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A European care bundle for prevention of ventilator-associated pneumonia

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Abstract *Background:* One recent approach to facilitating guideline implementation involves the use of care bundles. *Methods:* This document presents a care bundle package addressing VAP prevention in an attempt to promote guideline-compliant practices. Uniquely, the development of these care bundles used a formalised methodology to assess the supporting data, based on multi-criteria decision analysis. *Results:* The resulting VAP care bundles for prevention were: non-ventilatory circuit changes unless specifically indicated, alcohol hand hygiene, appropriately educated and trained staff, incorporation of sedation control and weaning protocols into patient care, and oral care with clorhexidine. *Conclusion:* Adoption of these care bundles should rationalise VAP prevention practises and improve outcomes, such as length of stay.

Keywords Ventilator-associated pneumonia · Care bundles · Prevention

Abbreviations

VAP	Ventilator-associated pneumonia
FASTHUG	Feeding analgesia sedation thromboembolic ulcer glucose
ICU	Intensive care medicine
HAP	Hospital-acquired pneumonia
MCDA	Multi-criteria decision analysis
CPIS	Clinical Pulmonary Infection Score
ATS	American Thoracic Society
IDSA	Infectious Disease Society of America
BSAC	British Society for Antimicrobial Chemotherapy
SHEA	Society of Healthcare Epidemiologists of America

Introduction

Ventilator-associated pneumonia (VAP) is a serious health care-acquired infection that occurs in up to about 30% of mechanically ventilated patients [1]. VAP is defined as pneumonia occurring more than 48 h after the initiation of mechanical ventilation [2]. The occurrence of VAP increases patient mortality to an estimated 20–55% and increases the duration of hospital stay by approximately 6 days [1, 3]; cost has been estimated to be above $40,000 [4].

One recent approach to facilitating guideline implementation involves the use of care bundles. A care bundle identifies a set of key interventions from evidence-based guidelines that, when implemented, are expected to improve patient outcome [5, 6]. The aim of care bundles is to change patient care processes and thereby encourage guideline compliance. Care bundles have been used in a number of clinical settings. Pronovost et al. [7] described a care bundle that significantly reduced the incidence of catheter-related bloodstream infections within 3 months of implementation (from 2.7 to 0 infections per 1,000 catheter days), with improvement being sustained over an 18-month assessment period.

The care bundle approach has also been investigated in the VAP setting. The 100k Lives Campaign (http://www.ihi.org) defined a four-component ventilator bundle [8] designed to reduce the incidence of clinical complications in patients with VAP. In a large multi-centre study compliance with the care bundle was associated with a lower incidence of VAP, with units achieving ≥95% bundle compliance experiencing a 59% reduction in VAP rate [8]. Smaller studies, using the same care bundle, have reported reductions in the length of time patients require mechanical ventilation and the length of ICU stay [9, 10]. Other reports, using slightly different intervention packages, have also shown compliance to be associated with a reduction in the incidence of VAP [11–13]. Though these care bundle packages have been shown to be clinically effective, their impact may be limited because the interventions prioritised are not always those identified by the evidence-based treatment guidelines. This publication aims to redress these limitations by developing a comprehensive care bundle package using a formalised evidence-based methodology.

Methods

VAP care bundle development methodology

This VAP care bundle was developed by a pan-European committee of 12 participants representing different disciplines (microbiology, infectious diseases, infection control, epidemiology, nursing, pneumology and critical care). It was based on the findings of a previous review of the hospital-acquired pneumonia (HAP) and VAP guidelines across Europe [14]. The methodology used during development of the VAP care bundle comprised multi-criteria decision analysis (MCDA), an established technique that supports decision making when numerous and conflicting evaluations are being assessed [15]. Multi-criteria decision analysis, sometimes called multi-criteria decision making, is a discipline aimed at supporting decision makers who are faced with making numerous and conflicting evaluations. MCDA aims at highlighting these conflicts and deriving a way to come to a compromise in a transparent process. Unlike methods that assume the availability of measurements, measurements in MCDA are derived or interpreted subjectively as indicators of the strength of various preferences. Preferences differ from decision maker to decision maker, so the outcome depends on who is making the decision and what their goals and preferences are.

The MCDA method used to develop the VAP care bundle followed a recognised process of "weighting and scoring"; more details of this process are given below. The model is described by a mathematical equation (Criteria A Weight × mean value + Criteria B Weight × mean value + ⋯), which generates an average weighted score for each care bundle intervention being assessed. Details of the equation and process are detailed elsewhere [15]. The process identifies nine criteria (Table 1) against which interventions are assessed. The criteria are weighted to demonstrate their relative importance to each other, and the interventions are scored to reflect their performance against each criterion. These weights and scores are used to generate a weighted benefit score for each intervention. By involving numerous participants, a range of opinions is illustrated in the weighting and scoring. Contributors were invited by the chairman based on publications and diversity of nationalities, and were multi-disciplinary. MCDA rates the concordance of opinion on each intervention, with a high level of concordance resulting in a high score and adding weight to the applicability of a particular recommendation.

VAP interventions considered for inclusion in the care bundle

A comprehensive list of interventions was produced based on those discussed in ten HAP/VAP guideline documents published in Europe since 2002 [12]. Suitable interventions for VAP prevention consisted of: semi-recumbent patient positioning, sedation vacation and use of a weaning protocol, strict hand hygiene using alcohol, use of non-invasive ventilation, oral care with chlorhexidine, no ventilatory circuit tube changes unless specifically indicated, appropriately educated and trained staff, cuff pressure control at least every 24 h, enteral

Table 1 Weighting of the criteria used to assess the applicability of VAP interventions for inclusion in the care bundle

Criterion	Mean weighting score
Ease of implementation within a care bundle package How easy it will be to implement the element of the care bundle?	18
Clinical effectiveness against VAP and the likely benefit Is there evidence that the intervention is clinically effective in its impact upon VAP? How big a benefit does the intervention produce?	16
Strength of clinical evidence concerning the intervention How good is the evidence that demonstrates the benefit of the intervention? Is all the evidence of the same standard? Are the study results relevant across the range of health systems?	15
Consistency of findings from different studies Are the findings of these studies consistent? Do the studies demonstrating benefit come from a range of health systems?	9
Generalisability to different health care systems and settings Is the recommendation acceptable across different health care systems?	9
Volume of clinical evidence supporting the intervention How many studies are available to show that benefit exists from the recommendation? Do the studies demonstrating benefit come from a range of health systems?	8
Cost effectiveness of the intervention Is the intervention cost effective? How cost effective is the intervention across the different health care systems?	7
Coverage in all VAP patients Is the benefit uniform across the complete VAP group of patients?	5
Impact on the health care system as a whole Think about the impact (positive or negative) on other services, e.g. will this intervention increase/decrease work load for other services (can this other part of the service deliver?), e.g. laboratories/imaging	3

feeding, use of heat moisture exchangers, avoidance of stress ulcer prophylaxis, use of sucralfate where stress ulcer prophylaxis is required, unit-specific microbiological surveillance, use of endotracheal tubes and a restricted transfusion trigger policy and selective digestive tract decontamination.

Definition and weighting of the assessment criteria

Nine assessment criteria were defined and independently weighted by the 12 committee members according to their relative importance to each other. The criteria and their definitions are provided in Table 1 along with the mean weights attributed to each criterion. Average weight was obtained by voting on the importance of each criterion by 12 contributors within a range of 0–20. The most important criteria were perceived to be ease of implementation, clinical effectiveness and the strength of the supporting data, all of which are key to optimising acceptance of any care bundle package.

Scoring of VAP interventions

The meeting participants individually scored each VAP intervention on a 10-point scale assessing its performance against each criterion. The individual scores for each intervention were then weighted using each criterion's weight as specified in Table 1. The weighted scores for each participant were then combined to generate a mean weighted score for each intervention, and the interventions were then ranked based on these scores. An example is provided as Supplementary electronic material. To check that agreement had been reached, participants were asked to review the ranked list and to agree that it reflected a consensus opinion of preference for interventions.

Role of the sponsor

Wyeth International had no control over and made no comments about the study design or the methods chosen, analysis of results, interpretation of findings or drafting of the paper. One representative attended, observing and listening, without participation in the investigators' discussions.

Results

The overall ranking of the VAP prevention intervention scores is presented in Fig. 1. An evident breakpoint in the scores occurred after the top five interventions and, as such, those most appropriate for inclusion as VAP care bundle recommendations were as follows:

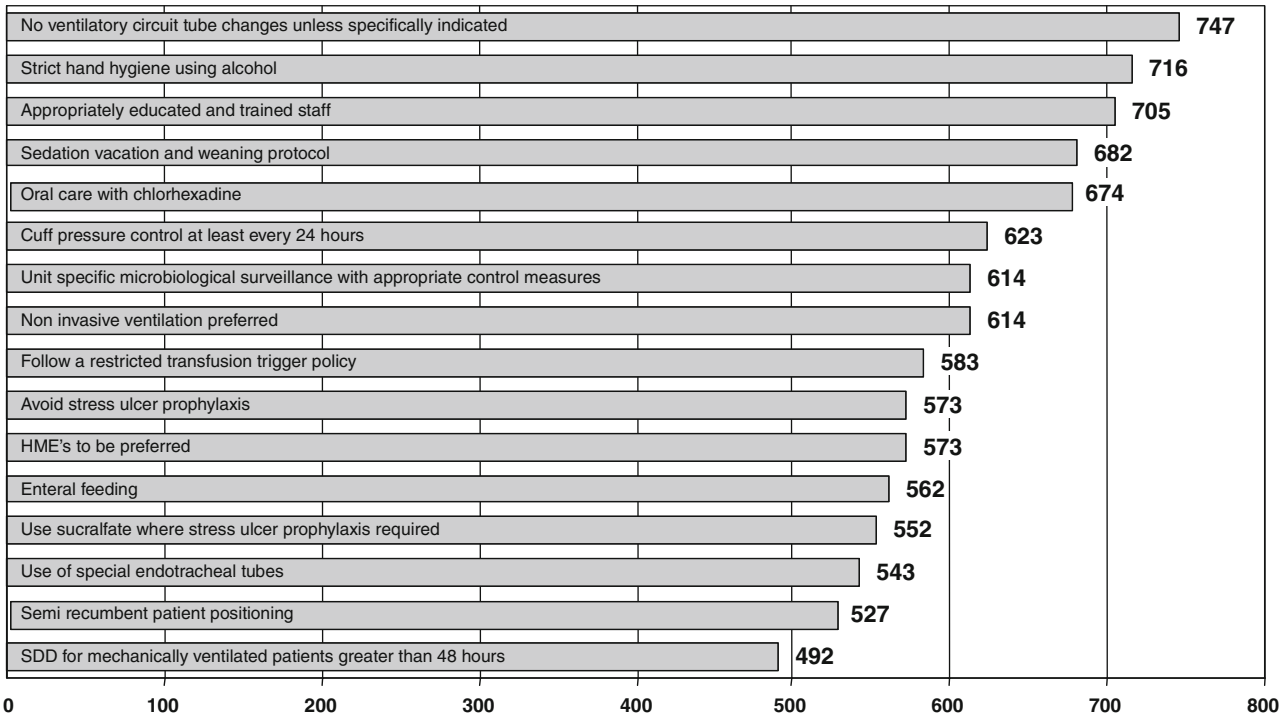

Fig. 1 Ranking of VAP prevention interventions. *SDD* selective decontamination of the digestive tract

- Not implementing ventilatory circuit changes unless specifically indicated [16–18].
- The use of strict hand hygiene using alcohol [19–23].
- The use of appropriately educated and trained staff [24–27].
- The incorporation of sedation vacation and weaning protocols into patient care [27–30].
- Oral care with chlorhexidine [31, 32].

Interventions such as the one stipulating good hand hygiene comprise general infection control procedures and should already be in place under national and local initiatives [33–35]. However, their inclusion in the VAP care bundle represents an opportunity to audit compliance and optimise the quality of hand hygiene practises. In addition, the requirement not to change ventilatory circuits unless indicated should represent an accepted care practice; however, the inclusion of this established intervention remains appropriate by emphasising its importance. The VAP prevention care bundle can be considered as emphasising certain generic infection control measures and adding other interventions that are specific to VAP.

Care bundles generally specify interventions that can be applied to the care of an individual patient at a particular time and place, ensuring their deliverability and accessibility. However, the intervention specifying the need for appropriately educated and trained staff does not fit this definition. Appropriate education/training is a key requirement, but may be better viewed as a tool to be built into the VAP care bundle implementation methodology.

Discussion

This document represents the first VAP prevention care bundle based on MDSA and is designed to be adaptable to the variable VAP treatment settings. Most of the interventions recommended in the care bundle packages presented here are broadly consistent with the comprehensive HAP/VAP management guidelines published by the British Society for Antimicrobial Chemotherapy [36] and the American Thoracic Society/Infectious Diseases Society of America [37]. However, there are some notable exceptions:

- The BSAC HAP guidelines graded their recommendations from A–D, with a Grade A recommendation being supported by the best quality evidence. In general the HAP prevention and treatment interventions specified in this document were ranked as Grades A or B. In the BSAC HAP prevention guidelines, hand hygiene practises were recommended as a good practise point as the supporting evidence was not specific to the treatment of HAP or VAP. The BSAC guidelines did not address oral care with chlorhexidine.

- In the ATS/IDSA guidelines most of the interventions recommended here were given a high or moderate recommendation based on the available evidence. However, though it was noted that the frequency of ventilator circuit changes does not impact on the incidence of VAP, no formal guidance was given on this point. In addition, oral care with chlorhexidine was not recommended based on a perceived lack of supporting evidence. Newer updates use the GRADE system approach, which also includes additional considerations besides the strength of evidence, including applicability and costs.

A number of different care bundles have previously been implemented to prevent VAP. The most commonly used is supported by the 100k Lives Campaign and comprises interventions of: peptic ulcer disease prophylaxis, deep vein thrombosis prophylaxis, head of the bed elevation and sedation vacation. This care bundle has reported considerable success in reducing the incidence of VAP [8, 38]. Despite the demonstrated efficacy of this care bundle, certain recommended interventions are not strongly supported by the available evidence base or do not directly target VAP. As such we acknowledge that in some cases certain bundle elements may be medically contra-indicated. Other care bundles focusing on the management of ventilatory equipment have reported variable effectiveness with respect to reducing the incidence of VAP [12, 13, 40, 41]. The MCDA method used to develop the VAP care bundle followed a recognised process of "weighting and scoring" that was not used by the IHI bundle.

The implementation of care bundles aims to promote beneficial changes in care processes [6]. Adoption of care bundle packages requires that local units define suitable assessment parameters for each intervention, the details of which should be customised according to the local treatment setting. It should be emphasised that the interventions need to be viewed as a package, with compliance being assessed for the bundle as a whole. As such, non-completion of a single intervention equates to failure of the whole bundle at a particular assessment. The goal for prevention care bundles is to routinely achieve 100% compliance on a per patient per day basis.

The details of how best to implement particular interventions should be tailored to the local situation, with practical details being specified for each intervention to ensure deliverability [39], and should encourage participation from all individuals involved in patient care [38–41]. Specific interventions requiring further definition include:

- Hand hygiene procedures should be modified when protective gloves are used to stipulate glove changes between patient contacts [23].

Each intervention needs to be readily assessable, and appropriate measurement parameters should be specified [39]. It is important to use simple measures that can be monitored for every patient and formulated into a simple document. The interventions should be readily assessable in terms of a yes/no answer to the question 'Was the intervention performed during a particular assessment period?' If the intervention was considered but there was a valid reason for not implementing it, that parameter can be classified as an exclusion rather than non-compliance. Ideally one individual should be able to assess compliance simply and quickly, without input from numerous sources. Example assessment tools include daily goals sheets, pocket guidance cards and compliance checklists [7, 42] that serve as a both a reminder to perform the intervention and as a detailed record of the patient care process [13].

Effective auditing of care bundle compliance facilitates the generation of real-time data, and implementation is highly dependent on the audit and feedback process [38]. This allows rapid feedback to staff as to whether their performance is in line with the care bundle and how it impacts on the quality of patient care [39], and this helps to promote the cultural changes required to attain uniform and optimal care processes [42]. Generating reliable data also allows improvements in care processes to be correlated with patient outcome measures to identify clinical benefits.

The evidence base used during the development of these care bundle packages was derived from European HAP guidelines produced between 2002 and 2006 [14]. Since 2006, various new studies have been reported that either support or contradict the previous data for certain interventions. New data were not considered after the intervention ranking process had been completed (April 2008), and considerable discussion centred on the omission of certain of these lines of evidence. However, it was of note that new data generally pertained to more controversial interventions and that these parameters did not score highly during the ranking process. This finding serves to further validate the use of MCDA for identifying key interventions for inclusion in these care bundles, as parameters for which the evidence base was weak or controversial ranked poorly. Identifying interventions is generally accepted as being able to improve patient care processes, which is important in promoting widespread acceptance of a care bundle package. Numerous studies have shown the care bundle approach to be feasible and effective in improving both patient care processes and patient outcome [7]. It has been noted, however, that the availability of a number of different care bundles addressing the same condition is likely to confuse practitioners and confound implementation [43–47]. Interestingly, a recent report from SHEA is consistent with our variables in the core elements of a preventive bundle. Interestingly, our report did not retain semi-recumbency because it did not have a high enough priority in the score (Fig. 1). Anyway, the effect of the proposed interventions in changing outcomes and

processes of care needs further validation in a prospective study, which is ongoing.

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Conflicts of interest statements RM has received speaker honoraria from Astra Zeneca and Wyeth; JR has received speaker honoraria and/or research funding from Pfizer, Johnson & Johnson, Merck, Astra Zeneca and Wyeth. He is a member of the advisory boards of Johnson & Johnson, Pfizer and Wyeth Pharmaceuticals; MS has received speaker honoraria and/or research funding from Pfizer, Roche Diagnostics, Becton-Dickinson, Chiron-Novartis, Wyeth, Astra Zeneca, Johnson & Johnson, GeneOhm and BioMérieux. He has served on advisory boards for Pfizer, Chiron-Novartis, Wyeth, Johnson & Johnson, Glaxo-SmithKline and 3M, and is a member of the Glaxo-SmithKline-supported Belgian Sanford Guide Working Party on Antimicrobial Therapy and their Infectious Diseases Advisory Board; JC serves on the Nektar advisory board and has received speaker honoraria from Pfizer, Astra Zeneca, Wyeth, Pharm-Olam, and Brahms; GC has received speaker honoraria from Pfizer, Wyeth, Merck and Glaxo-SmithKline; HL has received speaker honoraria research funding and/or consulting fees from Bayer, Pfizer, Sanofi-Aventis, Wyeth, Johnson & Johnson, Intermune, and Daiichi and Astellas; HG has received speaker honoraria and/or research funding from Wyeth, Glaxo-SmithKline, Pfizer, Merck and Sanofi-Aventis; PD has received speaker honoraria and/or research funding from Pfizer, Wyeth, Glaxo-SmithKline and Boehringer Ingelheim, and is a member of the Johnson & Johnson global anti-infective advisory board; AO, HE, DC and KD have no conflicts of interest to declare. This study, including working meetings and secretarial assistance, was supported by an unrestricted grant from Wyeth International.

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