The *epic* project. Updating the evidence-base for national evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in England: a report with recommendations

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Abstract

The evidence underpinning infection prevention and control guidelines requires updating at regular intervals as advances in technology and new research findings may influence guideline recommendations. The evidence-base for national guidelines published in 2001[1] for preventing healthcare-associated infections in hospitals in England has recently been updated using systematic review methods. A critical assessment of the updated evidence indicates that the current guidelines remain robust, relevant and appropriate, but that adjustments need to be made to some guideline recommendations. Periodically updating the evidence base and making necessary adjustments to guideline recommendations is essential, in order to maintain their validity and authority.

Introduction

National evidence-based guidelines for preventing healthcare-associated infections (HAI) in NHS hospitals in England were commissioned by the Department of Health (DH) and developed during 1998 to 2000 by a nurse-led multiprofessional team of researchers and specialist clinicians. Following extensive consultation, they were published in January 2001.[1] These guidelines describe the precautions healthcare workers should take in three areas: standard principles for preventing HAI, which include hospital environmental hygiene, hand hygiene, the use of personal protective equipment, and the safe use and disposal of sharps; preventing infections associated with the insertion and maintenance of short-term indwelling urethral catheters and central venous catheters.

The evidence for these guidelines was identified by multiple systematic reviews of experimental and non-experimental research and expert opinion as reflected in systematically identified professional, national and international guidelines, which were formally assessed by a validated appraisal process.[2,3] Databases were searched from 1966 to June 2000. A cardinal feature of evidence-based guidelines is that they are subject to timely review, in order that new research evidence and technological advances can be identified, appraised and, if shown to be effective in preventing HAI, incorporated into amended guidelines.

This report describes the processes used to identify new evidence, discusses that evidence and makes recommendations for changes to the current guidelines.

Method

Electronic databases (see Table 1) were systematically searched for experimental and non-experimental evidence from the beginning of January 1999 to the end of March 2004. Our strategy involved a comprehensive subject search, employing thesaurus and free text terms, and methodological filters to identify randomised controlled trials (RCT). Because there is limited RCT evidence in the field of infection prevention and control, additional studies, using acceptable non-experimental designs, were also included. Where new technologies relating to the search questions had been implemented, evidence for their effectiveness was included in the search process.

During 2000 to 2002, we were commissioned by the National Institute for Clinical Excellence (NICE) to develop a complementary set of evidence-based guidelines focused on preventing HAI in primary and community care.[4] The search strategies used were adapted and updated from those used in the *epic* guidelines and consequently, our MeSH and free text terms were expanded and in many instances, the evidence identified, retrieved and appraised was also of relevance to updating the hospital-focused guidelines. We also systematically searched for and critically appraised new international and national guidelines from government agencies and professional organisations. Hand searching and grey literature retrieval was not undertaken.

All retrieved evidence was assessed for quality and clinical relevance by two reviewers using the process developed by the Scottish Intercollegiate Guideline Network (SIGN). We have previously described the detailed processes we use for conducting systematic reviews in this field.[4]

Standard principles – hospital environmental hygiene

New evidence supporting the maintenance of hospital environmental hygiene is focused on the importance of ensuring that the physical environment is free of microbial contamination. The presence of invisible contamination as a result of touching by hands is not always explicitly linked to the development of nosocomial infection, but may act as a secondary reservoir.[5-15] Basic hygiene i.e. handwashing and

the use of foot pedals to avoid contaminating the bin, was critical. Routine disinfection should include door handles[5,6] and faucet handles, paper towel dispensers[6] and soap dispensers.[6-11]

Evidence was reviewed that suggested computers used in hospitals can be a potential source of nosocomial infection and that cleaning of computer equipment, e.g. mouse, keyboard, particularly in high-risk areas, must be incorporated into routine cleaning procedures.[7]

Areas that had more stringent routine cleaning programmes had less microbial contamination. Of 82% of ward sites assessed as visually clean, only 24% were considered clean using adenosine triphosphate bioluminescence (ATP) and 30% using microbial techniques.[8] Data suggested that visual assessment of cleanliness was of limited value and should be used only as the first stage in an integrated monitoring programme.

As regards equipment used for more than one patient, a systematic review identified a clear relationship between equipment contaminated with methicillin-resistant *Staphylococcus aureus* (MRSA) and colonised/infected patients within the clinical setting.[9] The equipment covered by this review included: carpet, laryngoscope blades, ventilation grills, curtains, moving and handling equipment, ultrasound probes, staff pens, stethoscopes, linen bags and dry mops. These objects were all found to act as reservoirs for MRSA. Current general cleaning practice was insufficient to remove MRSA from items of equipment and the inanimate environment. This review also considered staff knowledge and frequency of cleaning practices and concluded that further staff education was warranted to promote optimal cleaning practices to minimise contamination and spread of MRSA in the clinical area.

An observational study evaluated three audit tools of cleanliness in surgical and paediatric wards in four hospitals.[12] The three tools were: Audit for cleaning efficacy (ACE); Standards for environmental cleanliness (SEC); and the NHS patient environment audit (PEA). Both SEC and PEA rely on visual assessment, whereas ACE includes rapid hygiene monitoring (using ATP). The ACE audit gave a significantly ($p = < 0.001$) better indication of the adequacy of cleaning regimens and the study suggests that internal audits should incorporate rapid hygiene testing.

Another study compared MRSA acquisition rates pre- and post-increased cleaning in a male surgical ward, following recognition that standard outbreak cleaning produced only a temporary solution.[13] The cleaning hours were increased from 66.5 hours per week to 123.5 and an agreed cleaning protocol, included cleaning of ventilation ducts, radiators, equipment and curtain laundering. Although the follow-up was only for six months, only three patients were reported to be colonised with the outbreak strain of MRSA compared with 30 in the pre-intervention period, and no environmental swabs were positive. The increased cleaning costed £8,750 compared with £27,786 saved in treatment costs.

In an observational study conducted in an 11-bedded purpose-built cohort unit, investigators measured the effect of a detailed cleaning protocol and terminal disinfection programme on the environmental control of MRSA over the first six months of use in the unit.[14] Environmental contamination was measured at baseline, 48 hours, six weeks and six months and before and after every patient discharge. Environmental contamination remained at very low levels with none of the bed spaces remaining contaminated after terminal cleaning.

Finally, a prospective study comparing the effectiveness of standard hospital terminal cleaning of side rooms, with a commercial hydrogen peroxide vapour decontamination system (BIOQUELL).[15] Standard methods of terminal cleaning were ineffective in eliminating MRSA, with 66% of swabs MRSA-positive post-cleaning compared with 1.2% using hydrogen peroxide. The vapour system requires five hours to complete the process. No economic analysis was included, which is important as currently only BIOQUELL can administer the system.

Standard principles – hand hygiene

Following the publication of the 2001 guidelines, a number of studies reported the effectiveness of alcohol hand hygiene products and their impact on staff compliance with hand hygiene requirements. Our systematic review identified 17 acceptable studies that compared hand hygiene preparations including alcohol-based hand rubs and gels, antimicrobial handwashes and liquid soap. Five of the studies were RCTs, conducted in clinical settings comparing the use of alcohol-based preparations with other agents.[16-20] Four RCTs demonstrated alcohol to be a more effective hand hygiene agent than non-medicated soap and antimicrobial handwash,[16-19] while a fifth study found no statistical difference between the use of alcohol and antiseptic soap.[20] These studies underpin a growing trend to adopt the use of alcohol-based hand rinses and gels in clinical practice. Three clinically-based, quasi-experimental studies [21-23] and eight controlled laboratory experiments [24-31] also demonstrated an association between reductions in microbiological flora and the use of alcohol-based preparations. However, one laboratory study, using European Union (EU) reference standards raises the possibility that gels may not be as effective as hand rubs for short durations of use.[30] One clinically-based quasi-experimental study compared the use of two antimicrobial handwash preparations in reducing MRSA.[32]

When deciding which hand decontamination preparation to use, the practitioner must consider the need to remove transient and/or resident hand flora. Preparations with a residual effect contain antimicrobial agents and are not normally necessary for everyday clinical practice, but may be used for some invasive procedures and in outbreak situations. What is important is that healthcare practitioners use an appropriate preparation to decontaminate their hands. International guidelines[33] suggest that the acceptability of agents and techniques is an essential criterion for the selection of preparations for hand hygiene. Acceptability of preparations is dependent upon the ease with which the preparation can be used in terms of time and access together with their dermatological effects.[33]

Investigations into the technique of hand decontamination are limited. Our systematic review identified one RCT comparing different durations of handwashing and hand-rubbing on bacterial reduction that found no significant differences between the two study groups.[16] One laboratory study investigating methods of hand-drying found no statistically significant differences between the four methods studied.[34] A further study indicates that there is an association between hand contamination and the wearing of rings in clinical care.[35] It suggests that the removal of rings should result in decreased frequency of hand carriage of potential pathogens before and after the performance of hand hygiene. Consequently, the duration of hand decontamination, the exposure of all aspects of the hands and wrists to the preparation being used, the use of vigorous rubbing to create friction, thorough rinsing in the case of handwashing, and ensuring that hands are completely dry are key factors in effective hand hygiene and the maintenance of skin integrity.[33]

Table 1. Databases searched

- Medline
- Cumulated index of nursing and allied health literature (CINAHL)
- Embase
- The Cochrane Library
- The National Electronic Library for Health
- The NHS centre for reviews and dissemination (CRD)

  CRD includes three databases: Database of abstracts of reviews of effectiveness (DARE); NHS economic evaluation database (NHS EED); Health technology assessment (HTA) database
- Health CD database
- Health management information consortium database (HMIC)

  HMIC includes the Department of Health library and information service (HELMIS) and the Nuffield Institute and the King's Fund database
- The national research register
- The web of science
- The institute of health technology

Standard principles - personal protective equipment

Gloves

Much of the new evidence in this section adds weight to the existing recommendations. One area where new evidence has arisen confirms the need to decontaminate hands following the use of gloves. New expert opinion supports the use of handwashing after removing gloves as gloves reduce the risk of contamination, but do not necessarily eliminate it.[36] This was further confirmed by one clinical study that demonstrated hand contamination with vancomycin-resistant Enterococcus (VRE) after the removal of gloves.[37] An observational study of staff in an intensive care unit (ICU) showed that although compliance with handwashing was overall low, staff wearing gloves were more likely to wash their hands than those not wearing gloves.[38]

Sensitivity to latex

Since the publication of the 2001 guidelines, revised standards relating to the manufacture of medical gloves for single use have been implemented, which require gloves regardless of material to perform to the same standard.[39-41] A laboratory study comparing the performance of nitrile, latex, copolymer and vinyl gloves under stressed and unstressed conditions found that nitrile gloves had the lowest failure rate adding further evidence to support their use instead of latex.[42] In addition, the study noted variation in the performance of the same type of glove produced by different manufacturers and suggested a test and rating system would assist purchasing.

Protective clothing

New expert opinion confirms the guidance that protective clothing should be worn by all healthcare practitioners when contamination with blood, body fluids, secretions, or excretions (with the exception of sweat), or when close contact with the patient, materials or equipment may lead to contamination of the clothing with micro-organisms.[36] Plastic aprons continue to be recommended for general use, but unused aprons need to be stored carefully, i.e. away from potential contamination.[43]

Two studies compared the use of gowns and gloves as opposed to gloves only in the acquisition of VRE and, in both instances, reported gowns and gloves provided the better protection.[44,45] A third study demonstrated high levels of contamination of gowns, gloves and stethoscopes with VRE following examination of patients known to be infected, which highlights the importance of universal use of protective clothing to prevent dissemination of VRE from patients not known to be infected.[46]

Facemasks

Two studies were identified that reinforced the use of masks. One study was a case control study of infected and non-infected staff with documented exposure to severe acute respiratory syndrome (SARS) index patients.[47] The use of surgical masks or particulate filter respirators were the key infection prevention measure and the study showed that where all four infection prevention measures (masks, gloves, gowns and handwashing) were used, staff were not infected, whereas infected staff omitted at least one measure and two were only using paper masks rather than surgical or N95 masks. This study supports the view that SARS is spread by droplet and confirms the protective effect of appropriate masks.

The second study was a two-phase experiment to test the use of masks in preventing epidemic methicillin-resistant *Staphylococcus aureus* (EMRSA) carriage in staff.[48] Although during the period of wearing a mask, acquisition of nasal, throat and hand EMRSA reduced, due to the small numbers in the study, the significance was borderline.

Sharps

No additional research evidence was obtained as a result of the systematic review for the safe use and disposal of needles and sharp instruments.

Discussion

Although the current guidelines are robust, the new evidence in the fields of hospital environmental hygiene, hand hygiene and personal protective equipment suggests that the wording of the existing guidelines should be consistent with those in the NICE guidance on the prevention of HAI in primary and community care.

Evidence suggests that recommendations for hospital environmental hygiene need to include assessment and regular monitoring of cleaning and hygiene standards within all clinical areas, in particular high-risk areas such as ICUs and environments where patients with multi-resistant organisms have been placed.

Current guidance does not take account of the new evidence in the field of hand hygiene practice and requires updating to emphasise the use of alcohol hand rub between all clinical care activities that do not result in gross contamination.

The recommendations on the use of gloves need amending in two areas. First, they need to be strengthened as regards handwashing on the removal of gloves. Second, the revised standards on the quality of single-use gloves needs to be reflected in the guidelines.

Preventing urinary tract infections associated with the insertion and management of short-term indwelling urethral catheters

Our systematic review identified new evidence relating to the efficacy of using antiseptic impregnated or antimicrobial-coated urinary catheters and the importance of individual care regimens designed to minimise the problems or encrustation and blockage. In addition, there is evidence from best practice that emphasises that all procedures relating to the catheter or the catheter drainage system, including the related batch codes of these devices, are recorded in the patient's records.[49] Patients should be provided with adequate information in relation to the need, insertion maintenance and removal of their catheter by the person planning their care.[49]

Choice of catheter material

The most significant new evidence concerned the use of impregnated catheters. A Cochrane Review of the types of urethral catheters used for short- term catheterisation considered the use of antiseptic impregnated (silver alloy and silver oxide) and antibiotic coated catheters.[50] Silver alloy catheters were found to significantly reduce the incidence of asymptomatic bacteriuria in hospitalised adults catheterised for less than one week, compared with standard catheters. At greater than one week's use, the risk of asymptomatic urinary tract infection was still reduced using silver alloy. Silver alloy also reduced the risk of symptomatic urinary tract infection. However, the trials were generally of poor quality and the review noted that further economic evaluation is required to confirm cost effectiveness, i.e. that the increased cost of a silver alloy catheter (almost twice that of a standard catheter) is offset by the reduction in catheter-related infections. A theoretical economic evaluation suggested that silver catheters would provide savings in 84% of cases, but this needs to be tested in practice.[51]

Catheters coated with a combination of minocycline and rifampin may also be beneficial in reducing bacteriuria in hospitalised men catheterised less than one week, but this requires further testing.[50] Silver oxide catheters were not associated with a reduction in bacteriuria, which confirms a previous report[52] and are no longer manufactured.

Urinary blockage

Unless on insertion, the use of a catheter can be predicted to be a matter of a few days, patients may suffer from catheter encrustation and blockage. A laboratory study demonstrated that any effect from washouts was only temporary.[53] Study investigators commented that these agents may prove detrimental to patients with dehydration or low urine output. A study using a model bladder identified that while saline had no effect on encrustation, Suby G and mandelic acid washouts both made it more difficult for *Proteus mirabilis* to adhere to catheters.[54] Evidence from best practice suggests that the introduction of such agents may have local toxic side-effects and contribute to the development of resistant micro-organisms.[55]

A controlled laboratory study tested the effect of triclosan being added to the catheter balloon, using artificial urine contaminated with *P. mirabilis*.[56] The pH of the urine in the triclosan group stayed constant at 6.7 for seven days and the catheter drained freely, whereas the control pH rose from 6.1 to 8.6 and catheters blocked in a mean of 24 hours 15 minutes. This study suggests that triclosan can diffuse through the catheter into urine and reduce encrustation, but this has not been confirmed with a clinical study.

Discussion

The guidelines for preventing infections associated with the use of short-term indwelling urethral catheters continue to reflect current evidence. However, they should now include the appropriate use of silver alloy catheters and the need to develop individual care regimens, if it is anticipated that catheterisation may be required beyond a few days.

Preventing infections associated with the insertion and maintenance of central venous catheters

These guidelines are primarily based upon an expert review of evidence-based guidelines for preventing intravascular device-related infections developed at the Centers for Disease Control and Prevention (CDC) in the US by the Healthcare Infection Control Practices Advisory Committee (HICPAC).[57] In 2002, updated HICPAC guidelines for preventing intravascular device-related infections were published.[58] Using a validated guideline appraisal instrument developed by the AGREE collaboration,[59] three experienced appraisers independently reviewed these guidelines, taking into consideration supplementary information provided by HICPAC at our request. We concluded that the development processes were valid and that the guidelines were evidence based, categorised to the strength of the evidence examined, reflective of current concepts of best practice, and acknowledged as the most authoritative reference guidelines currently available. They were subsequently used as the principal source of evidence for updating the current guidelines. In addition, we systematically searched the literature up to March 2004 for additional evidence not cited in the HICPAC guidelines.

Catheter selection

Trial evidence continues to accumulate that confirms the efficacy of antimicrobial/antiseptic impregnated central venous catheters (CVCs) to prevent catheter-related bloodstream infections (CRBSI) in some circumstances. HICPAC reviewed new evidence including two meta-analyses, which concluded that catheters impregnated with chlorhexidine-silver sulphadiazine (CSS) decreased the incidence of CRBSI by 2.2% compared with inactive control catheters,[60,61] and a large RCT that showed that catheters treated with minocycline and rifampin were more efficacious in preventing CRBSI compared with those treated with CSS.[62] Our review identified a meta-analysis of 23 RCTs published between 1988 to 1999 and which included data on 4,660 catheters (2,319 anti-infective and 2,341 control).[63] Study authors concluded that: antibiotic and CSS coatings are anti-infective for short (about one week) insertion time. For longer insertion times, there are no data on antibiotic coating, and there is evidence of lack of effect for CSS coating. For silver-impregnated collagen cuffs, there is evidence of lack of effect for both short- and long-term insertion.

Two recent decision model analyses of the cost and efficacy of CVCs coated with either CSS or rifampin-minocycline (RM) at preventing CRBSI concluded that both reduced rates of CRBSI and were cost-effective and their use may lead to significant savings.[64,65]

HICPAC now recommend using an antimicrobial or antiseptic-impregnated CVC in adults whose catheter is expected to remain in place > 5 days if, after implementing a comprehensive strategy to reduce rates of CRBSI, the CRBSI rate remains above the goal set by the individual institution based on benchmark rates and local factors. The comprehensive strategy should include the following three components: educating persons who insert and maintain catheters; use of maximal sterile barrier precautions; and a 2% chlorhexidine preparation for skin antisepsis during CVC insertion.[58]

Catheter insertion site

No RCTs have satisfactorily compared infection rates for catheters placed in jugular, subclavian, and femoral sites. However, there is evidence that demonstrates that catheters inserted into an internal jugular vein have been associated with higher risks than those inserted in a subclavian or femoral vein.[66-68] Femoral catheters have been demonstrated to have relatively high colonisation rates when used in adults[69] and should be avoided, because they are associated with a higher risk of deep vein thrombosis (DVT) than are internal jugular or subclavian catheters[70-74] and because of a presumption that such catheters are more likely to become infected. Thus, in adult patients, a subclavian site is preferred for infection control purposes, although other factors, e.g. the potential for mechanical complications, risk for subclavian vein stenosis, and catheter-operator skill, should be considered when deciding where to place the catheter. HICPAC cited a meta-analysis of eight studies[75] and guidelines from NICE indicate that the use of bedside ultrasound for the placement of CVCs, substantially reduced mechanical complications compared with the standard landmark placement technique.[76] Consequently, the use of ultrasound may indirectly reduce the risk of infection by facilitating mechanically uncomplicated subclavian placement.

Skin antisepsis

HICPAC described compelling evidence that aqueous chlorhexidine 2% was superior to either 10% povidone iodine or 70% alcohol in lowering CRBSI rates when used for skin antisepsis prior to CVC insertion.[77,78] HICPAC now recommends the use of 2% chlorhexidine to be preferentially used for skin antisepsis prior to CVC insertion and for insertion site dressing changes.

A more recent meta-analysis assessed studies that compared the risk for CRBSI following insertion-site skincare with either any type of chlorhexidine gluconate (CHG) solution vs. povidone iodine (PI) solution.[79] This analysis indicated that the use of CHG rather than PI can reduce the risk for CR-BSI by approximately 49% (risk ratio, 0.51 [CI, 0.27 to 0.97]) in hospitalised patients who require short-term catheterisation, i.e. for every 1000 catheter sites disinfected with CHG rather than PI,[71] episodes of catheter colonisation and 11 episodes of CR-BSI would be prevented. In this analysis, several types of CHG solutions were used in the individual trials, including 0.5% or 1% CHG alcohol solution and 0.5% or 2% CHG aqueous solution. All of these solutions provided a concentration of CHG that is higher than the minimal inhibitory concentration for most nosocomial bacteria and yeasts.

Anticoagulants

Indwelling central venous and pulmonary artery catheters are thrombogenic and thrombus may serve as a nidus for microbial colonization of intravascular catheters.[80] Prophylactic heparin and warfarin have been widely used to prevent catheter thrombus formation and catheter related complications, such as CRBSI and DVT.[58,81]

A meta-analysis of randomised controlled trials[81] evaluating the benefit of infused prophylactic heparin through the catheter, given subcutaneously or bonded to the catheter in patients with CVCs found that prophylactic heparin: was associated with a strong trend for reducing catheter thrombus (RR, 0.66; 95% confidence interval [CI], 0.42,1.05).

The authors of this meta-analysis concluded that heparin administration effectively reduces thrombus formation and may reduce catheter-related infections in patients who have central venous and pulmonary artery catheters in place. However, the efficacy of using anticoagulants for preventing CRBSI remains controversial.

Heparin versus normal saline intermittent flushes

Although many clinicians use low dose intermittent heparin flushes to fill the lumens of CVCs locked between use in an attempt to prevent thrombus formation and to prolong the duration of catheter patency, the efficacy of this practice is unproven. Despite its beneficial

antithrombotic effects, decreasing unnecessary exposure to heparin is important to minimise adverse effects associated with heparin use, e.g. autoimmune-mediated heparin-induced thrombocytopenia, allergic reactions and the potential for bleeding complications following multiple, unmonitored heparin flushes.[82] The risks of these adverse effects can be avoided by using 0.9% sodium chloride injection instead of heparin flushes. A systematic review and meta-analysis of RCTs evaluating the effect of heparin on duration of catheter patency and on prevention of complications associated with the use of peripheral venous and arterial catheters concluded that heparin at doses of 10 u.i/mL for intermittent flushing is no more beneficial than flushing with normal saline alone.[83] This finding was in agreement with two other meta-analyses.[84,85] However, there are exceptions. Manufacturers of implanted ports or opened-ended catheter lumens may recommend heparin flushes for maintaining catheter patency and many clinicians feel that heparin flushes are appropriate for flushing CVCs that are infrequently accessed.

HICPAC reviewed all of the evidence[80-92] for intermittent heparin flushes and systemic heparin and warfarin prophylaxis and concluded that no data demonstrated that their use reduces the incidence of CRBSI and did not recommend them.[58] Although their use for preventing CRBSI remains controversial, patients who have CVCs may also have risk factors for DVT and systemic anticoagulants may be prescribed for DVT prophylaxis.

Discussion

The majority of the current guideline recommendations are congruent with the updated HICPAC guidelines[58] and with new evidence. However, adjustments will be needed in some intervention categories.

Our review identified increasing evidence of efficacy for antimicrobial/antiseptic coated or impregnated catheters to prevent CRBSI in well-defined patient populations, which reinforces our current recommendations for their use.

New guidelines will need to refer to NICE guidance on using ultrasound for placement of CVCs. As subclavian vein insertion is associated with the least risk of CRBSI, but is also associated with more mechanical complications then internal jugular or femoral insertion sites, the use of ultrasound locating devices may increase the utilisation of the subclavian vein site.

The use of 2% chlorhexidine gluconate for skin antisepsis prior to catheter insertion and for catheter site care should be explicitly emphasised in the guidelines. HICPAC is now recommending an alcoholic solution of chlorhexidine gluconate 2% as this combines the benefits of rapid action and excellent residual activity.

Finally, the theoretical benefit of using low dose intermittent heparin flushes for preventing infection is outweighed by potential adverse effects of unnecessary exposure to heparin. The guidelines should recommend the routine use of normal saline flushes and reserve heparin flushes for specific implanted ports or open-ended catheter lumens or for those catheters that are infrequently accessed.

Recommendations

The appraisal of new evidence (and in a few instances, a reappraisal of previous evidence) confirmed that although the original guidelines were generally robust and still applicable, a few recommendations require adjustment or change. Additionally, as a result of advances in technology, new guidance may now be needed in some areas.

We recommend that NICE include the *epic* guidelines for preventing HAI in hospitals in their programme of guidelines scheduled for review and revision. This will ensure that these guidelines remain accurate to emerging evidence and relevant to infection prevention control measures. In the meantime, we intend to share our findings with the professions through appropriate publications, emphasising the general robustness of the *epic* guideline recommendations, but emphasising that all evidence-based guidelines require periodic review and updating.

Referencing note

To match the style of the distributed version of this report we have used Vancouver referencing. Authors please not that in general they must use Harvard referencing for *BJIC*.

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