognized as 4 of the major contributors to VAP; however, evidence concerning the association of another potential device that could increase patient's risk in acquiring VAP has not been carefully examined. There is still uncertainty on VAP risk associated with the exposure to reprocessed tracheal suction catheter. However, an earlier randomized controlled trial in pediatric ICU suggested that reusing disposable suction catheters in the same pediatric patient for up to 24-hour period is both safe and cost-effective [18]. In addition, some literatures recommend the reuse of tracheal suction catheter provided that the cleaning and disinfection processes are effective and the structural or functional integrity of the catheter is maintained [19,20]. In contrast, a recently conducted study has reported a 2-fold reduction in the incidence of VAP after identification and modification of unsafe procedures related to the reuse of conventional tracheal suction catheter [21]. Although early and recent evidence has reported contradictory claims pertaining to safety and efficacy of reusing conventional tracheal suction catheter to the same patients, the accurate estimate of the magnitude of VAP risk associated with this device has been inconclusive.

The paucity of literature relating to VAP risk associated with exposure to reprocessed single-use tracheal suction catheter can be attributed to the increasing number of nurses who translate evidence-based practice guidelines for VAP prevention. These recent guidelines, concerning open suctioning in adult patients, recommend that tracheal suction catheters should not be reused routinely; instead, a brand new sterile suction catheter should be used for each episode of tracheal aspiration [22-24]. An accumulating number of ICU that favors the closed suction system (CSS) over open suction system (OSS) also adds to the paucity of information [25]. In ICU setting, CSS and OSS are 2 methods that are commonly used for endotracheal suctioning procedures. In OSS, this procedure involves disconnecting the intubated patient from the mechanical ventilator and uses a single-use conventional suction catheter during each episode of endotracheal aspiration. On the other hand, CSS uses a multiuse specialized in-line suction catheter without disconnecting the patient from mechanical ventilator during episode of endotracheal suctioning procedures. However, in a setting where resources are limited and there are no best policies and clinical practice guidelines for airway management or both, nursing practices regarding the reuse of reprocessed conventional suction catheter still persist. In this study, *reprocessed tracheal suction catheter* is defined as the reuse of a single-use conventional suction device that has been subjected to additional processing using disinfectant solution. This traditional-based practice as well as the conflicting and insufficient evidence have drawn our attention and motivated this study to investigate the association between exposure to reprocessed tracheal suction catheter and VAP development. Our aim is to provide an initial VAP risk estimates associated with this device. Such investigation is essential to provide a strong basis for clinical recommendations to improve nursing practice and achieve best patient outcomes for orally intubated, mechanically ventilated ICU patients.

2. Methods

2.1. Design

This preliminary, single unit–based investigation was designed as matched case-control study. Matching was done to allow estimation of the exposure risk, eliminate potential confounders, reduce bias, and gain statistical efficiency. To address potential confounders that may inflict bias in this study, we individually matched each case to 4 controls based on study eligibility criteria, their respective demographic and clinical characteristics, and VAP prevention strategies. Such process is necessary to ensure similar distributions across potential confounders that may affect study's internal validity. Subjects' demographic profile, such as age, including clinical characteristics and VAP prevention strategies were carefully assessed because these variables are known to be associated with VAP development. To address statistical efficiency, a total of 608 controls were frequency matched to 152 cases. This 4:1 ratio of controls per case is epidemiologically acceptable because of the limited number of VAP cases involved. Such matching may increase efficiency of VAP estimates by providing smaller SEs and narrower confidence intervals (CIs). In addition, matching or counter matching with 2 or more controls provides higher statistical power to detect interaction between variables [26].

2.2. Setting and samples

To investigate association between exposure to repetitive use of reprocessed single-use tracheal suction catheter and VAP risk, we performed a preliminary matched case-control study among 760 patients on mechanical ventilation for more than 24 hours in an adult ICU of 150-bed general hospital. The hospital has an airway management protocol including the reuse of reprocessed tracheal suction catheters for low-risk patients; however, upon reviewing the protocol document, we found out that the contents were not up to date and the manner of designing the policy document was not based on current and best available evidence. Nurses working in this setting repetitively use reprocessed single-use tracheal suction tubes for the same patients at routine intervals. Routine or scheduled changes of reprocessed single-use tracheal suction tubes usually occur every 12-hour shift. However, when these suction catheters lost its functional and structural integrity or considered to be totally soiled, the assigned ICU nurse independently used non-scheduled tracheal suction catheter changes where reprocessed suction tube is replaced with new sterile suction catheter. The disinfection process of suction tubes involved thorough mechanical cleaning with brush, detergent, and hot water for rinsing. After cleaning process, the suction tubes is flushed using syringe filled with 3% hydrogen peroxide and placed in a sterilized container jar with same disinfectant solution to soak for a minimum of 20 minutes and set in a dry sterile container jar. Before each catheter device is used to the same patient, the reprocessed suction tube is flushed and rinsed with sterile water. Based on the current practice, we took this opportunity to evaluate the impact of reusing reprocessed single-use tracheal suction catheters in intubated ICU patients under supported mechanical ventilation.