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| Surgical Site Infections (SSIs) following C section procedures: A Review of the Evidence around Interventions to Reduce Infection |
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| **Date:** 05 September 2013 | **Version:** 1 |
| **Publication/ Distribution:**  1000 Lives plus, Health Boards in Wales |
| **Purpose and Summary of Document:** The present document reports on a review of the current evidence / guidelines in the prevention and treatment of SSI. It covers evidence through the three phases of surgery – preoperative, intra-operative and postoperative phases. This document is intended as a summary document for discussion by Health Boards in the first instance. |

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**Introduction**

SSIs are defined as infections that occur in a wound following invasive surgical procedures1. SSIs are one of the most important causes of healthcare-associated infections (HCAIs) estimated to account for 23.7% of inpatient HAI within acute hospitals in NHS Wales2. SSIs cause excess morbidity and mortality and are estimated on average to double the cost of treatment, mainly due to an increase in hospital length of stay3. SSI have serious consequences for patients affected as they can result in pain, suffering and additional surgical intervention on occasions4. SSI is the second most common infection following a C section within a group of patients who are generally considered to be young, fit and well females5.

SSI can result from contamination of the wound site and microorganisms can gain access via a number of sources including from the skin prior to surgery, from surgical instruments, from the environment during surgery; or during provision of care post surgery1.Most importantly the key interventions focus on removing microorganisms from the skin prior to surgery as well as minimising the chance of multiplication of microorganisms during the surgical procedure; minimising the impact of existing co-morbidities on the immune response of the patient undergoing the surgical procedure; and reducing the risk of microorganisms gaining entry to the wound site post surgery1.

This review has been conducted to ascertain whether there is any new or up-to-date evidence / guidance on current interventions recommended for minimising the risk of SSI. It covers evidence through the three phases of surgery – preoperative, intra-operative and postoperative phases.

Clinical guidelines have been defined as ‘systematically developed statements which assist clinicians and patients in making decisions about appropriate treatment for specific conditions’. The Centers for Disease Control and Prevention (CDC)6 produced guidelines for prevention of SSI in 1999. Since this time The National Institute for Health and Clinical Excellence (NICE)1 has produced guidelines on preventing surgical wound infections (2008). These provide a comprehensive review of the evidence base on which recommendations for best practice are founded. Although the care bundles and care pathways utilised have been based on the NICE / CDC guidance there is a need for review of the evidence as a consequence of further research of current interventions and new research leading in some instances to new interventions.

This document will summarise those interventions currently in place within UK hospitals or under discussion for best practice:

1. **Pre operative phase**
	1. Screening and decolonisation
	2. Hair removal
	3. Preoperative showering

**2. Intra operative phase**

* 1. Skin preparation
	2. Antibiotic prophylaxis
	3. Normothermia
	4. Glucose control

*2.5 Other considerations:*

Incise drapes

Supplemented oxygen

Skin closure methods

Theatre environment

1. **Post operative phase**
	1. Surgical dressing
	2. Hand hygiene

*3.3 Other considerations:*

Educating women (pre operative and post operative)

Education of community midwives on diagnosing a wound specific to c sections

**Summary of main recommendations outlined in this document**

1. **Pre operative phase**
	1. *Screening and decolonisation*
* There is evidence to suggest a reduction in MRSA infections when MRSA screening is carried out.
* In Wales, the Welsh Healthcare Associated Infection Programme (WHAIP) has evaluated the Scottish Pathfinder Programme and concludes no evidence to support a change to universal MRSA screening of all patients admitted to hospital.
* All NHS bodies in Wales with in-patient beds are required to review local policy on MRSA screening to ensure that it includes recommendations set out in the CMO letter (18th February 2013).
	1. *Hair removal*
* Do not use hair removal routinely to reduce the risk of surgical site infection.
* If hair has to be removed, use electric clippers with a single-use head on the day of surgery.
* Do not use razors for hair removal, because they increase the risk of surgical site infection*.*
* Where hair removal is required it should be undertaken as close to the time of surgery as possible but clipping on the day of surgery may be preferable.

*1.3 Preoperative showering*

* Follow the NICE guidelines:

Advise patients to shower or have a bath (or help patients to shower, bath or bed bath) using soap, either the day before, or on the day of, surgery.

**2. Intra operative phase**

* 1. *Skin preparation*
* Prepare the skin at the surgical site immediately before incision using an antiseptic (aqueous or alcohol-based) preparation: povidone-iodine or chlorhexidine are most suitable.

The following is based on the Department of Health High Impact Intervention and should be considered in Wales:

* Patients skin has been prepared with 2% chlorhexidine gluconate in 70% isopropyl alcohol solution and allowed to air dry (if the patient has a sensitivity, povidone-iodine application is used)
	1. *Antibiotic prophylaxis*
* Prophylactic antibiotics given at C Section before skin incision. Inform patient that this reduces the risk of maternal infection more than prophylactic antibiotics given after skin incision, and that no effect on the baby has been demonstrated.
* Appropriate antibiotics administered within 60 minutes prior to incision.

*2.3 Normothermia*

* Maintain body temperature above 36oC in the peri-operative period.
* Full guidance can be obtained from the NICE; Inadvertent perioperative hypothermia (2008) guideline35.

*2.4 Glucose control*

* Do not give insulin routinely to patients who do not have diabetes to optimise blood glucose postoperatively as a means of reducing the risk of SSI.

The Department of Health High Impact Intervention8 recommends the following:

* A glucose level of <11mmol/l should be maintained in diabetic patients.
1. **Postoperative phase**
	1. *Surgical dressing*
* NICE guidelines1 recommend that the surgical incision is covered with an appropriate interactive dressing at the end of the operation.
* C Section NICE guidelines42 recommend that the dressing should be removed 24 hours after the c section.
	1. *Hand hygiene*
* NICE guidelines1 recommend using an aseptic non-touch technique for changing or removing surgical wound dressings.
1. **Pre operative phase**
	1. Screening and decolonisation

*Staphylococcus aureus* is the microorganism most commonly cultured from SSIs and is mainly thought to originate from the patients themselves. Operations on sites that are normally ‘clean’ have a relatively low rates of SSI (generally less than 2%), whereas after operations in ‘contaminated’ or ‘dirty’ sites, rates may exceed 10%1.

Within the Scottish targeted literature review (replacing the Scottish care bundle for reducing SSI)7 and the High Impact Intervention care bundle to prevent SSI (Department of health, England)8 screening of patients for meticillin resistant *Staphylococcus aureus* (MRSA) is carried out using local guidelines. Scotland has a National MRSA screening programme (in place since 2009). This was as a result from the findings within the MRSA Screening Pathfinder Programme report9. Health Protection Scotland (HPS) carried out a large prospective cohort study of MRSA screening that included decolonisation of approximately 80,000 admissions to acute settings within three NHS boards. Findings of the report demonstrated a significant reduction of MRSA colonisation prevalence which fell from 5.5% to 3.5% by the end of the study.

The programme recommended a minimum screening practice be adopted across NHS Scotland in the form of a three question clinical risk assessment (CRA) to be applied on admission or pre-admission. This was endorsed by the Scottish Government. The CRA approach offers the opportunity to apply a consistent risk-based approach to pre-emptive management of patients at high risk colonisation and infection.

In Wales the Welsh Government advised that national policy on MRSA screening of patients admitted to hospitals would be revisited when the Scottish Government pilot screening Pathfinder Programme outcome was evaluated (CMO / CNO letter (2008) 02).

Public Health Wales, Welsh Health Care Associated Infection Programme (WHAIP) team evaluated the Pathfinder Programme in 2011 (CMO letter 18th February 2013) and concluded that there is **no evidence to support a change to universal MRSA screening of all patients admitted to hospital** by swabbing. The approach within Wales should continue to focus on preventing and controlling all HCAIs. Standard Infection Control Precautions will help prevent all infections including those from MRSA transmission and through undetected carriers.

All NHS bodies with in-patient beds are required to **review local policy on MRSA screening** to ensure that - **as a minimum** - it includes:

* a requirement to use Clinical Risk Assessment (CRA) to assess each admission as to whether the patient:

- has a past history of *infection* at any time;

- is resident in a care home, other institutional setting or is a transfer from another hospital;

- has a wound or in-dwelling device present;

* a requirement to swab screen any patient who answers yes to any of the above questions using a minimum of 2 swab sites (nasal/perineum or nasal/throat if perineum is deemed difficult or unacceptable);
* a record of the assessment and results of the swab;
* prioritisation (within existing schemes of prioritisation) for pre-emptive isolation/cohorting pending swab results;
* a local written policy specifying units/specialities require universal admission swab screening - that should include **as a minimum** renal, cardiothoracic/vascular, intensive care and orthopaedics; and
* consideration of using Clinical Risk Assessment (CRA) in units/specialities in which there is universal admission swab screening, to direct prioritisation of pre-emptive isolation/cohorting in these units.

**Recommendation:**

* There is evidence to suggest a reduction in MRSA infections when MRSA screening is carried out.
* In Wales, the Welsh Healthcare Associated Infection Programme (WHAIP) has evaluated the Scottish Pathfinder Programme and concludes no evidence to support a change to universal MRSA screening of all patients admitted to hospital.
* All NHS bodies in Wales with in-patient beds are required to review local policy on MRSA screening to ensure that it includes recommendations set out in the CMO letter (18th February 2013)
	1. Hair removal

The adequate preparation of the skin site prior to the surgical procedure is vital to minimise the presence of microorganisms on the surface prior to incision. Historically this included the routine removal of hair to reduce contamination1. However there has been much debate that shaving using razors can cause skin damage in the form of micro-abrasions potentially causing multiplication of microorganisms at the surgical site7. Two Cochrane reviews and one systematic review have been undertaken which examined the effect of different methods of hair removal (shaving, clipping and depilatory creams) on the incidence of SSI10, 11, 12. Shaving tends to be used as it is cheap and quick to carry out. However the blade cuts the hair close to the skin surface whereas clippers leave longer hair stubble. Chemical depilatory creams result in more complete removal of hair but can be time consuming (up to 20 minutes). There was insufficient evidence in the reviews to state whether removing hair impacted on surgical site infection. However, if it is necessary to remove hair then both clipping and depilatory creams results in fewer SSIs than shaving using a razor. This is consistent with current recommendations in NICE CG74, 20081. This recommendation is also included in the Department of Health High Impact Intervention for SSI8, Health Protection Scotland targeted literature review7 and 1000 Lives campaign ‘How to Guide’ (The ‘How to Guide’ for reducing surgical complications)13.

The timing of hair removal may be important as deep skin organisms may be encouraged to the skin surface following skin damage and may, therefore, contaminate the operative field. From the Cochrane systematic reviews noted above no statistical difference was shown with clipping or shaving the day before surgery compared with the day of surgery. Although there is insufficient evidence on whether the timing of hair removal affects the risk of SSI, NICE guidelines1 recommend that where hair removal is required it should be undertaken as close to the time of surgery as possible but clipping on the day of surgery may be preferable.

**Recommendation:**

* Do not use hair removal routinely to reduce the risk of surgical site infection.
* If hair has to be removed, use electric clippers with a single-use head on the day of surgery.
* Do not use razors for hair removal, because they increase the risk of surgical site infection*.*
* Where hair removal is required it should be undertaken as close to the time of surgery as possible but clipping on the day of surgery may be preferable.
	1. Preoperative showering

When skin is incised, microorganisms colonising the surface may contaminate the exposed tissues and subsequently proliferate and lead to an SSI. A decreased risk of SSI may occur if an intervention is put in place to reduce the number of microorganisms on the skin surrounding the incision. The microbial flora on the skin comprises transient microorganisms that are acquired by touch and easily removed (by washing with soap), and resident flora that normally live in the skin appendages such as hair follicles. Although the resident flora are generally not pathogenic they are not so readily removed by soap but their numbers can be reduced by antiseptics. Many studies have conducted research around the clinical effectiveness of preoperative bathing or showering with antiseptics for the prevention of SSI1, 14, 15, 16, 17.

A search of electronic databases was undertaken by Chlebicki *et al.* (2013) to identify prospective controlled trials evaluating whole-body preoperative bathing with chlorhexidine versus placebo or no bath for prevention of SSI14. Chlorhexidine bathing did not significantly reduce overall incidence of SSI when compared with soap, placebo, or no shower or bath (relative risk, 0.90; 95% confidence interval: 0.77-1.05, P =.19). Conclusions: Meta-analysis of available clinical trials suggests no appreciable benefit of preoperative whole-body chlorhexidine bathing for prevention of SSI. However, most studies omitted details of chlorhexidine application. Better designed trials with a specified duration and frequency of exposure to chlorhexidine are needed to determine whether preoperative whole-body chlorhexidine bathing reduces SSI.

A Cochrane review by Webster and Osborne (2012)15 evaluated randomised controlled trials (7 trials) comparing preoperative showering or bathing with any antiseptic, before any type of surgery in any setting, to reduce SSI. All trails examined chlorhexidine. They concluded that while there was evidence to support the efficacy of preoperative showering as a measure to reduce the rate of SSI, there was no evidence of difference on SSI rates following use of chlorhexidine as a cleansing agent rather than a plain detergent or soap. Chlorhexidine was not found to be cost-effective. However limitations with the review were that only 1 study was published within the last 20 years. A systematic review by Jakobsson *et al.* (2011)16 examined the effects of the number of antiseptic showers, and type of antiseptic on SSI. Randomised and non-randomised clinical trials of preoperative disinfection showers in any healthcare setting, examining outcomes of surgical site infection or level of skin bacteria, were included. Trials of disinfection of hands or materials were excluded. A total of 10 studies (n=7351) were identified, which examined the effect of 1 shower (2 studies), 2 showers (5 studies), or 3 or more showers (3 studies). Most trials compared chlorhexidine with soap or placebo but differences between studies prevented meta-analysis. The authors stated that no definitive conclusion could be made about the optimal number of preoperative showers, but noted that in 8 of the studies, chlorhexidine led to a reduction in skin bacterial levels. However, skin bacteria do not necessarily correlate with surgical site infection risk. Limitations of most studies included that the number of showers was of secondary interest and the showering process was not explicitly described. Additionally, of the included studies, only 4 were assessed as being high quality evidence. A systematic review by Kamel *et al.* (2012)17also evaluated preoperative antiseptics for preventing surgical site infections. Randomised and non-randomised studies of 3 types of skin antiseptic (iodophors, alcohol, or chlorhexidine) used before thoracic, cardiac, plastic, orthopaedic, neurological, abdominal, or pelvic surgery were included. A total of 20 studies (n=9520) were identified, examining: one antiseptic versus another (9 studies), antiseptic showers (7 studies), iodophor incise drapes (3 studies), and antiseptic versus soap, alcohol or saline (2 studies). Heterogeneity between studies prevented meta-analysis. The authors stated that based on results from 3 RCTs and 4 cohort studies (n=2512), preoperative showering appeared to reduce skin bacterial levels, but that the effect on surgical site infection was inconclusive. They also stated that conclusions about the most effective antiseptic could not be made.

Taken together, these studies indicate that the benefits of preoperative bathing or showering with antiseptics in preventing surgical site infection appear to be uncertain. Evidence for the most effective type of antiseptic wash also appears to be inconclusive. These data are unlikely to affect recommendations in NICE CG741 to have a shower or bath with soap before surgery. Further robust evidence is needed from large trials to compare no showering versus single or multiple showers, including comparisons of soap versus a range of antiseptics.

No evidence was identified in respect to the optimal timing of preoperative showers prior to surgery. Based on best practice and expert opinion, showering should take place on the day of surgery if possible or otherwise the day before7.The Department of Health high impact intervention8 and Scottish targeted literature review7 recommend the NICE guidelines which are as follows:

Advise patients to shower or have a bath (or help patients to shower, bath or bed bath) using soap,

either the day before, or on the day of, surgery1.

**Recommendation:**

* Follow the NICE guidelines:

Advise patients to shower or have a bath (or help patients to shower, bath or bed bath) using soap, either the day before, or on the day of, surgery.

**2. Intra operative phase**

* 1. Skin preparation

The focus of this intervention is the removal of both the transient and resident flora on the skin. Although transient microorganisms can be readily removed by soap and water, the use of antiseptics is required to remove the resident flora prior to surgery. The antimicrobial activity of different antiseptics has been considered with much debate around the use of chlorhexidine and povidone-iodine.

A Cochrane review by Hadiati *et al.* (2012)18compared different types of preoperative skin preparation for preventing infection after caesarean section. Randomised, quasi-randomised, and cluster-randomised trials, evaluating any type of skin preparation of the incision area before elective or emergency caesarean section, were included. Studies of preoperative hand washing or bathing were excluded. A total of 5 trials (n=1462) were identified. Two trials compared incisional drapes with no drapes in women who had all received the same preoperative skin disinfection, and 3 trials compared different antiseptic preparations. In women who had received skin preparation preoperatively (with either iodine or chlorhexidine, though these antiseptics were not compared directly), the use of drapes versus no drapes did not make a significant difference to the primary outcome of surgical site infection (RR=1.29, 95% CI 0.97 to 1.71, p=0.084; 2 trials, n=1294). There was also no significant difference in infection with parachlorometaxylenol plus iodine versus iodine alone (RR=0.33, 95% CI 0.04 to 2.99, p=0.33; 1 trial, n=50). A single trial (n=79) comparing alcohol scrub plus iodophor drape versus iodophor scrub without drape reported no infections in either group.

Limitations of the evidence included the small number of trials identified, and the heterogeneity of disinfection methods which made pooling of data difficult. The authors concluded that there was insufficient evidence to determine the most effective type of skin preparation before caesarean section in preventing surgical site infection.

The systematic review by Kamel *et al.* (2012)17 also examined antiseptic skin preparations. Based on mixed results from 5 RCTs, 2 cohort studies, and 2 case control-studies, the authors stated that conclusions about the most effective antiseptic could not be made.

Fournel *et al.* (2010)19 performed a meta-analysis to assess the effect of intraoperative povidone-iodine application compared with no antiseptic solution (saline or nothing) on the SSI rate. The meta-analysis included randomized controlled trials that compared intraoperative povidone-iodine lavage with no povidone-iodine in patients undergoing surgery with SSI as the primary outcome. The meta-analysis results suggested that the use of intraoperative povidone-iodine reduced rates of SSI.

Lee *et al.* (2010)20 compared the use of chlorhexidine with use of iodine for preoperative skin antisepsis with respect to effectiveness in preventing surgical site infections (SSIs) and cost. Included studies were systematic reviews, meta-analyses, or randomized controlled trials comparing preoperative skin antisepsis with chlorhexidine and with iodine and assessing for the outcomes of SSI or positive skin culture result after application. Using results from the meta-analysis and cost data from the Hospital of the University of Pennsylvania, they developed a decision analytic cost-benefit model to compare the economic value, from the hospital perspective, of antisepsis with iodine versus antisepsis with 2 preparations of chlorhexidine (ie, 4% chlorhexidine bottle and single-use applicators of a 2% chlorhexidine gluconate [CHG] and 70% isopropyl alcohol [IPA] solution), and also performed sensitivity analyses. The meta-analysis revealed that chlorhexidine antisepsis was associated with significantly fewer SSIs and positive skin culture results than was iodine antisepsis. In the cost-benefit model baseline scenario, switching from iodine to chlorhexidine resulted in a net cost savings of $16-$26 per surgical case and $349,904-$568,594 per year for the Hospital of the University of Pennsylvania. The authors concluded that preoperative skin antisepsis with chlorhexidine is more effective than preoperative skin antisepsis with iodine for preventing SSI and results in cost savings.

Noorani *et al.* (2010)21 carried out a systematic review and meta analysis of preoperative chlorhexidine versus povidone-iodine antisepsis prior to clean-contaminated surgeries. The authors concluded that preoperative chlorhexidine should be used to prevent SSI as results showed reduction in SSI with chlorhexidine compared with povidone-iodine. However, in a study by Menderes *et al.* (2012)22 the rates of SSI were similar between povidone-iodine and chlorhexidine when used as antisepsis prior to caesarean section deliveries. The authors concluded that operative time, not antiseptic protocol, was a predictor of SSI.

In addition there has been research around the use of alcohol-based solutions as these may be more effective than aqueous solutions. Maiwald and Chan (2012)23 performed a systematic literature review of clinical trials and systematic reviews investigating chlorhexidine compounds for blood culture collection, vascular catheter insertion and surgical skin preparation. They conducted meta-analyses of the clinical efficacy of chlorhexidine compounds and reviewed the appropriateness of the authors' attribution. In all three application areas and for all outcomes, good evidence favouring chlorhexidine-alcohol over aqueous competitors, but not over competitors combined with alcohols was noted. For blood cultures and surgery, the authors found no evidence supporting chlorhexidine alone. A range of 29 to 43% of articles attributed outcomes solely to chlorhexidine when the combination with alcohol was in fact used. Unsubstantiated recommendations for chlorhexidine alone instead of chlorhexidine-alcohol were identified in several practice recommendations and evidence-based guidelines
The authors concluded: Perceived efficacy of chlorhexidine is often in fact based on evidence for the efficacy of the chlorhexidine-alcohol combination. The role of alcohol has frequently been overlooked in evidence assessments. This has broader implications for knowledge translation as well as potential implications for patient safety. Chlorhexidine is known to have a persistent effect and combined with alcohol which is fast drying would make 2% chlorhexidine in 70% isopropyl alcohol a suitable product24.

Current evidence still remains uncertain as to the most effective antiseptic for skin preparation before surgical incision. The NICE SSI evidence update, June 201325 suggest that the recommendations provided by the NICE CG74 should remain. It should be noted that the Department of Health high impact intervention states that patients skin has been prepared with 2% chlorhexidine gluconate in 70% isopropyl alcohol solution and allowed to air dry (if the patient has a sensitivity, povidone-iodine application is used)8. The evidence is based on a study (849 subjects) by Darouiche *et al*.(2010)26 of chlorhexidine-alcohol versus povidone-iodine for surgical-site antisepsis. The overall SSI rate was significantly lower in the chlorhexidine-alcohol group than in the povidone-iodine group. The recommendation included in England has also been concluded as best practice in Scotland7. Evidence from this RCT by Darouiche *et al.* (2012) was noted during the decision whether to review NICE CG74 in 2011, but it was considered insufficient to warrant an update of the guideline at that time.

**Recommendation:**

* Prepare the skin at the surgical site immediately before incision using an antiseptic (aqueous or alcohol-based) preparation: povidone-iodine or chlorhexidine are most suitable.

The following is based on the Department of Health High Impact Intervention and should be considered in Wales:

* Patients skin has been prepared with 2% chlorhexidine gluconate in 70% isopropyl alcohol solution and allowed to air dry (if the patient has a sensitivity, povidone-iodine application is used)
	1. Antibiotic prophylaxis

Antibiotic prophylaxis has been used as a method to prevent SSI since 1969, particularly for surgical procedures deemed as high risk1, 7. Antibiotic prophylaxis typically involves a single dose of antibiotic. The NICE guideline has provided evidence for an association with a reduction in SSI1. In particular for C section procedures a Cochrane review was conducted by NICE1 (81 trials identified) that assessed the effect of prophylactic antibiotic treatment on infectious complications in women undergoing caesarean birth. Antibiotic prophylaxis was associated with a reduction in wound infections for patients undergoing this procedure (both under elective or emergency circumstances).

The NICE guidance recommends the following in general:

Give antibiotic prophylaxis to patients before:

* Clean surgery involving the placement of a prosthesis or implant
* Clean-contaminated surgery
* Contaminated surgery
* Do not use antibiotic prophylaxis routinely for clean non-prosthetic uncomplicated surgery.
* Use the local antibiotic formulary and always consider potential adverse effects when choosing specific antibiotics for prophylaxis.
* Consider giving a single dose of antibiotic prophylaxis intravenously on starting anaesthesia.

Although antibiotic prophylaxis is recommended for C section procedures there has been debate around the timing of the prophylaxis. Traditionally antibiotics were given after cord clamping due to concerns that the antibiotic could harm the baby if given prior to this time. Studies into antibiotic timing have been conducted, for example,in the UK1, America27, 28 and Australia29.

The up-to-date guidance on antibiotic prophylaxis timing has been reviewed by NICE. In their most recent guidance for C Sections (NICE clinical Guidline 132, issued November 2011)30 the following is recommended:

* Offer women prophylactic antibiotics at CS before skin incision. Inform them that this reduces the risk of maternal infection more than prophylactic antibiotics given after skin incision, and that no effect on the baby has been demonstrated.
* Offer women prophylactic antibiotics at CS to reduce the risk of postoperative infections. Choose antibiotics effective against endometritis, urinary tract and wound infections, which occur in about 8% of women who have had a CS.
* Do not use co-amoxiclav when giving antibiotics before skin incision.

In addition NICE guidance has reviewed the timing of administration before incision1. The guidance concluded that the lowest SSI rate occurred in patients receiving antibiotic prophylaxis 0–2 hours prior to surgery. A statistically significant trend was observed toward higher rates of infection with each successive hour that antibiotic administration was delayed after the surgical incision (*z* score = 2.00, *P* < 0.05 (Wilcoxon test). The Canadian Agency for Drugs and Technologies in Health (2013)31, European Centre for Disease Prevention and Control (2013)32, Department of Health (2011)8, Scottish targeted literature review7, American College of Obstetricians and Gynaecologists (2010)33 concurred that the timing of administration should be within 60 minutes of surgery and this echoed a review paper published by James and Martinez in 200834.

**Recommendation:**

* Prophylactic antibiotics given at C Section before skin incision. Inform patient that this reduces the risk of maternal infection more than prophylactic antibiotics given after skin incision, and that no effect on the baby has been demonstrated.
* Appropriate antibiotics administered within 60 minutes prior to incision

(Appropriate antibiotics – using antibiotic guidelines)

* 1. Normothermia

Adult surgical patients are at risk of developing hypothermia at any stage of the perioperative pathway. Hypothermia is defined as a patient core temperature of below 36oC35. During the first 30 to 40 minutes of anaesthesia, a patient's temperature can drop to below 35°C. Reasons for this include loss of the behavioural response to cold and the impairment of thermoregulatory heat-preserving mechanisms under general or regional anaesthesia, anaesthesia-induced peripheral vasodilation (with associated heat loss), and the patient getting cold while waiting for surgery on the ward or in the emergency department.

It is important to prevent inadvertent perioperative hypothermia. Although there are several different types of patient warming devices available that can be used for prevention, the evidence for many of these was too limited for recommendations to be made in the guidelines, and further research in this area is required. There was sufficient evidence of clinical effectiveness and cost effectiveness for recommendations to be made on the use of forced air warming to prevent and treat perioperative hypothermia. The key priorities for implementation in the NICE guideline provide strong direction for healthcare professionals in helping to prevent perioperative hypothermia in adults undergoing surgery35.

The NICE guidelines1 recommend the NICE; Inadvertent perioperative hypothermia (2008) guideline35 for maintaining patient temperature. The guideline defines normothermia as the body temperature being within the range of 36 and 37.5oC. There is also further evidence to support the maintenance of body temperature during the perioperative period7. Both the Department of Health High impact intervention8 and the Scottish targeted literature review7 recommend that ‘body temperature is maintained above 36oC in the perioperative period’.

**Recommendation:**

* Maintain body temperature above 36oC in the peri-operative period
* Full guidance can be obtained from the NICE; Inadvertent perioperative hypothermia (2008) guideline35
	1. Glucose control

The complication of infection is an additional risk for diabetic patients following surgery as the metabolic response to surgery can include insulin-resistant hyperglycaemia1, 7. In critical illness, rigorous control of blood glucose levels has been shown to reduce infective complications. However, strict blood glucose control has not been universally adopted in routine surgical practice outside of the intensive care setting. The Department of Health High impact intervention8 recommends that a glucose level of <11mmol/l should be maintained in diabetic patients. It is concluded that this is a key recommendation and that the blood glucose level is presented to ensure clarity of the action required. This recommendation has also been noted in the Scottish targeted literature review7.

**Recommendation:**

* Do not give insulin routinely to patients who do not have diabetes to optimise blood glucose postoperatively as a means of reducing the risk of SSI

The Department of Health High Impact Intervention8 recommends the following:

* A glucose level of <11mmol/l should be maintained in diabetic patients

*2.5 Other considerations:*

Incise drapes

One of the commonly used operative strategies to reduce SSI is the use of a plastic adhesive incise drape. Preoperative skin preparation is intended to leave the skin as free as possible from microorganisms which may potentially access the surgical wound. Incise drapes are an additional intervention and comprise of adhesive films which cover the skin at the incision site to further minimise the risk of contamination of the wound by acting as a barrier to microorganisms1, 7.A Cochrane review found that there was insufficient evidence that the use of plastic adhesive drapes are associated with a reduction of SSI rate but there was some evidence that they increase infection rates7.Following the use of plastic adhesive, there was a move towards the use of antiseptic impregnated incise drapes such as iodophor impregnated drapes. An evaluation of their effectiveness undertaken in a systematic review however found no additional benefit in terms of reducing the SSI rate, although there was no association of increased risk36.

NICE guidelines1 recommend that if incise drapes are used they are impregnated with an antiseptic. This is also recommended within the Department of Health High Impact Intervention8.

Supplemented oxygen

The possibility of reducing SSI by the use of perioperative oxygenation has been examined in some studies however there has been variation in the conclusions resulting from the available data. Whereas some studies have shown significant reduction in SSI following perioperative inhalation of an oxygen-enriched (80%) mixture, conversely, other studies reported a lack of association of improved rates of SSI37-40.

Evidence from NICE1 states that the physiological mechanisms underlying the use of a FiO2 of 80% to reduce the incidence of SSI are unclear. However, optimisation of perioperative oxygen delivery by careful regard to fluid balance, inotropes, blood glucose control and warming has been shown as a benefit in secondary outcome measures such as reduction of length of stay and this may form the basis of future research, in particular in relation to the incidence of SSI. The NICE guideline further examines the evidence alongside expert opinion and concludes that optimal oxygenation should be maintained during and post surgery to ensure maintenance of >95% saturation of haemoglobin

The Department of Health high impact intervention recommends that Patients’ haemoglobin saturation is maintained above 95% (or as high as possible if there is underlying respiratory insufficiency) in the peri and post operative stages (recovery room)8. This later recommendation has also been concluded as a key recommendation in the Scottish targeted literature review7.

Wound closure methods

A review of the method of wound closure could be conducted in Wales using the current C Section SSI surveillance scheme (WHAIP). The scheme has data on the use of removable sutures, dissolvable sutures, glue and staples for wound closure. SSI rates by wound closure method could be determined.

Theatre environment

*Theatre wear*

NICE guidelines1 recommend all staff should wear non-sterile theatre wear in all areas where operations are undertaken. Staff leaving the operating area (wearing non-sterile theatre wear) should keep their movements in and out of the operating area to a minimum.

*Theatre staff*

The number of personnel / healthcare staff within the theatre during the C section procedure should be questioned as should the movement of staff in and out of the theatre during the procedure. Research / studies should be conducted into the effect of theatre traffic on the theatre environment during the procedure. Does this have an impact on SSI?

*Cleaning of the theatre*

Recommendations for cleaning procedures to be adopted within theatres specifically around C sections are outside the remit of this document. However, local policy / guidelines should be considered when determining the risk of SSI with theatre cleanliness and may be an important intervention for consideration.

1. **Post operative phase**
	1. Surgical dressing

As the majority of surgical procedures result in wounds, there is often a requirement that they are covered with a dressing that acts as a barrier between the wound and the outside environment. Wound dressings are important to absorb leakage as protection from microorganisms and should ideally promote or maintain an optimal environment to aid the healing process1.There are many products available now for use in chronic wound care and there have been numerous studies which have examined their appropriateness and effectiveness for surgical wounds and their potential to reduce SSI. The NICE guideline1 conducted a review of the evidence of a number of dressing types including hydroactive, hydrocolloid, polyurethane and absorbent dressings.It was concluded that although there was a lack of quality evidence to support the use of a postoperative dressing in reduction of SSI, it was clearly good clinical practice that a wound should be covered with an appropriate dressing. There is insufficient consensus of evidence to recommend one particular dressing type, however dressings such as semi-permeable film membrane which are in general use would be appropriate. This was substantiated by the findings of a Cochrane systematic review of dressings for reduction of SSI which concluded that decisions on wound dressing should be based on cost and/or patient preference41.The Department of Health high impact intervention8 recommends that the wound is covered with an interactive dressing at the end of surgery and while the wound is healing. A sterile dressing is taken as standard. This is also recommended in the Scottish targeted literature review7.

NICE guidelines1 recommend that the surgical incision is covered with an appropriate interactive dressing at the end of the operation. However, it does not make any recommendations about specific types of dressing.

The time that the wound dressing should be left in place post surgery has also been examined. There does not appear to be sufficient evidence to determine whether wound dressing should be left in place for 12 hours or 48 hours or more1. However the NICE caesarean section guidelines (2011) CG 132 recommends that the dressing should be removed 24 hours after the c section42. Best practice has traditionally been to allow the wound to remain covered for 48 hours. The latter practice remains in the Department of Health high impact intervention8 and the Scottish targeted literature review7. However, these guidelines may be for wounds in general whilst 24 hour coverage should be considered specifically for c sections.

**Recommendation:**

* NICE guidelines1 recommend that the surgical incision is covered with an appropriate interactive dressing at the end of the operation.
* C Section NICE guidelines42 recommend that the dressing should be removed 24 hours after the c section.
	1. Hand hygiene

**Recommendation:**

* NICE guidelines1 recommend using an aseptic non-touch technique for changing or removing surgical wound dressings.

*3.3 Other considerations:*

Educating women (pre operative and post operative)

The c section SSI surveillance scheme run by WHAIP has identified that hospitals in Wales provide patient leaflets to women before a planned C section. The content may vary from hospital to hospital but should include information such as shaving of pubic hair before planned surgery and bathing before surgery for example.

The mother should receive a wound care leaflet before leaving hospital following a c section. This should include information on how to take care of the wound, encourage the mother to wear loose comfortable clothes and cotton underwear42. The leaflet should also cover signs and symptoms of a wound infection and have clear instruction on who to contact with concerns. The NICE guidelines1 recommend the following:

* + Offer patients and carers clear, consistent information and advice throughout all stages of their care. This should include the risks of surgical site infections, what is being done to reduce them and how they are managed.
	+ Offer patients and carers information and advice on how to care for their wound after discharge.
	+ Offer patients and carers information and advice about how to recognise a surgical site infection and who to contact if they are concerned.
	+ Use an integrated care pathway for healthcare-associated infections to help communicate this information to both patients and all those involved in their care after discharge.

Education of community midwives on diagnosing a wound specific to C sections

As part of the c section SSI surveillance scheme, community midwives complete a form to determine whether a mother has had an SSI (up to 30 days after the procedure). The surveillance uses CDC definitions of an SSI and an SSI tool describing the different types of SSI is available from WHAIP. WHAIP (in conjunction with the c section SSI surveillance steering group) have developed an SSI prevention pathway which incorporates training on wound diagnosis. This should be available in 2014. To date the C section surveillance scheme has noted a significant decrease in the SSI rate for hospitals where training has been provided on wound diagnosis. Training around the C section surveillance definitions is essential.

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