Targeted literature review:

What are the key infection prevention and control recommendations to inform a minimising ventilator associated pneumonia (VAP) quality improvement tool?

Review of existing infection prevention and control quality improvement tool elements to ensure ongoing need and fitness for purpose

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HPS ICT Document Information Grid	
Purpose:	To present a review of the evidence to inform the content of HAI related quality improvement tools for NHSScotland. This supports the functions of HPS in developing effective guidance, good practice and a competent workforce and translating knowledge to improve health outcomes.
Target audience:	All NHSScotland staff involved in patient care activities where interventions can lead to HAI, particularly those interventions that can cause bloodstream infections such as line insertion. Infection prevention and control teams in NHS boards and other settings. Partner organisations particularly Healthcare Improvement Scotland and National Education for Scotland to ensure consistent information across similar improvement documentation.
Description:	Literature critique summary and presentation of key recommendations to inform HAI quality improvement tools, based around a framework that evaluates these against the health impact contribution and expert opinion/practical application.
Update/review schedule:	Every three years; however if significant new evidence or other implications for practice are published updates will be undertaken.
Cross reference:	Standard Infection Control Precautions Policies in the National Infection Prevention and Control Manual. http://www.nipcm.hps.scot.nhs.uk/ Data on HAI incidence and prevalence and process compliance data. Implementation support from Healthcare Improvement Scotland and/or others, education and training support from National Education Scotland. http://www.nes.scot.nhs.uk/education-and-training.aspx

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1. Executive summary

Ventilator associated pneumonia (VAP) is a leading cause of healthcare associated infection (HAI) within intensive care units (ICUs) and results in a high level of morbidity and mortality.[1;2] VAP can be caused by: aspiration of microorganisms from the oropharynx or stomach; contamination within the ICU environment, particularly immediate environment use of contaminated equipment, water, hands of healthcare workers; or via humidified unsterile water or microorganisms from other sites of infection/colonisation.[1-3] Risk factors which can increase the risk of VAP include prolonged duration of mechanical ventilation, patients lying in a supine position, increased gastric pH, and contaminated environment and equipment.[1-3]

The recommendations result from the review of scientific evidence and the process of assessing these within a health impact and expert opinion framework. The key recommendations and their scientific grade of evidence for a ventilator associated pneumonia quality improvement tool now are:

Key recommendations:

- Review all patients sedation each day and, if appropriate stop (Category B)
- Assess all patients for weaning and extubation each day (Category B)
- Avoid supine position; aim to have patient head up at least 30-45º (Category A)
- Consider using chlorhexidine as part of daily mouth care (Category A)
- Use subglottic secretion drainage in patients likely to be ventilated for more than 48 hours (Category A)

* to find out more information on the categories of these recommendations see **Appendix 2.**

Note: this review identifies the resulting key evidence based recommendations and does not aim to identify all the elements of a checklist covering ventilator associated infection. Other locally available procedures and tools should address all steps related to care of ventilated patients.

2. Aim of the review

To review the evidence base with a view to seeking expert opinion, to ensure that the key recommendations included within a quality improvement tool are the most critical for improving and streamlining practices related to the minimisation of ventilator associated pneumonia (VAP).

3. Background

3.1 The problem

Mechanical ventilation can be a life saving necessity for critically ill patients. However, this intervention can result in VAP, which is the leading cause of HAI within ICUs and associated with a high level of morbidity and mortality.[1;2] VAP can be caused by: aspiration of microorganisms from the oropharynx or stomach; contamination within the ICU environment, particularly the immediate patient environment, use of contaminated equipment, water, hands of healthcare workers or via humidified unsterile water or microorganisms from other sites of infection/colonisation.[1-3] Risk factors which can increase the risk of VAP include prolonged duration of mechanical ventilation, patients lying in a supine position, increased gastric pH.[1-3]

3.2 Out of scope for this review

This literature review does not address any issues specific to:

- Paediatric patients
- Specific care actions related to clinical management of patients (even if it is thought there may be an association with infection prevention)

3.3 Assumptions

There are a number of aspects related to healthcare delivery that were not within the remit of this review as it is clear that they are the responsibility of other professionals. These include that:

- Staff are appropriately trained and competent in all aspects of the management of mechanically ventilated patients preferably using an approved educational package.
- The overall approach to the delivery of healthcare is supported by patient safety and improvement approaches and organisational readiness.

4. Results

The recommendations presented are based on a review of the current evidence. The previous recommended criteria within the HPS bundle and checklist were used as a basis for the question set in **Appendix 1**. The methodology for this is described within **Appendix 2**.The results of the initial rapid search and review of the evidence is presented in **Appendix 3**.

4.1 Review of evidence base

4.1.1 Final recommendation - Review all patients sedation each day and, if appropriate stop (Category 1B)

Mechanical ventilation within intensive care is a life saving process when needed, however the risk of VAP has been shown to be directly associated with its duration and a cumulative incidence of 10 to 25% has been reported.[4] The sedation required can result in a number of adverse effects including prolonged intubation.[5] Interruption of sedation and 'wakening trials' have been shown to reduce the overall duration of mechanical ventilation needed without an adverse effect on patient safety.[5] It is therefore consistently recommended within current evidence based guidelines that there should be a daily review of sedation and interruption unless clinically contraindicated.[1;6;7]

4.1.2 Final recommendation - Assess all patients for weaning and extubation each day each day (Category 1B)

The duration of intubation is associated with an increased risk of VAP; therefore one of the simplest ways of reducing patients' risk is to ensure that they are extubated as soon as clinically possible. The Society for Healthcare Epidemiology of America (SHEA) guidelines recommend a daily assessment of readiness to extubate (spontaneous breathing trials) in patients without contraindications; this strategy has been found to be associated with extubation 1-2 days earlier compared to usual care.[7] In addition, both the SHEA and APIC guidelines recommend that along with review of sedation there should be a review of readiness to wean and this should be carried out on a daily basis.[1;7] The SHEA guidelines note that patients are 'more likely to pass a spontaneous breathing trial if they are maximally awake'.[7] The possibility of combining the sedation and ventilator weaning protocols has been reported elsewhere, however, it is not within the remit of this review to comment on this approach.[5;7]

4.1.3 Final recommendation - Avoid supine position; aim to have patient head up at least 30-45º (Category 1A)

This recommendation to avoid a supine position is consistent across all identified sources of evidence based guidance.[7;8] The recommended angle of elevation is generally stated as 30-45º (unless contraindicated).[1;6] A meta-analysis of RCTs evaluating the impact of the patient position on the incidence in VAP reported that an angle of 45º rather than 15-30º was associated with a significantly lower incidence of VAP.[9] Similarly, a recent (2016) Cochrane systematic review found evidence that a 30-60° angle significantly reduced the risk of VAP compared to a 0-10° angle.[10] The NICE patient safety guidance reports that obtaining an angle of 45º in patient positioning was difficult in practice, with an angle of around 30º being more practical.[8]

4.1.4 Final recommendation – Consider using chlorhexidine as part of daily mouth care (Category 1A)

The use of chlorhexidine as part of daily oral hygiene has been widely shown to be an effective way of reducing VAP in mechanically ventilated patients. This recommendation is consistent across all the current identified sources of evidence based guidance and is further underpinned by a number of systematic reviews and meta-analyses.[1;6;7;11-17]

However, there is increasing evidence that chlorhexidine may only be of benefit to certain patient groups, specifically cardiac surgery patients.[11;16;18] Klompas et al reappraised the available evidence in a meta-analysis which stratified cardiac and non-cardiac patients, no reduction in VAP was found in the non-cardiac patients whereas a significant reduction was observed in cardiac patients.[18] A similar result was found by Longti et al, their meta-analyses found that VAP reduction was only significant in cardiac patients; however one of their included studies did find that VAP was significantly reduced in non-cardiac patients when 2% chlorhexidine was used.[16]

There is also some inconsistency in the identified literature regarding the optimum concentration of chlorhexidine, recommended concentrations ranged from 0.12-2%.

Further studies are required to ascertain whether oral hygiene using chlorhexidine is beneficial to all patient groups as well as the optimum concentration; however, the use of chlorhexidine should be considered unless contraindicated.

4.1.5 Final recommendation - Ensure that subglottic secretion drainage is used in patients likely to be ventilated for more than 48 hours (Category A)

A recent systematic review and meta-analysis has found that subglottic secretion drainage systems were associated with a significantly reduced risk of VAP.[19] The use of subglottic secretion

drainage systems (SSDS) is also recommended by evidence based guidelines and may reduce incidence of VAP by up to 55%.[7] The SHEA guidelines recommend the use of subglottic secretion drainage if patients are likely to require ventilation for more than 48 or 72 hours;[7] the 2008 DH High Impact Intervention recommends the use of a tracheal tube (endotracheal or tracheostomy) which has a subglottic secretion drainage port if the patient is expected to be intubated for >72 hours.[6] In addition, one RCT was identified that assessed the impact of SSDS and semi-prone (30-45°) patient positioning, alone and in combination, on VAP prevention. The study found that both interventions significantly reduced VAP rates but that when used in combination the effect was significantly greater than using either intervention alone.[20]

4.2 Review of additional evidence based on initial search findings

4.2.1 Peptic ulcer prophylaxis

There is evidence to show that the risk of VAP increases with increased gastric pH as this is associated with greater colonisation with pathogens.[1] As a result the DH High Impact Intervention includes recommendations that stress ulcer prophylaxis is prescribed only to high risk patients according to locally developed guidelines.[6] Although this is discussed within the APIC guidelines, it is not specifically included as a key recommendation. The 2014 SHEA guidelines state this intervention is 'generally not recommended' as evidence suggest there is no impact on VAP rates, average duration of mechanical ventilation, length of stay or mortality.[1;7]

In conclusion there is insufficient evidence to include this as a key recommendation within a quality improvement tool.

5. Implications for research

A number of gaps in current evidence have been identified as a result of this review, which may have implications for future research priorities. These are summarised below:

- The optimum concentration of chlorhexidine for routine oral care and assessment of benefit in non-cardiac patients.

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Appendix 1: Previous criteria under review

The VAP prevention care bundle, checklist and associated tools were first published on the HPS website in 2008. The criteria below were used as the question set to frame this review of the evidence base

- Sedation to be reviewed and, if appropriate, stopped each day
- All patients will be assessed for weaning and extubation each day
- Avoid supine position, aiming to have the patient at least 30º head up
- Use chlorhexidine as part of daily mouth care
- Use subglottic secretion drainage in patients likely to be ventilated for more than 48 hours

Appendix 2: Literature review methodology

The evidence underpinning the criteria for a quality improvement tool was reviewed using a targeted systematic approach to enable input and resource to be concentrated where needed. This methodology is fully described within a separate HPS paper '*Rapid method for development of evidence based/expert opinion key recommendations, based on health protection network guidelines'.*

Initial rapid search and review

The initial search rapid literature search was carried out to identify mandatory guidance, or recent national or international evidence based guidance which either agrees or refutes that the current key recommendations are the most important to ensure optimal PVC care:

- The main public health websites were searched to source any existing quality improvement tools
- Relevant guidance and quality improvement tools e.g. Department of Health (DH), Centers for Disease Control and Prevention (CDC) etc were reviewed
- Additional literature identified and sourced e.g. from the relevant Cochrane reviews.

The quality of evidence based guidance was assessed using the AGREE instrument[21] and only guidance which achieved either a strongly recommend or recommend rating was included.

Targeted systematic review

As a result of initial rapid search and review, recommendations requiring a more in depth review were identified. This involved searching of relevant databases including OVID Medline, CINAHL, and EMBASE. All literature pertaining to recommendations where evidence was either conflicting or where new evidence was available were critically appraised using SIGN checklists and a 'considered judgement' process used to formulate recommendations based on the current evidence for presentation and discussion with the National Healthcare Associated Infection (HAI) Quality Improvement Tools Group in Scotland.

Grading of recommendations

Grading of the evidence is using the Healthcare Infection Control Practices Advisory Committee (HICPAC) method.[22] In addition to the overall assessment of the evidence underpinning the recommendation, other factors are considered which affect the overall strength of the recommendation such as the health impact and expert opinion on the potential critical outcomes.

The HICPAC categories are as follows:

Category 1A – strong recommendation based on high to moderate quality evidence
Category 1B – strong recommendation based on low quality of evidence which suggest net clinical benefits or harms or an accepted practice (e.g. aseptic technique)
Category 1C – a mandatory recommendation
Category II – a weak recommendation which shows evidence of clinical benefit over harm
No recommendation – not sufficient evidence to recommend one way or another

Framework for identifying final key recommendations

One way of improving implementation of evidence based guidance is by the identification of key recommendations which if applied will improve practice and outcome.[23-29] This is the foundation of 'care bundles' and other quality improvement tools which rely on the identification of key evidence based recommendations to ensure application in practice.[30]

A method has been developed which aims to reflect graded recommendations in line with ensuring healthcare quality, attention to cost and practical application. It combines approaches used by the Institute of Healthcare Improvement (IHI) and World Health Organisation, among others, in identifying the critical factors from the evidence to ensure patient safety in a range of fields.[29;31] The method considers the current NHSScotland Quality Strategy dimensions and finally expert opinion applied within a formal framework. This framework includes a range of practical considerations under the headings measurement and feedback, feasibility and sustainability, applicability and reach, training and informing.

Ultimately, HPS key recommendations are presented taking all of these factors into account, with the aim of improving practice and outcome.

Appendix 3: Search strategy

Database: Ovid MEDLINE(R) <2010 to June week 2 2016
Search Strategy:
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1 pneumonia, ventilator-associated.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier] (2420)
2 vap.tw. (2655)
3 exp pneumonia/ (81657)
4 exp respiration, artificial/ (65242)
5 exp ventilators, mechanical/ (8469)
6 4 or 5 (70852)
7 3 and 6 (4056)

8 1 or 2 or 7 (6862)
9 exp oral hygiene/ (16947)
10 (mouthwash$ or mouthrins$ or antiseptic or chlorhexidine or iodine).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier] (108950)
11 exp dental hygiene/ (16947)
12 9 or 10 or 11 (124583)
13 exp suction/ or drainage.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier] (95608)
14 patient positioning.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier] (5059)
15 (bed elevation or supine or psoition).tw. (22028)
16 recumbent.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier] (2301)
17 14 or 15 or 16 (28365)
18 exp intubation/ (47299)
19 exp extubation/ (0)
20 18 or 19 (47299)
21 12 or 13 or 17 or 20 (292212)
22 8 and 21 (1100)
23 limit 22 to english language (974)
24 limit 23 to human (938)
25 limit 24 to yr="2010 -Current" (365)
26 remove duplicates from 25 (359)