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ORIGINAL RESEARCH

Reducing Surgical Site Infections Post-Caesarean Section

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Background: Surgical Site Infections (SSI) are one of the most common complications after a caesarean with significant morbidity. Evidence suggests that SSI rates can be reduced post caesarean by using a Leukomed® Sorbact® (Essity) bacteria binding wound dressing, thereby reducing bacterial wound colonisation. Barking, Havering & Redbridge University Hospitals NHS Trust, London, UK (BHRUT) maternity unit sought change their clinical practice by using Leukomed Sorbact and evaluate if this reduced their SSI rate, SSI readmission rate, antibiotic usage and evaluate any associated cost savings.

Methods: From January 1st 2022, Mepore® (Molnlycke) wound dressings were replaced with Leukomed Sorbact for all caesareans. Retrospective and prospective audits were undertaken to compare SSI incidence pre- and post- implementation of the dressing. No changes were made to wound cleaning products, prophylactic antibiotic use or surgical technique. Wound closure technique remained the choice of the individual surgeon.

Results: Prior to this practice change, the baseline SSI rate between January–December 2021 was 6.1% and the SSI readmission rate was 1.27%. Comparative data for January–December 2022 showed a 38% reduction in SSI rates (overall SSI rate = 3.8%), a 31% reduction in readmission rate for SSI (overall rate = 0.88%), a 38% reduction in readmission bed days and a 30% reduction in antibiotic use. There was a reduction in SSI rates in all body mass index (BMI) categories. Total savings due to the reduction in SSI rates over twelve months were £234,784. The cost savings to BHRUT solely attributable to the reduction in readmissions was £49,750 or £21 per Caesarean, which will be an ongoing saving.

Conclusion: The use of Leukomed Sorbact dressings after Caesarean resulted in improved clinical outcomes with reduced SSI and readmission rates. Investment in the new dressing was cost effective when considering bed days freed, the reduction in antibiotic usage, reduced morbidity and improved patient experience.

Keywords: surgical site infection, caesarean, Leukomed Sorbact, antibiotic stewardship

Introduction

Childbirth, one of the most basic and natural functions, is not without risk, particularly when medical intervention such as Caesarean Section (CS) is required. Undergoing a caesarean increases the risk of maternal infection is associated with increased complications for subsequent deliveries and leads to increased financial costs.[1]

Surgical site infection (SSI) is one of the most common complications of CS. It is defined by The Surgical Wound Infection Task Force as 'an infection which targets the surgical wound and uterus when manipulated'[2] and is associated with significant morbidity, increased use of antibiotics, prolonged hospital spells, wound dehiscence (the partial or total separation of previously approximated wound edges due to a failure of wound healing), sepsis (a life threatening reaction of the body to infection) and occasionally maternal death.[3] The global incidence of SSI ranges from 3% to 15%.[3] The incidence in England, UK, where this quality improvement project was conducted, is on average 9.6% with readmission rates for SSI at 0.6%.[4] As CS rates continue to increase globally,[5] especially with increasing antimicrobial resistance, the risk posed by SSI will increase.

One of the main risk factors for SSI is maternal obesity.[3,4,6] A body mass index (BMI) of >25 kg/m is a major independent risk factor for infection compared with a BMI of 18.5–25 kg/m.[4] Given that in recent years the proportion of

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obese pregnant women has doubled from around 22% in 2010 to 44% in 2018,[6] this represents a major issue in post-operative management.

Despite these known issues, there is no mandated SSI registry or national collection of such data in England, meaning that comparison of SSI rates and readmission rates for SSI between obstetric units is impossible. Units in England and Wales are expected to audit their SSI data in-line with the National Institute for Health and Care Excellence (NICE) quality standard,[7] but as this data is not collated centrally, or shared nationally, there is no benchmarking which units can compare their performance or determine variations in practice. It is for this reason that publication of results is vital, in order that other units can determine best practice and use this to improve the quality of care they provide to patients.

NICE guidance on SSI prevention and management[8] provides the evidence on which decisions in England and Wales should be based and includes guidelines on; pre-operative care such as nasal decolonisation, hair removal and antibiotic prophylaxis, intra-operative care including antiseptic skin preparation, wound closure methods and wound dressing usage and post-operative care.

This guidance, released in 2019,[8] advises the use of an "interactive" wound dressing after caesarean, defined as a "dressing designed to promote wound healing through the creation and maintenance of a local, warm, moist environment underneath the chosen dressing" but does not specify any specific type. However, more recent Medical Technologies Guidance (MTG) from NICE released in 2021,[9] recommends using Leukomed® Sorbact® (Essity, Stockholm, Sweden) wound dressings for women undergoing caesarean sections as it reduces surgical site infections and is cost saving. Leukomed Sorbact is a sterile, single-use dressing with bacteria binding properties. The proprietary dialkylcarbamoyl chloride (DACC) inner layer, which is in contact with the wound surface, is hydrophobic and binds bacteria and fungi present at the wound site trapping them away from the wound. The bacteria are not lysed, reducing inflammation, and the reduced wound colonisation reduces the risk of SSI developing.

BHRUT chose to implement the NICE MTG guidance[9] and use Leukomed Sorbact after CS and analyse the results.

Materials and Methods

Queens Hospital, Barking, Havering & Redbridge University Hospitals NHS Trust (BHRUT) is a large teaching hospital in Romford, London, UK. The maternity department is the thirst busiest single-site maternity unit in England with circa 7500 deliveries per year. Like international trends,[5] the CS rate has increased from roughly 18% to around 32% over the last 10 years. It was identified that post-Caesarean section surgical site infection (SSI),[7] which leads to significant morbidity, poor patient experience, repeat surgery, and increased healthcare costs,[3] was an area for improvement as it was felt SSI rates could be improved. Hospital Episode Statistics (HES) for 2019/20 show a surgical site infection rate of 4% and a readmission rate for SSI of 5.7%.[10]

In addition, local challenges with regard to bed capacity and staffing levels required exploration of options to reduce readmissions and to maximise use of maternity resources.

One way of addressing such issues is the use of a treatment (or clinical) pathway, a structured, multi-professional tool provided to translate guidelines or evidence into local structures and standardise care relating to a specific clinical issue or procedure.[11] When used appropriately, a pathway reduces variations in care, complications and errors, thereby maximizing patient outcomes and clinical efficiency.[12]

The pathway in use at BHRUT prior to 2022 followed the 2019 NICE guidance on prevention and management of surgical site infections[8] to use an "interactive" wound dressing. All women undergoing a Caesarean had a Mepore (Molnlycke Gothenburg, Sweden) dressing applied after skin closure. Mepore is a simple, breathable, absorbent dressing with no specific antibacterial properties. This dressing was left in-situ for 24–48 hours and then removed. Whilst 2021 NICE guideline on Caesarean birth[13] recommends that standard dressings are removed after 6–24 hours, our protocol was variable depending on how much exudate (fluid that leaks out of blood vessels into nearby tissues and wounds) the wound was producing and followed the theory that

> …in clinical practice. surgical dressings should be kept undisturbed for a minimum of 48 hours after surgery, unless leakage occurs/associated symptomatology changes.[14]

Most women who had an uncomplicated elective caesarean were discharged within 24 hours and wound care management therefore took place in both the acute (within hospital) setting and within the community (by midwives working outside of the hospital setting, who visited the woman at home after delivery). However, variations in practice between the two settings potentially increased the risk of less than effective management as dressings were removed at varying times after delivery.

Thus, in December 2021, it was decided to review this multi-professional care pathway and after reviewing the medical literature and previous local SSI audit data a quality improvement project was set up aimed to reduce the rate of post Caesarean SSI. It was agreed that from 1st January 2022 BHRUT should switch from following the 2013 NICE quality standard[7] and instead implement the 2021 NICE MTG[9] and switch from using the inert Mepore dressings to the bacteria binding Leukomed Sorbact dressings on all clean, closed post-Caesarean wounds. To ensure there were no confounding variables, during the project time frame no other initiatives were implemented and no changes were made to wound cleaning products (ChloraPrep), prophylactic antibiotic use or surgical technique. Wound closure technique remained the choice of the individual surgeon.

Data Collection

A retrospective audit of all women undergoing a Caesarean was conducted between 1st January and 12th December 2021 with data analysed on Microsoft Excel to determine the baseline demographics, SSI rate, readmission for SSI rates and antibiotic use for SSI.

Between 13th and 24th December 2021, working in partnership with Essity, the company who produce the Leukomed Sorbact dressings, an implementation plan was developed to facilitate ease of practice change, ensure consistent clinical application and monitoring of the new dressing and to ensure contemporaneous wound management knowledge. Over a two-week period, over 200 members of staff – midwives, scrub nurses, theatre team, consultants, junior doctors (any doctor working within the maternity department below the level of a consultant) and community midwives (midwives who work outside of the hospital setting and whom are responsible for wound care after the woman is discharged from hospital) were provided with training and education, which covered both general wound-management principles and the application and management of the new dressing, which was left in-situ for five days rather than 24–48 hours with the previous dressing.

Between 1st January and 12th December 2022 all women undergoing a Caesarean had a Leukomed Sorbact wound dressing applied and this data was captured by a prospective audit, also analysed on Microsoft Excel.

The quality improvement project and both audits were registered with the Trusts' Research and Development Department and as per the NHS Heath Research Initiative Guidelines, ethics approval was not required as this was not a research study, rather an audit comparing a change in clinical practice.

Paper hospital healthcare records, electronic hospital records on E3 (EuroKing), discharge summaries, incident notifications for readmissions, wound swab results, antibiotics use and community midwifery records were all manually checked to validate the presence of an SSI. An SSI was recorded if any of the healthcare records documented that the surgical wound demonstrated local signs of infection, for example heat, redness, pain and swelling or more serious systemic signs, for example fever, pus, or raised white cell count in keeping with definition by NICE.[8] Women were seen postnatally at home by community midwives routinely for 10 days and up to 28 if a wound infection was identified, after which they are followed up by their General Practitioner (a doctor based in the community) at 6–8 weeks. Wound swab result data was collected but not used to diagnose SSI alone, due to the potential for contamination.

Essity developed an SSI information leaflet for women, distributed in the patient information pack on discharge and aided with the collection and analysis of the data collected, via an external auditor, in relation to the outcome parameters.

The audits sought to determine whether a real-world change in practice facilitated by external education and support could achieve better post-surgical outcomes such as a reduction in SSI and readmission for SSI rates, saved bed days, an increase in post-natal ward capacity and an improved patient experience.

Results

Clinical Outcomes

The retrospective audit of all women (n = 2436) undergoing a Caesarean section between January and December 2021 demonstrated an SSI rate and SSI readmission rate of 6.1% (n = 149) and 1.27% (n = 31) respectively. Post implementation of Leukomed Sorbact (n = 2368) these reduced to 3.8% (n = 91) and 0.88% (n = 22), respectively. Patient demographics were similar in terms of age, BMI and length of stay on initial admission. Figure 1 shows the month-by-month SSI rate for both data collection periods.

Leukomed Sorbact was used for all women irrespective of type of Caesarean and BMI. A reduction in SSI rates was identified in women undergoing both elective (44.4%) and emergency (35.3%) CS and the biggest reduction (52.4%) was in those with a BMI of 25–29.9 (overweight) group. As demonstrated in Figure 2 there was a reduction in SSI rates across all BMI ranges.

After discharge from hospital post Caesarean, 31 women were readmitted in 2021 and 22 in 2022 due to an SSI. The total number of days spent in hospital secondary to an SSI reduced by 38.3% from 2021 (107 days) to 2022 (66 days). In addition, the average length of stay for women readmitted was reduced by 9.7%.

Of particular note was the 30.4% reduction in antibiotic usage (2.3% to 1.6%), which is vital in the prevention of antibiotic resistance and in keeping with good antimicrobial stewardship.[8,14]

Although there were small numbers, there was also an 83% reduction in wound dehiscence rates (6 in 2021 and 1 in 2022).

The key clinical findings are summarised in Table 1.

Cost Savings

Although the unit cost the Leukomed Sorbact is higher than the previously used product, Mepore (£9.15 and 76p [excluding VAT] respectively), savings were realised in terms of lower SSI rates, reduced readmission rates and reduced length of stay when an SSI developed.

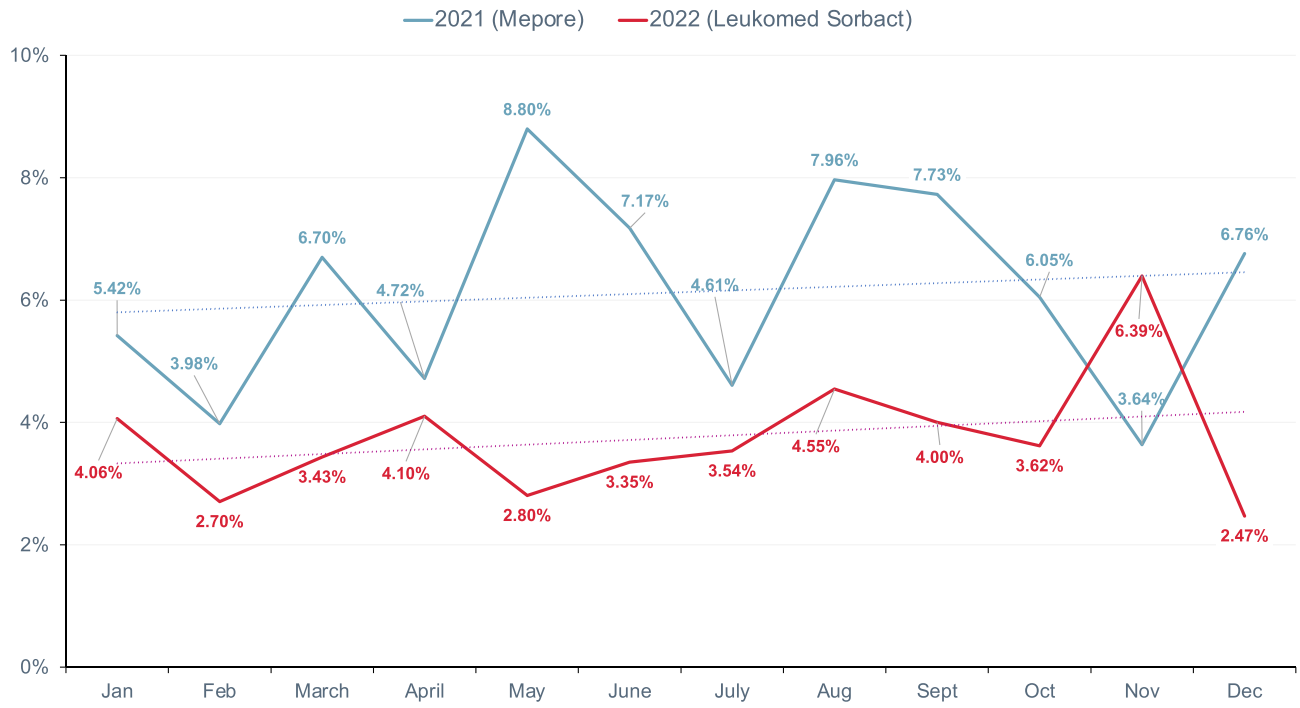

Figure 1 Comparison of month-by-month surgical site infection rates for 2021 and 2022.

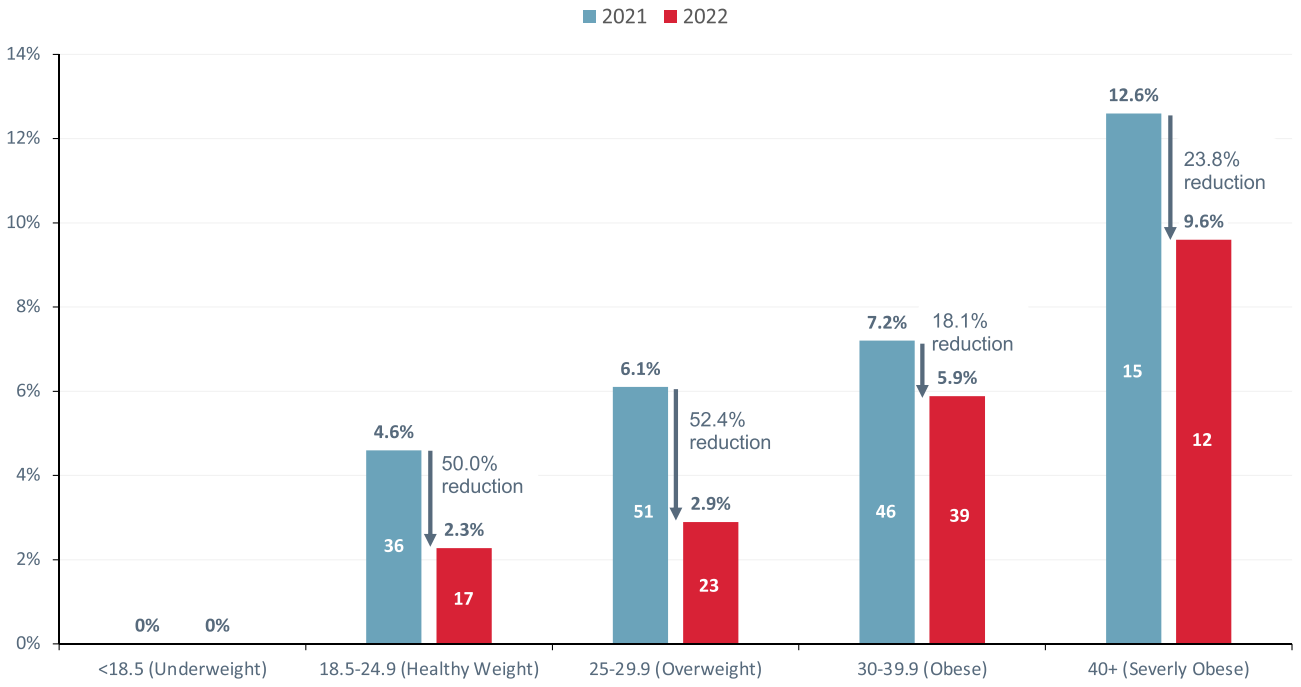

Figure 2 Comparison of surgical site infection rates across BMI groups between 2021 and 2022.

The mean attributable cost to the system, including community care, of a CS SSI is £4048.[15] Using this figure, the total costs due to SSIs were £603,152 (149 x £4048) in 2021 and £368,368 (91 x £4048) in 2022, meaning a saving of £234,784 was realised by reducing SSI rates.

To determine the financial savings to the hospital directly the costs secondary to readmissions were used. In 2021, the average cost to BHRUT of a readmission using Mepore dressings was £3942.25, whilst the average cost in 2022 using Leukomed Sorbact was £3083. This saving of £860 per patient readmitted was largely due to the reduced length of stay. Therefore, for the 22 readmissions in 2022 a cost saving of £18,920 was identified. In addition, the readmission rate

Table 1 Summary of Clinical Findings Between 2021 (Mepore Wound Dressings) and 2022 (Leukomed Sorbact Wound Dressings)

	2021	2022	Rate of Improvement (%)
Number of CS procedures	2436	2368	
Number (rate) of Caesarean SSIs (total)	149 (6.1%)	91 (3.8%)	37.7% Reduction
Number (rate) of Caesarean SSI (elective caesareans)	46 (5.4%)	28 (3%)	44.4% Reduction
Number (rate) of CS SSI (emergency caesarean)	103 (6.8%)	63 (4.4%)	35.3% Reduction
Number (rate) of patients readmitted for SSI	31 (1.27%)	22 (0.88%)	30.7% Reduction
Number of readmission episodes for SSI	34	24	29.4% Reduction
Number of readmission bed days for SSI (days)	107	66	38.3% Reduction
Average length of stay for SSI readmission (days)	3.1 days	2.8 days	9.7% Reduction
Number (rate) of CS SSI patients who had additional antibiotics	57 (2.3%)	39 (1.6%)	30.4% Reduction
Number of CS patients who developed wound dehiscence	6	1	83.3% Reduction

reduced by 30% and there were 10 fewer readmission episodes in 2022 than 2021. Using the average cost to BHRUT of a readmission in 2022 (£3083) there was an additional saving of £30,830 (£3083 x 10).

Ultimately, the total cost savings solely due to readmission costs (after the additional cost of the dressing has been considered) were £49,750 (£18,920 + £30,830). This equates to a cost saving per caesarean performed (2368) of £21, which will be a recurring saving going forwards.

Discussion

Childbirth is an extremely special and yet often challenging time. A Caesarean, whether elective or emergency, involves a healing process and recovery time and the development of a surgical site infection causes additional challenges, which have been shown to affect the mother-baby bonding experience.[16,17] The reduction is SSI rates, and readmission rates has been hugely welcomed by the women delivering by Caesarean at BHRUT who now have a better birth experience.

In addition to causing pain, swelling and lethargy which can result in difficulty looking after a new-born and more severe complications such as sepsis, post-Caesarean SSI is costly in terms of wound management costs, bed-days lost and impact upon stretched human and financial resources. In the UK there is no mandatory reporting of CS SSI rates but published prevalence rates are estimated to be just under 10%, with a readmission rate for SSI of 0.6%.[4] In a further study, using 2010 Government figures, the estimated costs for 800 Caesarean sections a year based on an infection risk of 9.6% were £18, 914 (95% Confidence Interval £11,521 to £9499), 28% of which were community care costs (£5370).[18] At 2019 prices, these increased to approximately £5 million for all caesarean sections performed in England (2018–2019). NHS Digital Hospital Episode Statistics (HES) data for the year 2019/2020 show 169,481 Caesarean procedures performed, 5.7% (n = 9624) of whom were readmitted for SSI.[10] Our data for the year 2021 showed a readmission rate of 1.27%, dropping to 0.88% in 2022, which led to a lowering of treatment costs and lost bed days. However, caution must be exercised when using HES data for monitoring and comparison as it is, as a consequence of collection methodology, old at time of publication. To ensure consistent and robust data collection going forwards, the author recommends centralised, mandated monthly data collection on a national basis. This would allow direct comparisons and benchmarking across all hospitals and be a driver to reduce SSI rates nationally.

The 2021 MTG NICE guideline recommends that Leukomed Sorbact should be

> considered as an option for people with wounds that are expected to have low to moderate exudate (defined as wounds that are wet and saturate between 25 – 75% of the bandage) after caesarean section,

suggesting that a saving of £107 per person can be achieved.[9] By implementing this guidance, we demonstrated a total cost saving of £234,784, equating to £99.15 per person, or when readmission costs alone were evaluated, a saving of £21 per caesarean performed. When the quality improvement project was being designed funding had to be sought for the additional cost of Leukomed Sorbact (£9.15 +VAT) compared to the Mepore (£0.76 +VAT) that was already in use. The additional cost over the 12 months amounted to roughly £23,840 for the 2368 Caesareans performed, however after taking this figure into account there has still been a huge cost saving. The creation of a business plan outlining the potential savings using the NICE guidance was used to apply for the initial funding.

There are alternatives to using Leukomed Sorbact and the NICE Caesarean Birth guidelines 2021 recommend that negative pressure wound therapy "be considered in women with a BMI of 35 kg/m2 or more to reduce the risk of wound infections".[13] However, these types of dressings are much more expensive than Leukomed Sorbact (typically about £150 versus £10), and from the NICE Caesarean Birth Evidence Review 2021 there was "no clinically important difference in satisfaction between those who received negative pressure wound therapy or standard dressing".[19] In addition, the Randomised Controlled Trials (RCTs) demonstrated that in women with a BMI >35 kg/m2 there was a clinically important decrease in the number of surgical site infections but no reduction in the need for antibiotics, compared to standard dressings. The same guideline identified that Leukomed Sorbact, referred to as a "Hydroactive dressing" again had RCT data demonstrating a statistically significant decrease in surgical site infections and a "clinically important decrease in the need for antibiotics" compared to those who received a standard dressing.[19] In addition, studies have shown its clinical and cost-effectiveness in post-Caesarean wounds,[20] and in a variety of infected and non-infected wound management.[21–23] Unfortunately, there are no direct comparison studies between Leukomed Sorbact and negative

pressure dressings to determine superiority. The reasons BHRUT chose to use Leukomed Sorbact over negative pressure dressings were the reduced cost, that they reduced antibiotic use, were easy to apply and to reduce variation in clinical practice to ensure robust data on outcomes could be collected.

An important point to note, which has implications for improving practice and lowering SSI rates, is that BHRUT used the dressing in all cases, irrespective of type of caesarean (elective or emergency), or BMI, both of which are risk factors for SSI.[24,25] Leukomed Sorbact dressings has been shown to be an effective wound-closure method for women with a BMI >35 kg/m^2,[26] and our data demonstrated improvements across all BMI categories, including an 18.1% reduction in the BMI 30–39.9 kg/m2 group and 23.8% in the BMI 40+ kg/m2 group.

Limitations

This article describes the real word application of national guidelines and evaluates the outcomes within one hospital Trust in London and is not a formal research study. Although this may be seen as a limitation, there is already RCT evidence for using Leukomed Sorbact[20] and this article adds evidence that the results seen in a research setting translate into frontline clinical practice.

In July 2022 BHRUT unilaterally introduced antibiotic impregnated sutures across all departments. However, comparison of data from January to June and from July to December 2022 indicates that this did not affect SSI numbers.

As described in the methodology, Mepore dressings were usually left in situ for 24–48 hours. As Leukomed Sorbact is waterproof, women were able to shower with it on, meaning that the dressings were left on for 5 days before removal. The additional time the wound was covered may also have contributed to the reduced rates of infection.

In December 2021, prior to switching wound dressings, Essity provided 2 weeks of training on wound infections and how to apply and remove the new dressing. Although it may be seen as a limitation of this study due to the primary-recency effect and an element of the Hawthorn effect, this was essential to ensure that the new dressing was used in accordance with manufacturer instructions by clinicians across both acute and community care. Had this been the case, the expectation would be an initial reduction in SS rates that, over time, returned back to normal. As demonstrated in Figure 1 this did not occur and rates of SSI remained reduced over the 12-month study period.

Leaflets explaining about the new product were given to women on discharge and may have led to greater focus and interest in their wound. This may have made it more likely they would report any concerns with their wound, however this would have expected to increase SSI rates rather than decrease them.

Implications for Practice

Leukomed Sorbact is simple to use and apply and can be left on for up to 7 days. We chose to remove it on day five as all women receive a postnatal review by their community midwife on this day to perform the new-born blood spot test and thus negated the need for additional visits.

We did not seek formal feedback from women on the dressings but anecdotally women were pleased they could shower with the dressing on and found it comfortable and reassuring that their wound was covered until closed. There were 4 women who reported to their midwife that they had erythema underneath the dressing at time of removal. One of these women had, what seemed to be, a reaction to the Chlorhexidine skin preparation, whilst in the other 3 it was impossible to say if the erythema was secondary to the dressing being removed incorrectly and causing skin trauma or if it was a sensitivity to the dressing or adhesive itself. There were no serious complications reported.

We observed a reduction in SSI rates across all BMI ranges and after both elective and emergency caesareans. Having one dressing for all women having a Caesarean meant we could standardise our practice and reduce variation. Further cost savings may be realised in hospitals which already use more expensive negative pressure dressings.

These positive results have been warmly welcomed by the other obstetric and gynaecology departments within our Local Maternity System with all hospitals within our region having now implemented this change. BHRUT is in the process of exploring how these results could be translated to open gynaecological surgery.

Conclusion

Preventing surgical site infections is an ongoing challenge for all hospitals worldwide and requires multiple approaches in improving pre, intra and post-operative care. BHRUT already implement the NICE SSI bundle[8] which includes pre-operative showering, nasal decolonisation, hair removal avoiding razors, sterile gloves and theatre gowns, antibiotic prophylaxis, antiseptic skin preparation and thermoregulation. The choice of post-operative wound dressing is just one aspect of this. This article demonstrates that, even with a relatively low SSI rate to begin with, BHRUT have been able to reduce this considerably by making a simple change in practice which has improved clinical outcome for our patients.

The reduction in SSI rates, readmission rates secondary to SSIs, bed days and dehiscence rates have all contributed to both significant clinical benefits and financial savings. These results demonstrate that the investment in the new dressing is cost effective. In addition, the reduction in antibiotic usage is in-line with good antibiotic stewardship and has been welcomed by our microbiology department.

Given that the use of Leukomed Sorbact is recommended by NICE,[9] and that Essity provides education and support for implementation, the success we have seen should be easily replicated in other maternity units currently using an interactive wound dressing. We suggest that all hospital Trusts should look at this as an exemplar model and consider implementing the NICE guidance.[9]

All maternity units should record their SSI rates and use this data to promote quality improvement projects to reduce infections. The author suggests that, as is currently required by Trusts in Wales, it should be made mandatory for Trusts in England to monitor SSI rates post-Caesarean section and report these centrally.

Abbreviations

SSI, Surgical Site Infection; BHRUT, Barking, Havering and Redbridge Universities Hospitals NHS Trust; BMI, Body Mass Index; CS, Caesarean Section; NICE, National Institute for Health and Care Excellence; MTG, Medical Technologies Guidance; DAAC, Dialkylcarbamoyl Chloride; HES, Hospital Episode Statistics; Randomised Controlled Trial.

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