British Society for Antimicrobial Chemotherapy

(BSAC)

Hospital Acquired Pneumonia (HAP)

Considered Judgement

Prevention Work Group

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Key to evidence grading

Levels of evidence	
1++	High quality meta-analyses, systematic reviews of RCTs, or RCTs with a very low risk of bias
1+	Well conducted meta-analyses, systematic reviews of RCTs or RCTs with a low risk of bias
1-	Meta-analyses, systematic reviews of RCTs, or RCTs with a high risk of bias
2++	High quality systematic reviews of case control or cohort studies High quality case-control or cohort studies with a very low risk of confounding, bias, or chance and a high probability that the relationship is causal
2+	Well conducted case control or cohort studies with a low risk of confounding, bias or chance and a moderate probability that the relationship is causal
2-	Case control or cohort studies with a high risk of confounding, bias or chance and a significant risk that the relationship is not causal
3	Non-analytical studies, e.g. case reports, case series
4	Expert opinion
Grades of recommendation	
A	At least one meta-analysis, systematic review, or RCT rated 1++, and directly applicable to the target population; *or* A systematic review of RCTs or a body of evidence consisting principally of studies rated as 1+, directly applicable to the target population, and demonstrating overall consistency of results.
B	A body of evidence including studies rated as 2++, directly applicable to the target population, and demonstrating overall consistency of results; *or* Extrapolated evidence from studies rated as 1++ or 1+
C	A body of evidence including studies rated as 2+, directly applicable to the target population and demonstrating overall consistency of results; *or* Extrapolated evidence from studies rated as 2++
D	Evidence level 3 or 4; *or* Extrapolated evidence from studies rated as 2+
Good Practice Point	
GPP	Recommended best practice based on the clinical experience of the HAP Working Group

List of abbreviations

Term	Abbreviation
American Society of Anaesthesiology	ASA
British Society for Antimicrobial Chemotherapy	BSAC
Chief Medical Officer	CMO
Chronic Obstructive Pulmonary Disease	COPD
Centers for Disease Control and Prevention	CDC
Control of Substances Hazardous to Health	COSHH
Department of Health	DH
Hospital Acquired	HA
Hospital Acquired Pneumonia	HAP
Healthcare Associated Infections	HCAI
High Efficiency Particulate Air	HEPA
Heated Humidifiers	HHs
Heat Moisture Exchangers	HMEs
Health & Safety Executive	HSE
Haemopoietic Stem Cell Transplant	HSCT
Invasive Aspergillosis	IA
Intensive Care Units	ICUs
Joint Committee on Vaccination and Immunisation	JCVI
Meticillin-resistant *Staphylococcus aureus*	MRSA
Personal Protective Equipment	PPE
Randomised Controlled Trials	RCTs
Respiratory Syncytial Virus	RSV
Severe Acute Respiratory Syndrome	SARS
Ventilator Associated Pneumonia	VAP

BSAC	Considered Judgement form HAP Prevention Working Party

Question 1 – Is there any evidence that staff education programmes reduce the incidence of HAP?

Reviewers — Dr Angela Galloway and Dr Robert Masterton

1. Volume of evidence:

The volume of firm evidence available was limited. There were four cohort studies[1,2,3,4] and one case control study[5,].

Data from two cohort studies[2,3] show that education programmes are effective in reducing the incidence of ventilator associated pneumonia (VAP) by 51% and 56% respectively. A cohort study by Baxter[4] also showed that introducing protocols and education was effective in reducing VAP by 50%. One other cohort study[1] and a case control study[5] show that as part of a broad intervention, programmed education can be successful in controlling staff to staff or staff to patient outbreaks of primary respiratory pathogens e.g. pertussis and respiratory syncytial virus (RSV).

There is evidence from a cohort study that when a higher proportion of care is provided by qualified registered nursing staff, there is a lower incidence of HAP[6].

2. Applicability:

Most of the evidence related to VAP. Outbreaks of HAP are not so frequent, are usually related to endogenous organisms rather than primary respiratory pathogens and are not generally spread via the respiratory route.

3. Generalisability:

Three papers look at VAP[2,3,4], otherwise information is extrapolated from data on pertussis and RSV in the USA but this is reasonable.

4. Consistency:

All papers suggest education helps.

5. Clinical impact:

There is good evidence that education programmes reduce the incidence of VAP.

6. Other factors:

None.

7. Evidence statement:	Evidence grading
There is consistent evidence that staff education programmes in themselves reduce the incidence of VAP. As part of an overall infection control programme there is evidence that staff education can reduce hospital acquired respiratory infections.	**2++**
8. Recommendation:	
Hospital education programmes should form part of the risk reduction measures for HAP as part of an overall infection control strategy.	**B**

Education to staff on the risk prevention measures for HAP should form part of their induction and continuing professional development.	**GPP**
Appropriate levels of experienced nursing staff should be involved in patient care to prevent HAP.	**GPP**

References:

1 CDC543. Christie CD, Glover AM, Willke MJ *et al.* Containment of pertussis in the regional pediatric hospital during the Greater Cincinnati epidemic of 1993. *Infect Control Hosp Epidemiol* 1995; **16**: 556-63.

2 WY1511. Salahuddin N, Zafar A, Sukhyani L *et al.* Reducing ventilator-associated pneumonia rates through a staff education programme. *J Hosp Infect* 2004; **57**: 223-7.

3 WY1631. Zack JE, Garrison T, Trovillion E *et al*. Effect of an education program aimed at reducing the occurrence of ventilator-associated pneumonia. *Crit Care Med* 2002; **30**:2407-12.

4 WY2000. Baxter AD, Allan J, Beddard J et al. Adherence to simple and effective measures reduces the incidence of ventilator-associated pneumonia. *Can J Anesth* 2005; **52**: 535-41.

5 CDC786. Macartney KK, Gorelick M, Manning M, *et al.* Nosocomial respiratory syncytial virus infections: the cost-effectiveness. *Pediatrics* 2000; **106**: 520-6.

6 WY1635. Neddleman J, Buerhaus P, Mattke P *et al*. Nurse-staffing levels and the quality of care in hospitals. *N Eng J Med* 2002; **346**: 1715-22.

BSAC	Considered Judgement form HAP Prevention Working Party

Question 2/5 - Is there any evidence that routine screening of:

a) the environment for organisms causing HAP, reduces the incidence of HAP?

Reviewers – Carole Fry and Jean Armstrong

1. Volume of evidence:

There is an absence of evidence that examines the benefit of routine surveillance for HAP organisms in the environment.

2. Applicability:

No evidence.

3. Generalisability:

No evidence.

4. Consistency:

No evidence.

5. Clinical impact:

No evidence.

6. Other factors:

No evidence.

7. Evidence statement:	Evidence grading
There is an absence of evidence that routine environmental screening for organisms causing HAP, affects the incidence of HAP.	-
8. Recommendation:	
No recommendation can be made to support routine screening of the environment for organisms causing HAP.	-
Future Research Recommendation Future research is recommended in order to assess whether routine screening of the environment for organisms causing HAP reduces the incidence of HAP due to multi-resistant Gram negative bacteria e.g. *Pseudomonas aeruginosa* or *Acinetobacter* species.	

References:

None identified.

BSAC	Considered Judgement form HAP Prevention Working Party

Question 2/5 - Is there any evidence that routine screening of:

b) specimens from patients for organisms causing HAP reduces the incidence of HAP?

Reviewers – Carole Fry and Jean Armstrong

1. Volume of evidence:
There is an absence of evidence regarding the routine screening of patients for evidence of organisms causing HAP.
2. Applicability:
No evidence.
3. Generalisability:
No evidence.
4. Consistency:
No evidence.
5. Clinical impact:
No evidence.
6. Other factors:
None.

7. Evidence statement:	**Evidence grading**
There is no evidence that taking screening specimens from patients reduces the incidence or prevents HAP.	**-**
8. Recommendation:	
No recommendation can be made on taking patient screening specimens to reduce the incidence of HAP.	**-**
Surveillance of organisms causing pneumonia in intensive care patients should be carried out to identify cross-infection or outbreaks and other infection control problems e.g. a single case of hospital acquired Legionella infection.[7]	**GPP**
Surveillance should also be performed on ICUs to determine the incidence of and organisms causing VAP to provide feedback to clinicians.[8]	**GPP**
Future Research Recommendation Future research is recommended in order to assess whether taking routine screening samples from patients helps to reduce the incidence of HAP or assists in targeting treatment through the early recognition of organisms	

causing HAP.	

References:

7 CDC955. Haley RW, Culver DH, White J.W. The efficacy of infection surveillance and control programs in preventing nosocomial infections in U.S. hospitals. *Am J Epidemiol* 1985; **121**: 182-205.

8 WY2001. Pearson ML. Guidelines for preventing health-care-associated pneumonia, 2003. Recommendations of the CDC and the Healthcare Infection Control Practices Advisory Committee. *Resp Care* 2004;**49**:926-39.

BSAC	Considered Judgement form HAP Prevention Working Party

Question 3 – Is there any evidence that immunisation reduces the incidence of HAP?

Reviewers – Dr Angela Galloway and Jean Armstrong

1. Volume of evidence:

There is one meta-analysis of twenty observational studies of pneumonia in the elderly.[9]

While there are a number of cohort studies[7,10,11] and three randomised controlled trials[12,13,14] there is an absence of evidence that immunisation of patients or staff prevents HAP.

Published papers cover influenza (including influenza pneumonia), the elderly and healthcare workers and mainly relate to outbreaks in nursing homes. There is evidence that with influenza prevention in healthcare workers and patients, pneumonia secondary to influenza, is reduced in elderly patients.

A case control study found that not immunising healthcare workers for influenza was associated with significantly increased patient mortality due to respiratory tract infection associated with influenza-like illness.[10]

2. Applicability:

Generally applicable.

3. Generalisability:

Extrapolation from a meta-analysis by Gross (1995) - as influenza immunisation prevents pneumonia in 53% of elderly patients this may reduce HAP.[9]

4. Consistency:

High degree of consistency in studies – no conflicting results.

5. Clinical impact:

Existing UK guidance already highlights the importance of immunisation for high risk patients (adult and paediatric). Immunisation of healthcare workers involved with at risk patients is also recommended. The use of the new conjugated pneumococcal vaccine is being explored as standard immunisation for children. This may have considerable financial implications initially.

6. Other factors:

The Department of Health Chief Medical Officer (CMO) recommendations on influenza/pneumococcal immunisation should be considered.[15,16] Introduction of a pneumococcal immunisation programme for those aged 65 years and over, and current influenza immunisation programmes are all also relevant.

7. Evidence statement:	Evidence grading
There is no direct evidence that influenza immunisation of healthcare workers or patients will directly reduce the incidence of HAP although there is evidence to suggest that influenza immunisation prevents pneumonia in	**2+**

elderly patients.	
Likewise there is no direct evidence that pneumococcal immunisation of healthcare workers or patients will directly reduce the incidence of HAP.	**2+**
There is also evidence that failure to immunise healthcare workers against influenza may result in increased risk of mortality in elderly patients from 'influenza like illness'.	**2**
8. Recommendation:	
Use of influenza immunisation in healthcare workers and patients should be encouraged.	**C**
Use of pneumococcal immunisation in elderly and at risk groups should also be encouraged.	**C**
In line with the recommendations of the Joint Committee on Vaccination and Immunisation (JCVI), influenza immunisations should be actively encouraged in at risk patients and healthcare workers.[15,16]	**GPP**

References:

7 CDC955. Haley RW, Culver DH, White J.W. The efficacy of infection surveillance and control programs in preventing nosocomial infections in U.S. hospitals. *Am J Epidemiol* 1985; **121**: 182-205.

9 CDC1055. Gross PA, Hermogenes AW, Sacks HS, *et al.* The efficacy of influenza vaccine in elderly persons: a meta-analysis and review of the literature. *Ann Intern Med* 1995; **123**: 518-27.

10 CDC911. Potter J, Stott DJ, Roberts MA , *et al.* Influenza vaccination of healthcare workers in long-term-care hospitals reduces the mortality of elderly patients. *J Infect Dis* 1997; **175**: 1-6.

11 CDC1052. Fedson DS, Kessler HA. A hospital-based influenza immunization program, 1977-1978. *Am J Public Health* 1983; **73**: 442-5.

12 CDC909. Wilde JA, McMillan JA, Serwint J, *et al.* Effectiveness of influenza vaccine in healthcare professionals: a randomized trial. *JAMA* 1999; **281**: 908-13.

13 CDC917. Saxen H, Virtanen M. Randomized placebo-controlled double blind study on the efficacy of influenza immunization on absenteeism of healthcare workers. *Pediatr Infect Dis J* 1999; **18**: 779-83.

14 CDC910. Carman WF, Elder AG, Wallace LA, *et al.* Effects of influenza vaccination of health-care workers on mortality of elderly people in long-term care: a randomised controlled trial. *Lancet* 2000; **355**: 93-7.

15 WY1509. Immunisation Against Infectious Disease 1996 - "The Green Book" new November 2005 chapters *http://www.dh.gov.uk/assetRoot/04/12/32/35/04123235.pdf* (25 November 2005, date last accessed).

16 WY2002. Immunisation Against Infectious Disease 1996 - "The Green Book" new November 2005 chapters *http://www.dh.gov.uk/assetRoot/04/12/32/41/04123241.pdf* (25 November 2005, date last accessed).

BSAC	Considered Judgement form HAP Prevention Working Party

Question 4 – Is there any evidence that the use of clinical guidelines/protocols can reduce the incidence of HAP?

Reviewers – Dr Angela Galloway and Dr Robert Masterton

1. Volume of evidence:

The two randomised controlled trials (RCTs) show that care protocols in intensive care units (ICU) decrease the incidence of ventilator associated pneumonia (VAP), particularly in trauma patients. [17,18]

Two other RCTs on the use of weaning protocols for ventilated patients on ICU, found that the use of protocols by nurses and respiratory therapists resulted in reduced duration of mechanical ventilation, improved clinical outcome and reduced costs.[19,20] Also the use of protocols for reducing sedation were reported as being effective in reducing the duration of ventilation and ICU stay.[21,22]

While there were few papers, those identified provided good evidence that clinical guidelines reduced the incidence of VAP. [17,18,19,20,21,22,23]

There is no other direct evidence that guidelines affect the incidence of HAP outside of ICUs.

2. Applicability:

Fully.

3. Generalisability:

Although there are few studies and only small numbers of patients the consistency of the results makes it reasonable to generalise the findings across all ventilated patients.

4. Consistency:

High degree of consistency in studies – no conflicting results.

5. Clinical impact:

Production and adherence to clinical guidelines for the management of ventilated patients is likely to reduce the incidence of VAP. This is likely to lead to reductions in mortality and morbidity, though to date these have not been demonstrated.

6. Other factors:

None.

7. Evidence statement:	Evidence grading
There is an absence of evidence that guidelines can reduce the incidence of HAP outside of ICUs.	-

There is good evidence that within ICUs, care protocols reduce the incidence of VAP.	**1++**
There is evidence that the use of protocols for weaning and sedation, which are non-physician-led, can reduce the duration of mechanical ventilation, reduce ICU stay and improve outcome	**1++**
8. Recommendation:	
No recommendation can be made in respect of the value of guidelines in the reduction of HAP outside of ICUs.	**-**
Care protocols and guidelines for weaning and sedation should be developed and actively followed in the critical care setting to reduce the incidence of VAP.	**A**
Clinical guidelines should be monitored to ensure compliance to reduce the incidence of HAP.	**GPP**

References:

17 WY1500. Marelich GP, Murin S, Battistella F, *et al.* Protocol weaning of mechanical ventilation in medical and surgical patients by respiratory care practitioners and nurses: effect on weaning time and incidence of ventilator-associated pneumonia. *Chest* 2000; **118**: 459-67.

18 WY1501. Ibrahim EH, Ward S, Sherman G, *et al.* Experience with a clinical guideline for the treatment of ventilator-associated pneumonia. *Crit Care Med* 2001; **29**: 1109-15.

19 WY2003. Ely EW, Baker AM, Dunagan DP et al. Effect on the duration of mechanical ventilation of identifying patients capable of breathing spontaneously. *N Engl J Med* 1996: 335: 1864-9.

20 WY2004. Kollef MH, Shapiro SD, Silver P et al. A randomized, controlled trial of protocol-directed weaning from mechanical ventilation. Crit Care Med 1997; 25:567-74.

21 WY2005. Brook AD, Ahrens TS, Schaiff R et al. Effect of a nursing-implemented sedation protocol on the duration of mechanical ventilation. *Crit Care Med* 199:27:2609-15:

22 WY1633. Kress JP, Pohlman AS, O'Connor ME, Hall JB. Daily interruption of sedative infusions in critically ill patients undergoing mechanical ventilation. *N Engl J Med* 2000:342:1471-77.

23 WY2006. MacIntyre NR, Cook DJ, Ely EW et al. Evidence-based guidelines for weaning and discontinuing ventilatory support: a collective task force facilitated by American College of Chest Physicians; the American Association for Respiratory Care; and the American College of Critical Care Medicine. *Chest* 2001;120 (6 Suppl):375s-95S).

BSAC	Considered Judgement form HAP Prevention Working Party

Question 6 – Is there any evidence that using prophylactic antifungal agents during building work prevents HAP?

Reviewers – Dr Angela Galloway and Dr Robert Masterton

1. Volume of evidence:

There is only one small cohort study reporting the use of antifungal prophylaxis in immunocompromised patients during construction work.[24] There is good evidence of use of antifungal prophylaxis for neutropenic patients in general[25,26] and specifically to support the use of itraconazole in this situation.[25,27,28] There is no clear evidence based indication against the use of any antifungal prophylaxis.[29]

2. Applicability:

Applicable for immunosuppressed patients (especially those who are neutropenic).

3. Generalisability:

Not generally recommended but antifungal prophylaxis should be considered in high risk patients.

4. Consistency:

Not applicable.

5. Clinical impact:

The cost of using antifungal prophylaxis should be considered in all building projects (cost of drug and monitoring). For larger projects e.g. involving demolition and reconstruction, the additional cost may need to cover several months.

6. Other factors:

Even assessing the evidence base for the impact during demolition – there is little data available.

7. Evidence statement:	Evidence grading
There is no good evidence for the widespread use of antifungal treatment as prophylaxis during construction work, although use in immunocompromised patients is recommended.[27]	**3**
8. Recommendation:	
Where there is a high institutional rate of Invasive Aspergillosis (IA) or building work is underway, a risk assessment should be undertaken. Those patients who are immunosuppressed, especially those who are neutropenic (neutrophil count less than 0.5 X 10^9 per litre for more than two weeks or less than 0.1 x 10^9 per litre for one week), who are visiting hospital regularly or staying as an in-patient but not in a High Efficiency Particulate Air (HEPA) filtered environment should be considered for antifungal prophylaxis.[30]	**D**

The use of antifungals to prevent IA in the immunosuppressed during building work should be based on a robust risk assessment.	**GPP**

References:

24 WY335. Shields ML, Joyner MV, Lee R. Invasive aspergillosis in immunocompromised patients. *BMJ* 1990; **301**: 1046-7.

25 WY1564. Morgenstern GR, Prentice AG, Prentice HG, Ropner JE, Schey SA, Warnock DW. A randomized controlled trial of itraconazole versus fluconazole for the prevention of fungal infections in patients with haematological malignancies. UK Multicentre Antifungal Prophylaxis Study Group. *Br J Haematol* 1999: **105**: 901-11.

26 WY2007. Gøtzsche PC, Johansen HK. Routine versus selective antifungal administration for control of fungal infections in patients with cancer. *Cochrane Database of Systematic Reviews* 2005;**issue 3**; 1-29

27 WY1566. Harousseau JL, Dekker AW, Stamatoullas-Bastard A *et al.* Itraconazole Oral Solution for Primary Prophylaxis of Fungal Infections in Patients with Hematological Malignancy and Profound Neutropenia: a Randomized, Double-Blind, Double-Placebo, Multicenter Trial Comparing Itraconazole and Amphotericin B. *Antimicrob Agents and Chemother* 2000;.**44**: 1887-93.

28 WY2008. Glasmacher, Prentice A, Gorschlüter M *et al*. Itraconazole prevents invasive fungal infections in neutropenic patients treated for hematologic malignancies: Evidence from a meta-analysis of 3,597 patients. *J Clin Oncol* 2003; **21**: 4615-26.

29 WY1555. Cornely O, Ullman AJ, Karthaus M. Evidence based assessment of primary antifungal prophylaxis in patients with haematological malignancies. *Blood* 2003; **101**: 3365-72.

30 WY1608. Working party of the British Society for Antimicrobial Chemotherapy. Chemoprophylaxis for candidosis and aspergillosis in neutropenia and transplantation: a review and recommendations. [published erratum appears in *J Antimicrob Chemother* 1993; **32**:925] *J Antimicrob Chemother* 1993; **32**: 5-21

BSAC	Considered Judgement form HAP Prevention Working Party

Question 7 - For equipment and devices what are the best methods of sterilisation or disinfection and maintenance to reduce the risk of HAP for:

a. mechanical ventilators

Reviewers – Dr Robert Masterton and Dr Robert Spencer

1. Volume of evidence:

There is an absence of evidence as to the best sterilisation /disinfection/ maintenance procedures for mechanical ventilators to reduce the risk of HAP.

2. Applicability:

No evidence.

3. Generalisability:

Not evidence.

4. Consistency:

No evidence.

5. Clinical impact:

No evidence.

6. Other factors:

No evidence.

7. Evidence statement:	Evidence grading
There is an absence of evidence as to the best sterilisation or disinfection and maintenance methods for mechanical ventilators to reduce the risk of HAP.	-
In line with the Medical Device Agency guidance on single-use medical devices,[31] devices designated for 'single-use' must not be reused under any circumstances. The reuse of 'single-use' devices can affect their safety, performance and effectiveness, exposing patients and staff to unnecessary risk. The reuse of 'single-use' devices has legal implications: • Anyone who reprocesses or reuses a device intended by the manufacturer for use on a single occasion, bears full responsibility for its safety and effectiveness. Anyone who reprocesses a single-use device and passes it to a separate legal entity for use, has the same legal obligations under the Medical Devices Regulations as the original manufacturer of the device.	4

8. Recommendation:	
No recommendation can be made about the best sterilisation or disinfection and maintenance methods for mechanical ventilators to reduce the risk of HAP.	-
Use single use items once.	**GPP**
Sterilise, disinfect and maintain equipment according to manufacturers' instructions.	**GPP**

References:	
31	WY1556. Medical Devices Agency. *Single-use Medical Devices: Implications and Consequences of Reuse Bulletin DB2000(04). 2000*. Available from http://devices.mhra.gov.uk/mda/mdawebsitev2.nsf/72a26a46ed28515400256a7600410653/ b7d0158a173d0c5a80256c8b004de2b7?OpenDocument (21 June 2005, date last accessed).

BSAC	Considered Judgement form HAP Prevention Working Party

Question 7 - For equipment and devices what are the best methods of sterilisation or disinfection and maintenance to reduce the risk of HAP for:

b. ventilator circuits

Reviewers – Dr Robert Masterton and Dr Robert Spencer

1. Volume of evidence:

A meta-analysis by Hess, which included 4RCTs and 7 observational studies, found that changing the ventilator circuit less frequently than 24 hourly reduced the risk of VAP.[32]

The systematic review by Dodek [33] assessed 3 randomised controlled trials (RCTs), Kollef (1995), Dreyfuss (1991) and Long (1996).[34,35,36] One of the RCTs (Kollef (1995)[34] was considered a higher level trial than the other two. Dodek (2004) concluded that the frequency of ventilator circuit changes does not influence the incidence of ventilator associated pneumonia (VAP), that less frequent changes of ventilator circuits are not associated with harm and that more frequent changes are associated with increased cost. [33]

Lorente in an RCT also found no difference in the rate of VAP in patients with ventilator circuits containing HMEs with 48 hour circuit changes or no planned change.[37]

2. Applicability:

Generally applicable to all ventilated patients.

3. Generalisability:

These studies were all conducted in ventilated patients where circuits were changed if there were signs of visible contamination or damage.

4. Consistency:

Studies consistent.

5. Clinical impact:

None.

6. Other factors:

None.

7. Evidence statement:	Evidence grading
Studies have shown no evidence that additional changes of circuit (before seven days) have any impact on the incidence of HAP.	**1+**
8. Recommendation:	
Changing circuits before seven days is of no benefit.	**A**
New ventilator circuit tubing should be provided for each patient.	**B**
If a ventilator circuit becomes soiled or damaged it should be changed.	**GPP**

If any closed breathing circuits are disconnected facial protection should be used alongside personal protective equipment (PPE) to prevent contamination of the healthcare worker. This is especially important when dealing with patients with highly communicable infections eg SARS or Avian flu.	**GPP**
Breathing circuit condensate should be periodically drained and discarded, ensuring condensate does not drain toward the patient, to prevent VAP.[38,39]	**GPP**
Future Research Recommendation Further research into the maximum length of time that would be appropriate without changing tubing, for safety and infection control reasons, is required.	

References:

32 WY2009. Hess DR – AARC Evidence based clinical practice guidelines; Care of the ventilator circuit and its relation to ventilator-associated pneumonia. *Respiratory Care* 2003; **48**: 869-79.

33 WY1533. Dodek P, Keenan S, Cook D, *et al.* Evidence-based clinical practice guideline for the prevention of ventilator-associated pneumonia. *Ann Intern Med* 2004; **141**: 305-13.

34 WY532. Kollef MH, Prentice D, Shapiro SD, *et al.* Mechanical ventilation with or without 7-day circuit changes. A randomized controlled trial. *Ann Intern Med* 1995; **123**: 168-74.

35 WY458. Dreyfuss D. Prospective study of nosocomial pneumonia and of patient and circuit colonization during mechanical ventilation with circuit changes every 48 hours versus no change. *Am Rev Respir Dis* 1991; **143**: 738-43.

36 CDC965. Long MN, Wickstom G, Grimes A, *et al.* Prospective, randomized study of ventilator-associated pneumonia in patients with one versus three ventilator circuit changes per week. *Infect Control Hosp Epidemiol* 1996; **17**: 14-9.

37 WY1642 Lorente L, Lecuona M, Martin MM *et al*. Ventilator-associated pneumonia using a closed versus open tracheal suction system. *Crit Care Med* 2005; **33**: 115-19.

38 PRC41 Hubmayr RD. Statement of the 4th International consensus conference in critical care on ICU-acquired pneumonia – Chicago, Illinois, May 2002. *Intensive Care Med* 2002; **28**: 1521-36.

39 WY2010. American Thoracic Society/. Guidelines for the management of adults with hospital-acquired, ventilator-associated pneumonia. *Am J Respir Crit Care Med* 2005; **171**: 3880416.

BSAC	Considered Judgement form HAP Prevention Working Party

Question 7 - For equipment and devices what are the best methods of sterilisation or disinfection and maintenance to reduce the risk of HAP for:

c. heated humidifiers (HHs) and heat moisture exchangers (HMEs)

Reviewers – Dr Robert Masterton and Dr Robert Spencer

1. Volume of evidence:

There is good evidence from two meta-analyses[32,40] and a systematic review[33]. A meta-analysis[40] covers all eight randomised controlled trials (RCTs) cited by the other papers which examined the use of different humidifier types and their effect on ventilator associated pneumonia (VAP) incidence.[41,42,43,44,45,46,47,48] Kola concluded that the use of heat moisture exchangers (HMEs) may be associated with a statistically significant reduction in the incidence of VAP compared with heated humidifiers in patients ventilated for more than 7 days.[40] Dodek noted concern about endotracheal tube obstruction and HME use[33], but this has not been confirmed in recent studies evaluating newer HMEs.[49]

2. Applicability:

The studies are applicable to ventilated patients only.

3. Generalisability:

Generalisable to ventilated patients only.

4. Consistency:

Studies consistent.

5. Clinical impact:

Two of the RCTs[34,48] examined by Kola[40] showed a reduction in costs with HMEs compared to HHs.

6. Other factors:

None.

7. Evidence statement:	**Evidence grading**
There is evidence that newer HMEs are associated with a reduced risk of VAP.	**1+**
8. Recommendation:	
HMEs are safe to use provided manufacturers instructions are followed.	**1+**
HMEs are more effective in reducing the incidence of VAP compared to HHs provided there are no contraindications to their use (eg patients at risk of airways obstruction).	**A**
When HMEs are used, the type chosen should be one that has adequate moisture output to minimise the risk of airway obstruction.	**GPP**

The benefit of use of HMEs versus HHs should be established for each patient.	**GPP**
The decision on the use of HMEs should not be based solely on infection control considerations.	**GPP**
National guidelines should be followed for management of patients with highly communicable infections eg SARS and Avian flu.	**GPP**

References:

32 WY2009. Hess DR. AARC Evidence-based clinical practice guidelines: Care of the ventilator circuit and its relation to ventilator-associated pneumonia. *Resp Care* 2003; **48**: 869-79.

33 WY1533. Dodek P, Keenan S, Cook D, *et al.* Evidence-based clinical practice guideline for the prevention of ventilator-associated pneumonia. *Ann Intern Med* 2004; **141**: 305-13.

40 PMA2. Kola A, Eckmanns T, Gastmeier. Efficacy of heat and moisture exchangers in preventing ventilator-associated pneumonia: meta-analysis of randomized controlled trials. *Intensive Care Med* 2005; **31**: 5-11.

41 WY925. Martin C, Perrin G, Gevaudan MJ, *et al.* Heat and moisture exchangers and vaporizing humidifiers in the intensive care unit. *Chest* 1990; **97**: 144-9.

42 WY549. Roustan JP, Kienlen J, Aubas P, *et al.* Comparison of hydrophobic heat and moisture exchangers with heated humidifier during prolonged mechanical ventilation. *Intensive Care Med* 1992; **18**: 97-100.

43 WY1537. Kollef MH, Shapiro SD, Boyd V, *et al.* A randomized clinical trial comparing an extended-use hygroscopic condenser humidifier with heated-water humidification in mechanically ventilated patients. *Chest* 1998; **113**: 759-67.

44 WY556. Kirton OC, DeHaven B, Morgan J, *et al.* A prospective, randomized comparison of an in-line heat moisture exchange filter and heated wire humidifiers: rates of ventilator-associated early-onset (community-acquired) or late-onset (hospital-acquired) pneumonia and incidence of endotracheal tube occlusion. *Chest* 1997; **112**: 1055-9.

45 WY926. Boots RJ, Howe S, George N. Clinical utility of hygroscopic heat and moisture exchangers in intensive care patients. *Crit Care Med* 1997; **25**: 1707-12.

46 WY555. Dreyfuss D. Mechanical ventilation with heated humidifiers or heat and moisture exchangers: effects on patient colonization and incidence of nosocomial pneumonia. *Am J Respir Crit Care Med* 1995; **151**: 986-92.

47 WY927. Memish ZA, Oni GA, Djazmati W, *et al.* A randomized clinical trial to compare the effects of a heat and moisture exchanger with a heated humidifying system on the occurrence rate of ventilator-associated pneumonia. *Am J Infect Control* 2001; **29**: 301-5.

48 WY2011. Branson RD, Davis K Jr, Brown R, Raskin M. Comparison of three humidification techniques during mechanical ventilation: patient selection, cost and infection considerations. *Respir Care* 1996; **41**: 809-16.

49 WY1638. Hurni JM, Feihl F, Lazor R *et al.* Safety of combined heat and moisture exchanger filters in long-term mechanical ventilation. *Chest* 1997; **111**: 686-91.

BSAC	Considered Judgement form HAP Prevention Working Party

Question 7

c1) Is there any evidence that frequency of changes of humidifiers has any effect on the incidence of HAP?

Reviewers – Dr Robert Masterton and Dr Angela Galloway

1. Volume of evidence:

There is a systematic review[32] and three randomised controlled trials (RCTs).[50,51,52]Two specifically addressed the issue of the effect of the use of reduced frequency of changes of humidifier on VAP.[50,51]

Markowicz looked at efficacy and safety studying three different types of HMEs and found that some HMEs may be used for 48 hours without change but that this depends on the brand. Not all HMEs performed equally.[50]

Davis reported that changing HMEs after three days did not diminish efficiency or increase the incidence of VAP.[51]

2. Applicability:

The studies are applicable to ventilated patients only.

3. Generalisability:

Generalisable to ventilated patients only.

4. Consistency:

Studies consistent.

5. Clinical impact:

None.

6. Other factors:

None.

7. Evidence statement:	Evidence grading
There is no evidence that more frequent changing of HHs and HMEs than manufacturers recommend, reduces the risk of HAP.	**1+**
8. Recommendation:	
Where HMEs are used (except with high minute volume) these should not be changed routinely – but manufacturer's guidance should be followed.	**A**
If there is any evidence or suspicion of contamination these should be changed.	**GPP**
The technical performance of HMEs for more that 48 hours should be monitored, especially in patients with COPD.	**GPP**

References:

32 WY2009. Hess DR – AARC Evidence based clinical practice guidelines; Care of the ventilator circuit and its relation to ventilator-associated pneumonia. *Respiratory Care* 2003; **48**: 869-79.

50 WY1639. Markowicz P, Ricard J-D, Dreyfuss D *et al*. Safety, efficacy, and cost-effectiveness of mechanical ventilation with humidifying filters changed every 48 hours: A prospective, randomized study. *Crit Care Med* 2000; **28**: 665-71.

51 WY1640. Davis K Jr, Evans SL, Campbell RS *et al*. Prolonged use of heat and moisture exchangers does not affect device efficiency or frequency rate of nosocomial pneumonia. *Crit Care Med* 2000; **28**: 1412-18.

52 WY1641. Thomachot L, Leone M, Razzouk K *et al*. Randomized clinical trial of extended use of a hydrophobic condenser humidifier: 1 vs 7 days. *Crit Care Med* 2002; **30**: 232-37.

BSAC	Considered Judgement form HAP Prevention Working Party

Question 7 - For equipment and devices what are the best methods of sterilisation or disinfection and maintenance to reduce the risk of HAP for:

d. nebulisers

Reviewers – Dr Robert Masterton and Dr Robert Spencer

1. Volume of evidence:

Evidence from three diagnostic studies suggests that nebulisers can act as a source of respiratory tract infection.[53,54,55]

2. Applicability:

Generally applicable to all nebulisers but evidence is limited.

3. Generalisability:

Limited evidence.

4. Consistency:

Consistent but small volume of evidence.

5. Clinical impact:

Moderate clinical impact if precautions not taken.

6. Other factors:

None.

7. Evidence statement:	**Evidence grading**
There is evidence from diagnostic studies that nebulisers can become contaminated and infect patients. They must be cleaned and disinfected after each treatment to minimise the risk of HAP.	**3**
8. Recommendation:	
Nebulisers should be single patient use but need to be disinfected and cleaned with sterile water between each use.	**D**
Nebulisers used as part of the ventilator circuit should be single use only.	**GPP**
National guidelines should be followed with regard to the use and cleaning of nebulisers.	**GPP**

References:

53 WY541. Mastro TD, Fields BS, Breiman RF, *et al.* Nosocomial Legionnaires' disease and use of medication nebulizers. *J Infect Dis* 1991; **163**: 667-71.

54 WY540. Craven DE, Lichtenberg DA, Goularte TA, *et al.* Contaminated medication nebulizers in mechanical ventilator circuits. Source of bacterial aerosols. *Am J Med* 1984; **77**: 834-8.

55 WY542. Mertz JJ, Scharer L, McClement JH. A hospital outbreak of Klebsiella pneumonia from inhalation therapy with contaminated aerosol solutions. *Am Rev Respir Dis* 1967; **95**: 454-60.

BSAC	Considered Judgement form HAP Prevention Working Party

Question 7 - For equipment and devices what are the best methods of sterilisation or disinfection and maintenance to reduce the risk of HAP for:

e. filters

Reviewers – Dr Robert Masterton and Dr Robert Spencer

1. Volume of evidence:

Three diagnostic studies [54,56,57] provided evidence to support the use of filters to protect circuit systems but no evidence was established that use of filters specifically protects against HAP.

2. Applicability:

Studies applicable to ventilated patients.

3. Generalisability:

Studies designed to protect equipment not patients.

4. Consistency:

Studies consistent.

5. Clinical impact:

None.

6. Other factors:

None.

7. Evidence statement:	**Evidence grading**
There is an absence of evidence that filters protect against HAP.	**-**
There is some evidence that the use of filters protects the ventilator circuit from contamination.	**2+**
8. Recommendation:	
Filters protect mechanical ventilator circuits from contamination and on this basis are recommended.	**C**
National guidelines should be followed with regard to use of expiratory filters for patients requiring mechanical ventilation who are suffering from highly communicable infections eg SARS, Avian Flu.	**GPP**

References:

54 WY540. Craven DE, Lichtenberg DA, Goularte TA, *et al.* Contaminated medication nebulizers in mechanical ventilator circuits. Source of bacterial aerosols. *Am J Med* 1984; **77**: 834-8.

56 WY547, Luttropp HH, Berntman L. Bacterial filters protect anaesthetic equipment in a low-flow system. *Anaesthesia* 1993; **48**: 520-3.

57 WY550. Berry AJ, Nolte FS. An alternative strategy for infection control of anesthesia breathing circuits: a laboratory assessment of the Pall HME Filter. *Anesth Analg* 1991; **72**: 651-5.

BSAC	Considered Judgement form HAP Prevention Working Party

Question 7 - For equipment and devices what are the best methods of sterilisation or disinfection and maintenance to reduce the risk of HAP for:

g. suction equipment

Reviewers – Dr Robert Masterton and Dr Robert Spencer

1. Volume of evidence:

One systematic review[32], two RCTs and an observational study examined the effect of daily changes of in-line suctioning and found this had no effect on the incidence of VAP compared to less frequent changes.[58,59,60]

2. Applicability:

Applicable to ventilated patients.

3. Generalisability:

Fully generalisable to ventilated patients although the volume of evidence is small.

4. Consistency:

Studies consistent.

5. Clinical impact:

None.

6. Other factors:

None.

7. Evidence statement:	**Evidence grading**
There is no evidence that changing closed suction equipment daily reduces the risk of VAP.	**1+**
The maximum duration that a closed suction catheter can be used for safety and infection control considerations is not known.	**-**
8. Recommendation:	
Daily changes of suction equipment are not required.	**A**
Suction equipment may be changed weekly unless it becomes contaminated or damaged, in which case it should be changed immediately.	**GPP**

References:

32 WY2009. Hess DR – AARC Evidence based clinical practice guidelines; Care of the ventilator circuit and its relation to ventilator-associated pneumonia. *Respiratory Care* 2003; **48**: 869-79.

58 CDC336. Kollef MH, Prentice D, Shapiro SD *et al.* Mechanical ventilation with or

without daily changes of in-line suction catheters. *Am J Respir Crit Care Med* 1997; **156**: 466-72.

59 WY1006. Darvas JA, Hawkins LG. The closed tracheal suction catheter: 24 hour or 48 hour change? *Australian Crit Care* 2003; **16**: 86-92.

60 WY2012. Stoller JK, Orens DK, Fatica c *et al*. Weekly versus daily changes of in-line suction catheters: impact on rates of ventilator-associated pneumonia and associated costs. *Respir Care* 2003;**48**: 494-99.

BSAC	Considered Judgement form HAP Prevention Working Party

Question 7 - For equipment and devices what are the best methods of sterilisation or disinfection and maintenance to reduce the risk of HAP for:

h. resuscitation equipment

Reviewers – Dr Robert Masterton and Dr Robert Spencer

1. Volume of evidence:

There are four diagnostic studies on use of bag-valve mask ventilation (manual ventilation/'Re-breathe') bags that provide evidence to suggest that contaminated resuscitation equipment can act as a source of HAP.[61,62,63,64]

2. Applicability:

Generally applicable.

3. Generalisability:

Small volume of evidence.

4. Consistency:

Consistent.

5. Clinical impact:

None.

6. Other factors:

None.

7. Evidence statement:	**Evidence grading**
There is evidence that use of contaminated resuscitation equipment can act as a source of microorganisms causing HAP.	**3**
8. Recommendation:	
Multi-use, bag-valve mask ventilation (manual ventilation/'Re-breathe') bags should be decontaminated between each patient use according to manufacturer's guidelines to minimise the risk of HAP.	**C**
All reuseable resuscitation equipment should be appropriately decontaminated after use according to manufacturer's recommendations.	**GPP**
If possible single patient use equipment (eg Ambu bag) should be used.	**GPP**

References:

61 WY566. Weber DJ, Wilson MB, Rutala WA *et al.* Manual ventilation bags as a source for bacterial colonization of intubated patients. *Am Rev Respir Dis* 1990; **142**: 892-4.

62 WY564. Stone JW, Das BC. Investigation of an outbreak of infection with

Acinetobacter calcoaceticus in a special care baby unit. *J Hosp Infect* 1986; **7**: 42-8.

63 WY565. Thompson AC, Wilder BJ, Powner DJ. Bedside resuscitation bags: a source of bacterial contamination. *Infect Control* 1985; **6**: 231-2.

64 WY567.Fierer J, Taylor PM, Gezon HM. Pseudomonas aeruginosa epidemic traced to delivery-room resuscitators. *N Engl J Med* 1967; **276**: 991-6.

BSAC	Considered Judgement form HAP Prevention Working Party

Question 7 - For equipment and devices what are the best methods of sterilisation or disinfection and maintenance to reduce the risk of HAP for:

i. anaesthetic machines and breathing systems

Reviewers – Dr Robert Masterton and Dr Robert Spencer

1. Volume of evidence:
A diagnostic study by du Moulin (1997) suggested that basic hygienic management of anaesthetic equipment will prevent cross-infection.[65]
2. Applicability:
Only one study.
3. Generalisability:
Only one study.
4. Consistency:
Only one study.
5. Clinical impact:
None.
6. Other factors:
None.

7. Evidence statement:	**Evidence grading**
There is evidence that basic hygienic management of anaesthetic equipment will ensure safety from cross-infection.	**3**
8. Recommendation:	
Basic hygienic measures should be taken on anaesthetic equipment to reduce the risk of HAP.	**D**
Provided filters are in place to protect the equipment, anaesthetic equipment should be decontaminated according to the manufacturer's instructions.	**GPP**
Changing HME and anaesthetic machine valve between patients and weekly circuit changes should be adequate to prevent infection from anaesthetic machines.	**GPP**
If anaesthetic equipment is used on a known infected patient, tubing and filters should be changed before the next patient use.	**GPP**
Further research recommendation Studies are required to establish the best sterilisation or disinfection and	

maintenance methods that reduce the risk of HAP from anaesthetic machines and breathing systems.	

References:	
65	WY568. du Moulin GC, Sauberman AJ. The anesthesia machine and circle system are not likely to be sources of bacterial contamination. *Anesthesiology* 1977; **47**: 353-8.

BSAC	Considered Judgement form HAP Prevention Working Party

Question 7 - For equipment and devices what are the best methods of sterilisation or disinfection and maintenance to reduce the risk of HAP for:

k. pulmonary function testing equipment

Reviewers – Dr Robert Masterton and Dr Robert Spencer

1. Volume of evidence:

Two diagnostic studies investigated the use of spirometers associated with HAP caused by Acinetobacter.[66,67]

A case-controlled study found that mouthpieces of spirometry tubing may become contaminated and recommended that they should not be shared to prevent acquisition of microorganisms causing HAP.[68]

2. Applicability:

Studies are applicable.

3. Generalisability:

The available evidence is limited to spirometry. However it is reasonable to extrapolate to other respiratory equipment.

4. Consistency:

Consistent to spirometers.

5. Clinical impact:

None.

6. Other factors:

None.

7. Evidence statement:	Evidence grading
There is evidence that mouthpieces of spirometry tubing may become contaminated during use and therefore should not be shared to prevent HAP.	**2+**
8. Recommendation:	
Spirometry mouthpieces should be single use only.	**C**
All respiratory equipment should be viewed as a potential infection risk for HAP where contamination by respiratory secretions is possible and therefore precautions should be taken to reduce such risks.	**GPP**

References:

66 WY563. Cunha BA, Klimek JJ, Gracewski J *et al.* A common source outbreak of Acinetobacter pulmonary infections traced to Wright respirometers. *Postgrad Med J*

1980; **56**: 169-72.

67 WY562. Irwin RS, Demers RR, Pratter MR. An outbreak of acinetobacter infection associated with the use of a ventilator spirometer. *Respir Care* 1980; **25**: 232-7.

68 WY571. Rutala DR, Rutala WA, Weber DJ *et al.* Infection risks associated with spirometry. *Infect Control Hosp Epidemiol* 1991; **12**: 89-92.

BSAC	Considered Judgement form HAP Prevention Working Party

Question 8/9a - Is there any evidence that hand hygiene reduces the risk of transmission of microorganisms causing HAP?

Reviewers – Carole Fry and Jean Armstrong

1. Volume of evidence:

There is good evidence from a systematic review[69], case control and cohort studies,[70,71,72,73] for the effects of hand hygiene on staff to patients and staff to equipment transfer of bacteria.

There is good evidence of an inverse relationship between high standards of hand hygiene and the incidence of healthcare associated infections (HCAI) but no good evidence of a direct relationship with the prevention of HAP.

The evidence based guidelines (*epic* Project) covering the prevention of healthcare associated infection recommend implementation of a hand hygiene policy to prevent hospital acquired infection. [74]

2. Applicability:

Fully.

3. Generalisability:

The evidence, whilst about the reduction of HCAI, is reasonable to extrapolate to HAP.

4. Consistency:

Excellent consistency of findings.

5. Clinical impact:

This is a very simple and cheap intervention that delivers cost effectively without interference to direct patient care.

6. Other factors:

Hand hygiene is reliant on the proper provision of facilities as well as high standards of staff education.

7. Evidence statement:	Evidence grading
Hand hygiene is effective in reducing transmission of microorganisms between patients, staff, equipment and the environment.	**2++**
Hand hygiene is effective in reducing HCAI.	**2++**
8. Recommendation:	
No specific recommendation can be made that hand hygiene will prevent HAP.	**-**
Hand hygiene guidelines are available as part of evidence-based guidelines for preventing healthcare associated infections and should be followed.[74]	**GPP**

Hand hygiene practices should be incorporated into clinical guidelines for the prevention of HAP.	**GPP**
With a view to reducing the incidence of HAP, staff hand hygiene should form part of routine care with hands being decontaminated immediately before and after every episode of direct patient contact and after any activity or contact that potentially results in hands becoming contaminated.	**GPP**
Hand decontamination after glove removal should be performed.	**GPP**
Performance audits of hand hygiene should be performed to demonstrate and maintain high levels of practice.	**GPP**

References:

69 CDC255. Boyce JM, Pitter D, HICPAC/SHENIDSA Hand Hygiene Task Force. Guideline for hand hygiene in healthcare settings. *Federal Regis Lancet Infect Dis* 2003; **5**: 269-70.

70 WY438. Pittet D, Hugonnet S, Harbarth S *et al.* Effectiveness of a hospital-wide programme to improve compliance with hand hygiene. Infection Control Programme. *Lancet* 2000; **356**: 1307-12.

71 CDC241. Adams BG, Marrie T J. Hand carriage of gram-negative rods may not be transient. *J Hyg* 1982; **89**: 33-46.

72 CDC243. Adams BG, Marrie T J. Hand carriage of aerobic gram-negative rods by healthcare personnel. *J Hyg* 1982; **89**: 23-31.

73 CDC259. Doebbeling BN, Pfaller MA, Houston AK *et al.* Removal of nosocomial pathogens from the contaminated glove. Implications for glove reuse and handwashing. *Ann Intern Med* 1988; **109**: 394-8.

74 WY1557. Department of Health and the Hospital Infection Society. The *epic* Project: Developing National Evidence-based Guidelines for Preventing Healthcare Associated Infections – Standard Principles for preventing hospital-acquired infections. *J Hosp Infect* 2001; **47** Suppl: S6.

BSAC	Considered Judgement form HAP Prevention Working Party

Question 8/9b - Is there any evidence that personal protective equipment (PPE) reduces the risk of transmission of microorganisms causing HAP?

Reviewers – Carole Fry and Jean Armstrong

1. Volume of evidence:

There is an absence of evidence available to address this question. The evidence that is available relates to healthcare associated infections (HCAI) and not directly to HAP. There is data showing that the appropriate use of personal protective equipment (PPE) is effective in preventing the spread of microorganisms and HCAI.[74,75]

There is also evidence that surgical masks are inadequate to protect against tuberculosis and some respiratory viruses (eg SARS).[76]

2. Applicability:

Fully applicable to HAP patients.

3. Generalisability:

Fully generalisable.

4. Consistency:

High degree of consistency in studies – no conflicting results.

5. Clinical impact:

This is a very simple and relatively cheap intervention. In terms of both HCAI and HAP it is not known whether it delivers cost effectively.

6. Other factors:

This relies on the provision of appropriate equipment and the necessary training in its use. National health and safety at work requirements such as Personal Protective Equipment (PPE) regulations[77],[78] and Control of Substances Hazardous to Health (COSHH) regulations[79] should be followed.

7. Evidence statement:	Evidence grading
The correct use of PPE will reduce the incidence of HCAI and thereby potentially reduce the incidence of HAP.	**2**
8. Recommendation:	
The role for PPE in the prevention of HAP should involve local risk assessment with reference to national health and safety at work requirements e.g. PPE Regulations[77,78] and local infection control advice.	**D**
High standards of hygiene including hand hygiene and PPE will protect healthcare workers and patients against HCAI from microorganisms including influenza and other viral respiratory pathogens.	**GPP**

Care needs to be taken in the use of PPEs to prevent spreading infection between patients e.g. gloves can contaminate hands if not removed correctly hence the importance of hand decontamination after glove removal[80]	**GPP**
Gloves should be put on immediately before an episode of patient contact or treatment and removed as soon as the activity is completed.	**GPP**
Gloves should be changed between caring for different patients or between different care/treatment activities for the same patient.	**GPP**
Personal respiratory protection is required in certain respiratory infections eg multi-drug resistant tuberculosis, SARS, Avian flu etc or when patients who are severely immunocompromised are exposed to infection (eg not in a HEPA filtered environment). In these instances specialised respiratory protective equipment should be worn.	**GPP**
National guidelines should be followed with regard to protection of staff against highly communicable infections eg SARS, Avian flu.	**GPP**
Isolation of patients with multi-drug resistant infections including pneumonia should be performed alongside the use of PPE to prevent the spread of infection.	**GPP**

References:

74 WY1557. Department of Health and the Hospital Infection Society. The *epic* Project: Developing National Evidence-based Guidelines for Preventing Healthcare Associated Infections – Standard Principles for preventing hospital-acquired infections. *J Hosp Infect* 2001; **47** Suppl: S6.

75 CDC256. Garner JS, Healthcare Infection Control Practices Advisory Committee. Guideline for isolation precautions in hospitals. The Hospital Infection Control Practices Advisory Committee. *Infect Control Hosp Epidemiol* 1996; **17**: 53-80.

76 WY2013. Wake D, Bowry AC, Crook B, Brown RC. Performance of respirator filters and surgical masks against bacterial aerosols. *J Aerosol Science* 1997; **28**: 1311-29.

77 WY1567. Health and safety executive. *Personal Protective Equipment at Work Regulations 1992. Guidance on Regulations L25.* London: HSE Books, 1992 ISBN 0 7176 0415 2.

78 WY1568. Health and safety executive. *Personal Protective Equipment at Work Regulations 2002.* London: HSE Books, 2002

79 WY1569. *The Control of Substances Hazardous to Health Regulations 2002*. Statutory Instruments 2002; London: H.M Stationery Office. No. 2677 ISBN: 0110429192.

80 CDC259. Doebbeling BN, Pfaller MA, Houston AK *et al.* Removal of nosocomial pathogens from the contaminated glove. Implications for glove reuse and handwashing. *Ann Intern Med* 1988; **109**: 394-8.

BSAC	Considered Judgement form HAP Prevention Working Party

Question 8/9e - Is there any evidence that closed suctioning of respiratory tract secretions reduces the risk of HAP?

Reviewers – Carole Fry and Jean Armstrong

1. Volume of evidence:

A systematic review by Dodek[33] considered evidence from four randomised controlled trials (RCTs)[81,82,83,84] and concluded that the type of suctioning system (open or closed) had no effect on the incidence of ventilator associated pneumonia (VAP). Two further RCTs confirmed these findings.[85,86]

Three randomised controlled trials (RCTs) [81,82,83] include assessment of closed and open suctioning but not in relation to preventing HAP.

Combes[82] reported a 3.5 times greater risk of VAP in patients receiving open versus closed suctioning.

2. Applicability:

Applicable to ventilated patients.

3. Generalisability:

Generalisable to ventilated patients only.

4. Consistency:

Not all studies consistent.

5. Clinical impact:

Not applicable.

6. Other factors:

Not applicable.

7. Evidence statement:	Evidence grading
There is no available evidence in relation to HAP.	-
There is a volume of evidence that shows that closed suctioning as opposed to open suctioning of respiratory tract secretions does not affect risk of VAP.	1+
There is no evidence that closed suctioning increases the risk of VAP	1+
8. Recommendation:	
No recommendation can be made on the use of closed suctioning to reduce the risk of HAP to patients.	-
Closed and open suctioning systems can be used without affecting the risk	B

of VAP.	
From a safety perspective, closed suctioning of respiratory tract secretions is of value in reducing the aerosolisation of respiratory tract secretions and protection of healthcare workers.	**GPP**
The number of disconnections of suction equipment should be minimised to reduce the risk of exposure of staff to infected secretions.	**GPP**

References:

33 WY1533. Dodek P, Keenan S, Cook D, *et al.* Evidence-based clinical practice guideline for the prevention of ventilator-associated pneumonia. *Ann Intern Med* 2004; **141**: 305-13.

81 CDC337. Deppe SA, Kelly JW, Thoi LL *et al.* Incidence of colonization, nosocomial pneumonia, and mortality in critically ill patients using a Trach Care closed-suction system versus an open-suction system: prospective, randomized study. *Crit Care Med* 1990; **18**: 1389-93.

82 WY197. Combes P, Fauvage B, Oleyer C. Nosocomial pneumonia in mechanically ventilated patients, a prospective randomised evaluation of the Stericath closed suctioning system. *Intensive Care Med* 2000; **26**: 878-82.

83 CDC335. Johnson KL, Kearney PA, Johnson SB. Closed versus open endotracheal suctioning: costs and physiologic consequences. *Crit Care Med* 1994; **22**: 658-66.

84 WY930. Zeitoun SS, de Barros AL, Diccini S *et al.* Incidence of ventilator-associated pneumonia in patients using open-suction systems and closed-suction systems: a prospective study -- preliminary data. *Rev Lat Am Enfermagem* 2001; **9**: 46-52.

85 WY1031 Topeli A, Harmanci A, Cetinkaya Y, Akdeniz S, Unal S. Comparison of the effect of closed versus open endotracheal suction systems on the development of ventilator associated pneumonia. *J Hosp Infect* 2004, 58: 14-9.

86 WY1642. Lorente L, Lecuona M, Martin MM *et al*. Ventilator-associated pneumonia using a closed versus an open tracheal suction system. *Crit Care Med* 2005; **33**: 115-9.

BSAC	Considered Judgement form HAP Prevention Working Party

Question 10 a(1) - Is there any evidence that the use of non-invasive positive pressure ventilation reduces the risk of HAP?

Reviewers – Dr Robert Masterton and Dr Angela Galloway

1. Volume of evidence:

There is evidence that in selected patients non-invasive ventilation (NIV) reduces the risk of HAP. A Cochrane systematic review by Burns included five RCTs on non-invasive ventilation and found that in patients with COPD, NIV reduces the risk of HAP.[87]

2. Applicability:

Applicable to ventilated patients

3. Generalisability:

The majority of the available data relates to a narrow group of medical respiratory failure patients which are not generalisable.

4. Consistency:

Highly consistent findings.

5. Clinical impact:

Reduces patients' risk and resource implications.

6. Other factors:

None.

7. Evidence statement:	**Evidence grading**
There is evidence that non-invasive ventilation reduces the risk of HAP.	1++
8. Recommendation:	
Non-invasive ventilation (NIV) rather than mechanical ventilation should be used in selected patients to reduce the risk of HAP.	**A**

References:

87 WY2014.Burns KEA, Adhikari NKJ, Meade MO. Noninvasive positive pressure ventilation as a weaning strategy for intubated adults with respiratory failure (Review). *The Cochrane Collaboration* 2005; **3**: 1-26.

145 WY1032. Torres A, Gatell JM, Aznar E et al. Re-intubation increases the risk of nosocomial pneumonia in patients needing mechanical ventilation. *Am J Crit Care Med* 1995: 152: 137-41.

BSAC	Considered Judgement form HAP Prevention Working Party

Question 10a – Is there any evidence that enteral feeding increases the risk of HAP?

Reviewers – Jean Armstrong and Dr Robert Masterton

1. Volume of evidence:

There is one well conducted cohort study in ventilated patients showing a relationship between enteral feeding and aspiration[88] but limited other evidence to support this.

2. Applicability:

Fully.

3. Generalisability:

Fully.

4. Consistency:

Insufficient studies to demonstrate consistency or otherwise.

5. Clinical impact:

Little likely impact.

6. Other factors:

Nil.

7. Evidence statement:	Evidence grading
There is an absence of evidence that the incidence of HAP in ventilated patients will be reduced by taking measures to reduce aspiration associated with enteral feeding.	**2-**
8. Recommendation:	
There is no specific evidence to support a recommendation being made.	**-**
In ventilated patients the rate and volume of enteral feeding should be adjusted to avoid gastric distension and reduce the risk of aspiration.	**GPP**

References:

88 CDC988. Treloar DM, Stechmiller J. Pulmonary aspiration in tube-fed patients with artificial airways. *Heart Lung* 1984;**13**: 667-71.

BSAC	Considered Judgement form HAP Prevention Working Party

Question 10a(2) - Is there any evidence that different methods of enteral feeding reduce the risk of HAP?

Reviewers – Dr Robert Masterton and Dr Angela Galloway

1. Volume of evidence:

A systematic review by Collard (2003)[89] reviewed four RCTs that evaluated different methods of enteral feeding including intermittent feeding,[90] the use of metoclopramide, and acidification of feeding. He reported no difference in the incidence of VAP or mortality with any of these four strategies.

A meta-analysis by Heyland (2002) of 7 RCTs looked specifically at post-pyloric feeding and reported that this was associated with a significant reduction in VAP compared with gastric feeding but suggested that further studies are warranted.[91]

A meta-analysis by Marik (2003) which included 9 RCTs comparing gastric versus post-pyloric feeding found that there was no significant difference in the incidence of pneumonia in each group.[92]

2. Applicability:

Fully

3. Generalisability:

Fully

4. Consistency:

All studies look at different aspects.

5. Clinical impact:

None

6. Other factors:

None

7. Evidence statement:	Evidence grading
There is no clear evidence that intermittent feeding, small intestine feeding, the use of metoclopramide, or acidification of feeding prevent VAP.	**1+**
8. Recommendation:	
The decisions on the method of enteral feeding to be used for critically ill patients should be made locally by each unit and on an individual patient basis.	**A**
When enteral feeding is used the method of delivery should be optimised for each individual patient.	**GPP**
Future Research Recommendation Further research is required into the effect of different modes of feeding on the incidence of HAP.	

References:

89 PMA28. Collard HR, Saint S, Matthey MA. Prevention of ventilator-associated pneumonia: An evidence-based systematic review. *Ann Intern Med* 2003: 138: 494-501.

90 WY1014. Bonten MJM, Gaillard VA, van der Hulst R *et al*. Intermittent enteral feeding: the influence of respiratory and digestive tract colonization in mechanically ventilated intensive-care-unit patients. *Am J Respir Crit Care Med* 1996; **154**: 394-9.

91 WY2015. Heyland DK, Drover JW, Dhaliwal R, Greenwood J. Optimizing the benefits and minimizing the risks of enteral nutrition in the critically ill: role of small bowel feeding. *JPEN J Parenter Enteral Nutr* 2002; **26**: S51-5.

92 PMA24. Marik PE, Zaloga GP. Gastric versus post-pyloric feeding: a systematic review. *Critical Care* 2003; **7**: 46-51.

BSAC	Considered Judgement form HAP Prevention Working Party

Question 10b – Is there any evidence that prevention of aspiration reduces the risk of HAP?

Reviewers – Jean Armstrong and Dr Robert Masterton

1. Volume of evidence:

There is an absence of evidence that prevention of aspiration as such with endotracheal intubation will reduce the incidence of HAP.

There is evidence from a systematic review by Dezfulian of 5 RCTs that subglottic drainage is effective in preventing early onset VAP in patients expected to remain ventilated for more than 72 hours. [93]

A cohort study by Cook (1988) found that witnessed aspiration was associated with an increased risk of VAP.[94]

2. Applicability:

Fully.

3. Generalisability:

Not generalisable.

4. Consistency:

No consistency – very limited number of trials.

5. Clinical impact:

Little likely.

6. Other factors:

None.

7. Evidence statement:	Evidence grading
There is evidence of a relationship between aspiration in ventilated patients and the occurrence of VAP.	**2++**
There is evidence that drainage of subglottic secretions can prevent VAP.	**1+**
8. Recommendation:	
Measures should be taken to reduce the risk of aspiration to prevent VAP.	**B**
Attention needs to be paid to the endotracheal cuff pressure to avoid aspiration and prevent tracheal damage (>25<30cm water).[95]	**GPP**

References:

93 PMA6. Delfuzian C, Shojania K, Collard HR, Kim HM, Matthay MA, Saint S. Subglottic secretion drainage for preventing ventilator-associated pneumonia: a

meta-analysis. *Am J Med* 2005; **118**: 11-8.

94 WY1026. Cook DJ, Walter SD, Cook RJ *et al*. Incidence and risk factors for ventilator-associated pneumonia in critically ill patients. *Annals Intern Med* 1998; **129**: 433-40.

95 WY2016. Rello J, Jubert P Valles *et al*. Evaluation of outcome for intubated patients with pneumonia due to *Pseudomonas aeruginosa*. *Clin Infect Dis* 1996; **23**: 973-78.

BSAC	Considered Judgement form HAP Prevention Working Party

Question 10d – Is there any evidence that reduction of gastric acid by different methods compared to sucralfate, reduces the incidence of HAP?

Reviewers – Jean Armstrong and Dr Robert Masterton

1. Volume of evidence:

Collard in a systematic review looked at evidence from 7 meta-analyses which included 20 RCTs reviewing the risk of VAP associated with the various methods of stress ulcer prophylaxis.[89] Evidence from 4 of these meta-analyses[96,97,98,99] showed that sucralfate significantly reduced the incidence of VAP compared with H_2 antagonists. Three other meta-analyses did not show a statistically significant reduction in VAP with the use of sucralfate but did show trends.[100,101,102]

2. Applicability:

Applicable in ICU patients.

3. Generalisability:

Fully.

4. Consistency:

Good.

5. Clinical impact:

Given the wide clinical need for stress ulcer prophylaxis in critically ill patients this has wide ranging implications.

6. Other factors:

This work relates to gastric emptying issues and risks of aspiration/adverse colonisation.

7. Evidence statement:	Evidence grading
There is evidence that a reduction of gastric acid by various methods including antacids and H_2 antagonists for stress ulcer in ICU patients increases the risk of VAP.	**2++**
There is evidence that use of sucralfate is associated with a reduced risk of VAP compared to use of other agents that raise gastric alkalinity in ventilated patients.	**2++**
8. Recommendation:	
Whenever clinically appropriate stress ulcer prophylaxis should be avoided in order to help preserve gastric function	**B**
Where stress ulcer prophylaxis is indicated, sucralfate is to be preferred in order to reduce the risk of VAP.	**B**

Sucralfate should only be used in patients with low to moderate risk of gastro-intestinal bleeding	**GPP**

References:

89 PMA28. Collard HR, Saint S, Matthey MA. Prevention of ventilator-associated pneumonia: An evidence-based systematic review. *Ann Intern Med* 2003: 138: 494-501.

96 WY2017. Messori A, Trippoli S, Vaiani M, *et al*. Bleeding and pneumonia in intensive care patients given ranitidine and sucralfate for prevention of stress ulcer: meta-analysis of randomised controlled trials. *BMJ* 2000; **321**: 1103-6.

97 WY202. Tryba M, Cook DJ. Gastric alkalinization, pneumonia, and systemic infections: the controversy. *Scand J Gastroenterol* 1995; **210**: 53-9.

98 WY2018. Cook DJ. Stress ulcer prophylaxis: gastrointestinal bleeding and nosocomial pneumonia. Best evidence synthesis. *Scan J Gastroenterol Suppl.* 1995; **210**: 48-52.

99 WY2019. Tryba M. Sucralfate versus antacids or H2-antagonists for stress ulcer prophylaxis: a meta-analysis on efficacy and pneumonia rate. *Crit Care Med* 1991; **19**:942-9.

100 CDC993. Cook DJ, Reeve BK, Guyatt GH *et al*. Stress ulcer prophylaxis in critically ill patients. Resolving discordant meta-analyses. *JAMA* 1996; **275**: 308-14.

101 WY2020. Tryba M. Prophylaxis of stress-ulcer bleeding. A meta-analysis. *J Clin Gastroenterol.* 1991; **13 Suppl 2**: S44-55.

102 CDC994. Cook DJ, Laine LA, Guyatt GH *et al.* TA. Nosocomial pneumonia and the role of gastric pH. A meta-analysis. *Chest* 1991;**100**: 7-13.

BSAC	Considered Judgement form HAP Prevention Working Party

Question 11 – Is there any evidence that instructing patients to cough frequently, take deep breaths and be ambulatory pre- and post-operatively can reduce the incidence of HAP?

Reviewers – Carole Fry and Jean Armstrong

1. Volume of evidence:

There were two cohort studies[103,104] and one RCT [105] which did not specifically look at HAP but considered pulmonary complications in general.

There was one RCT which concluded that the most effective regimen of prophylaxis against pulmonary complications after abdominal surgery was deep breathing for low risk patients.[106]

2. Applicability:

Generally applicable.

3. Generalisability:

Reasonable.

4. Consistency:

Not clear.

5. Clinical impact:

Evidence not clear that the manoeuvres help.

6. Other factors:

None.

7. Evidence statement:	Evidence grading
There is an absence of evidence that instructing patients to cough or take deep breaths can reduce the incidence of HAP.	**2-**
8. Recommendation:	
No recommendations can be made in respect of instructing patients to cough frequently or take exercise in order to reduce the incidence of HAP.	**-**
Coughing during the post-operative recovery period should be encouraged in all patients in order to reduce the risk of other pulmonary complications.	**GPP**
Early post operative mobilisation should be encouraged in order to reduce the risk of other postoperative complications.	**GPP**

References:

103 CDC 379. Roukema JA, Carole EJ, Prins JG. The prevention of pulmonary complications after upper abdominal surgery in patients with noncompromised

pulmonary status. *Arch Surg* 1988; **123**: 30-4.

104 CDC376. Vraciu JK, Vraciu RA. Effectiveness of breathing exercises in preventing pulmonary complications following open heart surgery. *Phys Ther* 1977; **57**: 1367-71.

105 CDC377. Celli BR, Rodriguez KS, Snider GL. A controlled trial of intermittent positive pressure breathing, incentive spirometry, and deep breathing exercises in preventing pulmonary complications after abdominal surgery. *Am Rev Respir Dis* 1984; **130**: 12-5.

106 CDC382. Hall JC, Tarala RA, Tapper J *et al.* Prevention of respiratory complications after abdominal surgery: a randomised clinical trial. *BMJ* 1996; **312**: 148-52.

BSAC	Considered Judgement form HAP Prevention Working Party

Question 12 - Is there any evidence for the role of :

a. Physiotherapy and respiratory therapists in reducing the incidence of HAP

Reviewers – Carole Fry and Jean Armstrong

1. Volume of evidence:

There are no data on the role of physiotherapists and respiratory therapists in reducing the incidence of HAP.

There is one case control study which shows the benefit of chest physiotherapy in preventing VAP.[107]

There is evidence from an RCT by Hall that use of physiotherapy with incentive spirometry, in high risk surgical patients, can reduce respiratory complications.[108]

A systematic review by Stoller (2001) assessing the role of respiratory therapists reported 5 RCTs which showed that respiratory therapists were effective in implementing respiratory care protocols to wean patients from mechanical ventilation and in appropriately allocating respiratory care in adult non-ICU patients.[109] This resulted in reduced costs with no detrimental effects.

2. Applicability:

Fully.

3. Generalisability:

Applies to prevention of VAP only.

4. Consistency:

Insufficient data to comment.

5. Clinical impact:

If applied to all potentially eligible patients this would have major resource implications especially around staffing.

6. Other factors:

None.

7. Evidence statement:	Evidence grading
There is no direct evidence available to assess the role of physiotherapists and respiratory therapists in reducing the incidence of HAP.	-
There is evidence that when respiratory therapists follow protocols on weaning that this will lead to reduced duration of mechanical ventilation, ICU stay and improved outcome.	1+

There is some evidence that using physiotherapy and incentive spirometry in high risk abdominal surgery patients can reduce respiratory complications including pneumonia.	**1+**
8. Recommendation:	
No recommendation can be made about the roles of physiotherapists and respiratory therapists in reducing the incidence of HAP.	**-**
Physiotherapists and respiratory therapist have a role in preventing respiratory complications in post-operative ventilated patients.	**A**
Physiotherapists and respiratory therapists have a holistic role in the pre- and post-operative care of patients, especially in high risk patients, where risk assessment indicates this may be of value.	**GPP**
Future Research Recommendation Further research is required to establish the role of physiotherapy in preventing HAP.	

References:

107 WY1023. Ntoumenopoulos G, Presneill JJ, McElholum M, Cade JF. Chest physiotherapy for the prevention of ventilator-associated pneumonia. *Intensive Care Med* 2002; **28**: 850-56.

108 WY219. Hall JC, Tarala R, Harris J *et al.* Incentive spirometry versus routine chest physiotherapy for prevention of pulmonary complications after abdominal surgery. *Lancet* 1991; **337**: 953-6.

109 WY2021. Stoller JK. Are respiratory therapists effective? Assessing the evidence. *Respir Care* 2001; **46**: 56-66.

BSAC	Considered Judgement form HAP Prevention Working Party

Question 12 - Is there any evidence for the role of:

b. Positional strategies in reducing the incidence of HAP

Reviewers – Carole Fry and Jean Armstrong

1. Volume of evidence:

An RCT by Drakulovic found that the use of semi-recumbent positioning[110] may prevent ventilator associated pneumonia (VAP), although an earlier study with smaller numbers of patients concluded differently.[111] Drakulovic et al, also reported that supine body positioning and enteral feeding were independent risk factors for the development of nosocomial pneumonia.[110]

In an RCT, Guerin looked at the effect of prone positioning on patients with acute respiratory failure and found that there was no general benefit from using prone positioning and there were concerns about safety.[112]

A cohort study by Kollef (1993) showed that patients nursed in supine head positioning during the first 24 hours of ventilation had increased risk of VAP.[113]

In a cohort study Kollef (1997) found that there was a significant increase in VAP in patients transported out of ICU for interventions which was most likely related to positioning.[114]

2. Applicability:

Fully applicable to ventilated patients.

3. Generalisability:

It is unclear if the evidence may be relevant to non-ventilated patients.

4. Consistency:

Insufficient data to comment.

5. Clinical impact:

If applied to all potentially eligible patients this could have a beneficial effect on other aspects of patient recovery.

6. Other factors:

None.

7. Evidence statement:	Evidence grading
There is some evidence that use of the semi-recumbent position may reduce VAP.	**1-**
8. Recommendation:	
Consideration may be given to adopting a positional strategy to prevent VAP.	**C**

Consideration may be given to adopting a positional strategy to also prevent HAP.	**GPP**
If a patient does not require supine positioning consideration should be given to using semi-recumbent positioning as a strategy to prevent VAP (provided there are no contraindications).	**B**
Patients transported out of ICU should be maintained in the semi-recumbent position is possible.	**GPP**
Patients should be kept in a semi-recumbent position during enteral feeding to prevent aspiration.	**GPP**

References:

110 CDC218. Drakulovic MB, Torres A, Bauer TT *et al.* Supine body position as a risk factor for nosocomial pneumonia in mechanically ventilated patients: a randomised trial. *Lancet* 1999; **354**: 1851-8.

111 CDC219. Torres A, Serra-Batlles J, Ros E *et al.* Pulmonary aspiration of gastric contents in patients receiving mechanical ventilation: the effect of body position. *Ann Intern Med* 1992; **116**: 540-3.

112 WY1008. Guerin C, Gaillard S, Lemasson *et al*. Effects of systematic prone positioning in hypoxemic acute respiratory failure. A randomized controlled trial. *JAMA* 2004; **292**: 2379-87.

113 WY1028. Kollef MH. Ventilator-associated pneumonia. A multivariate analysis. *JAMA* 1993;**270**:1965-70.

114 WY185. Kollef MH, Von Harz B, Prentice D, Shapiro SD, Silver P, John RS. Patient transport from intensive care increases the risk of developing ventilator-associated pneumonia. *Chest* 1997;**112:**765-73.

BSAC	Considered Judgement form HAP Prevention Working Party

Question 12 continued

Is there any evidence for the role of:

c. Kinetic beds (oscillatory therapy) in reducing the incidence of HAP

Reviewers – Carole Fry and Jean Armstrong

1. Volume of evidence:

There is one meta-analysis, which includes 6 independent studies[115] and one systematic review that looked at 8 RCTs[33] which reviewed the use of kinetic (oscillating) beds. While these may have an impact on reducing complications associated with intensive care, it was inconclusive with regard to the development of HAP.

2. Applicability:

Not applicable.

3. Generalisability:

Not applicable.

4. Consistency:

Not consistent.

5. Clinical impact:

If applied to all potentially eligible patients this would have major resource implications especially around staffing, capital outlay and maintenance of equipment as well as on feasibility.

Patient acceptability is also an important consideration.

6. Other factors:

None.

7. Evidence statement:	**Evidence grading**
There is limited evidence to support the use of kinetic therapy to prevent HAP.	**1-**
8. Recommendation:	
No recommendation for use of kinetic therapy to prevent HAP can be made from the evidence.	**-**
Future Research Recommendation Research is required to assess the value of kinetic therapy in the prevention of HAP in different patient populations, especially in intensive care units (ICUs).	

References:

115 WY1502. Choi SC, Nelson LD. Kinetic therapy in critically ill patients. Combined results based on meta-analysis. *J Crit Care* 1992; 7: 57-62.

33 WY1533. Dodek P, Keenan S, Cook D, *et al.* Evidence-based clinical practice guideline for the prevention of ventilator-associated pneumonia. *Ann Intern Med* 2004; **141**: 305-13.

BSAC	Considered Judgement form HAP Prevention Working Party

Question 13 - Is there any evidence for the role of incentive spirometry in reducing the risk of HAP?

Reviewers – Carole Fry and Jean Armstrong

1. Volume of evidence:

Evidence is poor with only one randomised controlled trial (RCT) study of some relevance looking at post-operative pneumonia in surgical patients.[108]

2. Applicability:

Generally applicable.

3. Generalisability:

Not generalisable.

4. Consistency:

Not applicable. Most references found are consistent in not looking at the role of incentive spirometry in reducing HAP.

5. Clinical impact:

There is no good evidence that incentive spirometry has any effect on HAP.

6. Other factors:

None.

7. Evidence statement:	Evidence grading
There is an absence of evidence that incentive spirometry has any impact on reducing the risk of HAP in low risk surgical patients after abdominal surgery.	**2-**
There is some evidence that the use of incentive spirometry in high risk surgical patients may be beneficial.	**2-**
8. Recommendation:	
Incentive spirometry has no role to play in prevention of HAP in low risk (ASA grade 1 or 2) surgical patient, including patients who had no pre-existing pulmonary complications.	**D**
Incentive spirometry should be used in high risk patients to prevent respiratory complications.	**D**
Future Research Recommendation Research is required to assess the effects of incentive spirometry in patients requiring surgery.	

References:	
108	WY219. Hall JC, Tarala R, Harris J *et al.* Incentive spirometry versus routine chest physiotherapy for prevention of pulmonary complications after abdominal surgery. *Lancet* 1991; **337**: 953-6.

BSAC	Considered Judgement form HAP Prevention Working Party

Question 14 – What hospital building recommendations or specifications are most effective for preventing the transmission of Aspergillus spores in new and existing intensive or specialist care units?

Reviewers – Dr Angela Galloway and Dr Robert Masterton

1. Volume of evidence:

There is a large body of evidence demonstrating an association between building works, environmental contamination with Aspergillus and pulmonary aspergillosis.[116,117,118]

There is poor quality of evidence in relation to:

- type of building work (construction versus demolition)
- relative contributions of various mechanisms to reduce risk
    a. dust reduction
    b. environmental and air monitoring
    c. antifungal prophylaxis
    d. air handling

2. Applicability:

Fully applicable.

3. Generalisability:

Highly reasonable.

4. Consistency:

High degree of consistency in recommendation for methods of dust reduction.[116,117,118]

5. Clinical impact:

Large potential impact if measures other than simple dust reduction are used.

6. Other factors:

Introducing widespread environmental control eg High Efficiency Particulate Air (HEPA) filtration is expensive.

7. Evidence statement:	Evidence grading
There is good evidence that methods to reduce dust levels result in lower levels of fungal spores in the environment and reduced the incidence of pulmonary aspergillosis during building work.	**2++**
There is evidence that high counts of aspergillus are associated with pulmonary Invasive Aspergillosis (IA). There is an absence of evidence that routinely monitoring spore counts during building work is useful although it is recommended by some authors.[119,120,121]	**2**
Although a protective environment with HEPA filtration reduces the	**2++**

incidence of IA in haemopoietic stem cell transplant (HSCT) patients this will not by itself prevent IA during building work.[120,121]	
8. Recommendation:	

During building works, consideration must be given to addressing the risk of pulmonary aspergillosis. This must include:
• identifying high risk patients i.e. those with acute leukaemia, HSCT patients, patients receiving chemotherapy resulting in severe neutropenia, other immunosupressed patients including those on long term corticosteroids or other immunosuppressive therapy
• methods to reduce all patient's exposure to Aspergillus e.g. use of floor to ceiling barriers, sealing of windows
• the use of HEPA filtration in high risk units
  ○ e.g. HSCT units
  ○ e.g. critical care (NB. Contamination of ventilated areas which are not HEPA filtered)
• dust reduction in clinical areas including cleaning (damp dusting, use of HEPA-filtered vacuum cleaner)
	B
	B
	B
	B

The routine monitoring of air for fungal spores during building work is not recommended.	**D**
During building work, environmental monitoring for fungal spores in critical areas housing at risk patients is useful in monitoring the effectiveness of control measures.	**GPP**
In an outbreak situation environmental or air monitoring maybe useful in identifying the source of infection.	**GPP**
Ventilation systems, especially those which are not HEPA-filtered, may become contaminated during building work. During building work all filters should be regularly inspected and replaced as necessary.	**GPP**

References:

116 WY1570. Centers for Disease Control and Prevention Guidelines for preventing health-care-associated pneumonia, 2003: recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee. *MMWR* 2004; **53** (No RR-3): 6-7.

117 WY1558. Sub-committee of the scientific advisory committee of the national disease surveillance centre. *National guidelines for the prevention of nosocomial invasive aspergillosis during construction/renovation activities. 2002.* Available from: http://www.ndsc.ie/Publications/Aspergillosis/d574.PDF (24 May 2005, date last accessed).

118 WY1559. Division of Nosocomial and Occupational Infections Bureau of Infectious Diseases Centre for Infectious Disease Prevention and Control Population and Public Health Branch Health Canada. *Construction-related Nosocomial Infections in Patients in Healthcare Facilities - Decreasing the Risk of Aspergillus,*

Legionella and Other Infections. Canada Communicable Disease Report 2001; 2752 Available from http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/01pdf/27s2e.pdf (21st June 2005, date last accessed).

119 WY251. Streifel AJ, Vesley D, Rhame FS *et al.* Control of airborne fungal spores in a university hospital. *Environ Int* 1989; **15**: 221-7.

120 WY247. Iwen PC, Davis JC, Reed EC *et al.* Airborne fungal spore monitoring in a protective environment during hospital construction, and correlation with an outbreak of invasive aspergillosis. *Infect Control Hosp Epidemiol* 1994; **15**: 303-6.

121 WY236. Cornet M, Levy V, Fleury L *et al.* Efficacy of prevention by high-efficiency particulate air filtration or laminar airflow against Aspergillus airborne contamination during hospital renovation. *Infect Control Hosp Epidemiol* 1999; **20**: 508-13.

BSAC	Considered Judgement form HAP Prevention Working Party

Question 15 – What hospital building recommendations or specifications are most effective for preventing the transmission of Legionella in new and existing intensive or specialist care units?

Reviewers – Dr Angela Galloway and Dr Robert Masterton

1. Volume of evidence:

There is a large body of evidence consisting of cohort and case control studies.[122,123,124,125,126,127,128,129,130,131]

The Health & Safety Executive (HSE) has issued comprehensive guidance[132] which has recently been revaluated.[133]

2. Applicability:

Fully applicable.

3. Generalisability:

Highly reasonable.

4. Consistency:

Results consistent in demonstrating that each process had an effect in reducing Legionella load although the effect may be temporary. It is not possible however to make full comparisons between the different methods.

5. Clinical impact:

Large impact but hospitals should already be adhering to Department of Health (DH) advice for control of Legionella in hospitals.

6. Other factors:

None.

7. Evidence statement:	Evidence grading
There is a good evidence base showing a relationship between Legionella contamination of hospital water with hospital acquired (HA) Legionella pneumonia.	**2+**
There is good evidence that controlling the risk of Legionella in hospital water supplies reduces the risk of HA Legionella pneumonia.	**2+**
There are a number of methods available to control Legionella in water systems: a) heat b) biocides e.g. chlorine, chlorine dioxide c) ionisation e.g. copper-silver d) ultra violet light and Ozone but a poor quality of evidence comparing the methods.	**2-**

8. Recommendation:	
No recommendation can be made about the most appropriate method of controlling Legionella in hospital water supplies, due, in some part, to the differences in the design of hospital water systems.	-
Appropriate Legionella control of hospital water is required.	**B**
UK HSE guidance on Legionnaires disease - control of Legionella bacteria in water systems[132,133] and all other national guidance should be followed.	**GPP**
For primary prevention attention needs to be given to the design of the water system and maintenance according to national guidance (i.e. circulating water maintained above 60°C).	**GPP**
For secondary prevention (i.e. preventing further cases after a case of hospital acquired infection), additional measures may be required e.g. use of biocides, heat flush etc.	**GPP**
Routine culturing for Legionella, while not routinely recommended, is appropriate in high risk area for haemopoietic stem cell and solid organ transplant wards.	**GPP**
Infection control teams should work closely with hospital engineers, management and physicians to ensure awareness of hospital acquired Legionnaires disease.[134]	**GPP**
Future Research Recommendations Research is needed to confirm the relationship between environmental Legionella and hospital acquired Legionnaire's disease including establishing the relative importance of different serogroups of Legionella pneumophila and other Legionella species.	
Research is required into the different methods of controlling Legionella appropriate to use in different healthcare settings.	

References:

122 WY270. Stout JE, Lin YS, Goetz AM *et al.* Controlling Legionella in hospital water systems: experience with the superheat-and-flush method and copper-silver ionization. [erratum appears in *Infect Control Hosp Epidemiol* 1999; **20**: 302]. *Infect Control Hosp Epidemiol* 1998; **19**: 911-4.

123 WY275. Zacheus OM & Martikainen PJ. Effect of heat flushing on the concentrations of Legionella pneumophila and other heterotrophic microbes in hot water systems of apartment buildings. *Can J Microbiol* 1996; **42**:811-8.

124 WY276. Mermel LA, Josephson SL, Giorgio CH *et al.* Association of Legionnaires' disease with construction: contamination of potable water? *Infect Control Hosp Epidemiol* 1995; **16**: 76-81.

125 WY280. Liu WK, Healing DE, Yeomans JT *et al.* Monitoring of hospital water supplies for Legionella. *J Hosp Infect* 1993; **24**: 1-9.

126 WY269. Liu Z, Stout JE, Boldin M *et al.* Intermittent use of copper-silver ionization for Legionella control in water distribution systems: A potential option in buildings housing individuals at low risk of infection. *Clin Infect Dis* 1998; **26**: 138-40.

127 WY282. Farrell ID, Barker JE, Miles EP *et al.* A field study of the survival of Legionella pneumophila in a hospital hot-water system. *Epidemiol Infect* 1990; **104**: 381-7.

128 WY286. Edelstein PH, Whittaker RE, Kreiling RL *et al.* Efficacy of ozone in eradication of Legionella pneumophila from hospital plumbing fixtures. *Appl Environ Microbiol* 1982; **44**: 1330-4.

129 WY273. Mietzner S, Schwille RC, Farley A *et al.* Efficacy of thermal treatment and copper-silver ionization for controlling Legionella pneumophila in high-volume hot water plumbing systems in hospitals. [erratum appears in *Am J Infect Control* 1998; **26**: 112] *Am J Infect Control* 1997; **25**: 452-7.

130 WY283. Ezzeddine H, Van Ossel C, Delmee M *et al.* Legionella spp. in a hospital hot water system: effect of control measures. *J Hosp Infect* 1989; **13**: 121-31.

131 WY1571. Hamilton E, Seal DV, Hay J. Comparison of chlorine and chlorine dioxide disinfection for control of Legionella in a hospital potable water supply. *J Hosp Infect* 1996; **32**: 156-60.

132 WY1572. Health and Safety Commission. Legionnaires' disease: Control of Legionella bacteria in water systems (L8), 3rd edition. London: HSE, 2000.

133 WY1560. BRE Environment. *Evaluation of HSC's ACOP and Guidance "Legionnaires disease: Control of Legionella bacteria in water systems "(L8)*. http://www.hse.gov.uk/research/rrpdf/rr140.pdf (16 May 2005, date last accessed).

134 WY1573. O'Neill E, Humphries H. Surveillance of hospital water and primary prevention of nosocomial Legionellosis: What is the evidence? *J Hosp Infect* 2005; **59**: 273-9.

BSAC	Considered Judgement form HAP Prevention Working Party

Question 16 – Is there any evidence that cleanliness of intensive care units (ICUs) affects the incidence and transmission of organisms causing HAP?

Reviewers – Dr Angela Galloway and Dr Robert Masterton

1. Volume of evidence:

There are a small number of cohort studies that demonstrate environmental risk related to poor cleaning e.g. Meticillin resistant *Staphylococcus aureus* (MRSA), *Clostridium difficile* but these do not relate directly to HAP or specifically to intensive care units (ICUs). There are a small number of cohort papers that describe the environment as acting as a reservoir for organisms causing infection in patients, though these do not relate directly to HAP or ICUs. These studies demonstrate that taking action to remove the reservoir is effective in preventing related infections.

The epic project review revealed little research evidence of an acceptable quality upon which to base guidance relating to hospital environmental hygiene.[135] However, it noted that there is a large body of clinical evidence, derived from case reports and outbreak investigations, which show links between poor environmental hygiene and the transmission of microorganisms causing healthcare acquired infection (HCAI).[136,137]

2. Applicability:

The available evidence is not directly related to HAP. Given that the routes of transmission for organisms causing of HAP are different from those described in the available reports, where the issues relate mainly to direct contact and contamination spread, the applicability of the available evidence is not strong.

3. Generalisability:

It is not possible to generalise from the available evidence as this is of a low volume and not directly related to HAP, ICUs or in all instances cleaning.

4. Consistency:

The small volume of available evidence is consistent in demonstrating that the environment can act as a reservoir for infection and that taking action to remove the reservoir is effective in preventing infection. However the nature of the evidence is not specific to HAP, ICUs or in all instances to cleaning. The consistency of the evidence makes extrapolation to these issues reasonable.

5. Clinical impact:

There are strong public and staff resource implications around this issue.

6. Other factors:

There are now published cleanliness standards for health providing facilities and these form part of performance assessment reviews.[138,139]

7. Evidence statement:	Evidence grading
There is evidence that there is a risk of HCAI related to persistence of	**2+**

organisms in the environment and that this may be caused by poor standards of hospital cleanliness though no direct association from this has been shown with regard to the development of HAP.	
8. Recommendation:	
In order to reduce the risks of HCAI, including HAP, good approved standards of hospital cleanliness should be maintained.	**D**
The hospital environment must be visibly clean, free from dust and soilage, and acceptable to patients, their visitors and staff.	**GPP**
All staff involved in hospital hygiene activities should undergo education and training related to the prevention of HCAI: such training to include the link between these infections and the cleanliness of the environment.	**GPP**

References:

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BSAC	Considered Judgement form HAP Prevention Working Party

Question 17 – Is there any evidence that use of oral endotracheal intubation is associated with a lower incidence of HAP or VAP compared to nasotracheal intubation?

Reviewers – Angela Galloway and Dr Robert Masterton

1. Volume of evidence:

There is one randomised controlled trial (RCT),[140] which specifically addresses the issue of oral versus nasotracheal intubation with regards to the development of ventilator associated pneumonia (VAP). This and four other RCTs also assess the development of maxillary sinusitis.[141,142,143,144] These all demonstrate an association between nasotracheal intubation and maxillary sinusitis.

There is evidence that re-intubation is associated with increased incidence of VAP.[145]

2. Applicability:

Fully.

3. Generalisability:

Highly reasonable.

4. Consistency:

Good.

5. Clinical impact:

Little likely impact.

6. Other factors:

None.

7. Evidence statement:	Evidence grading
There is evidence from one well conducted RCT that orotracheal intubation is associated with a lower incidence of VAP compared to nasotracheal intubation. This study and four other studies also showed that orotracheal intubation resulted in a reduced incidence of sinusitis.	**1-**
Re-intubation is associated with an increased risk of VAP.	**2+**
8. Recommendation:	
Oral endotracheal intubation should be used in preference to nasotracheal intubation.	**C**
Re-intubation should be avoided if possible.	**C**

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BSAC	Considered Judgement form HAP Prevention Working Party

Question 18 - Is there any evidence that the use of red cell transfusions increase the risk of HAP?

Reviewers – Dr Robert Masterton and Dr Angela Galloway

1. Volume of evidence:

There is a cohort study that demonstrates that transfusion of ≥4 units or red cell concentrate is associated with an increased risk of HAP in cardiac surgery patients.[146]

There is evidence from another cohort study that the use of stored red blood cells increases the risk of HAP.[147]

There is also evidence that a restrictive transfusion policy in intensive care unit patients is at least as effective as a liberal policy with regard to the effect on mortality and multi-organ failure.[148]

In a cohort study Jensen reported that leucocyte-depleted blood was better than buffy-coat-reduced blood in preventing pneumonia in patients undergoing colorectal surgery.[149]

2. Applicability:

Applicable in cardiac and colorectal surgery.

3. Generalisability:

Not generalisable.

4. Consistency:

Studies consistent.

5. Clinical impact:

None.

6. Other factors:

None.

7. Evidence statement:	**Evidence grading**
There is some evidence that the use of red cell transfusions increases the risk of HAP.	**2+**
8. Recommendation:	
Red cell transfusions should be avoided and if used should be with fresh red cells.	**C**
Future Research Recommendation Further research needs to be carried out to establish the effect of red cell transfusions on the development of HAP in other patient groups.	

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