Avoidable bed days over a two year period. Although Caesarean deliveries are considered to be a clean surgical procedure, evidence from recent studies suggests that the rates of SSI are higher than might be expected. A recent study, supported by the Health Protection Agency, considered post-operative complications following 4,107 Caesarean deliveries across 14 hospitals in England and Wales (Wloch et al 2012). The overall SSI rate was 9.6% while it increased to 19.8% in women with a BMI>35 and 15.6% in women with diabetes. These are comparable to infection rates following dirty surgical procedures such as large bowel surgery.

Reducing C-section wound complications

Wrightington, Wigan and Leigh NHS Foundation Trust has undertaken a study into the use of a disposable Negative Pressure Wound Therapy (NPWT) system for women with a BMI>35, undergoing Caesarean section deliveries. The results of a 30 month audit are highlighted.

The burden of surgical site infections (SSI) for the NHS is a significant one in both human and financial terms. NICE estimates that 5% of all patients undergoing surgery will develop a wound infection, while recent HPA data suggests 13.7% of all healthcare-acquired infections are post-surgical wound infection. (HPA 2011) In addition to the burden to patients, these episodes represent a significant financial burden to the health service. In a recent clinical and cost analysis in the Plymouth area, Jenks et al (2014) reviewed the impact of SSI following all surgical procedures to an individual hospital and found that they accounted for almost 4,700 avoidable bed days over a two year period.

Although Caesarean deliveries are considered to be a clean surgical procedure, evidence from recent studies suggests that the rates of SSI are higher than might be expected. A recent study, supported by the Health Protection Agency, considered post-operative complications following 4,107 Caesarean deliveries across 14 hospitals in England and Wales (Wloch et al 2012). The overall SSI rate was 9.6% while it increased to 19.8% in women with a BMI>35 and 15.6% in women with diabetes. These are comparable to infection rates following dirty surgical procedures such as large bowel surgery which has an infection rate of 14.7% (Wloch et al 2012).

A second study from 2011 corroborates these findings. Leth et al (2011) in a study of 2,492 patients, examined the role of diabetes and BMI in relation to post Caesarean section wound infection. Patients with a BMI of 30 or more were considered as obese. The infection rate for this group was 23.9% versus 17.5% in the non-obese patient group.

A large scale review of the Pan Celtic Network examined 22151 Caesarean section procedures to establish the rate of SSI across Scotland, Ireland and Wales (HPS 2008). The cumulative incidence of SSI across the three networks was 8.5% (1881 patients in total). Obesity was linked with increased SSI in all networks (HPS 2008).

It would therefore seem apparent from the literature that patients with an elevated BMI of over 30 undergoing Caesarean section are more likely to develop an infection than someone who is of normal weight. This is a worrying trend given the increasing rates of obesity which have increased from 50.5% of women in 1993 to 60.4% in 2012 (HSCIC 2014). Importantly, these patients are at risk of developing significant complications at a time when they should be recovering and bonding with their new baby. Readmission to hospital for additional care at this time may increase anxiety both for the patient and their family.

Some commentators have discussed the nature of the relationship between obesity and infection. It is postulated that when operating on patients with excessive adipose tissue the surgeon may experience technical difficulties when closing the wound due to lack of muscle tone and the thickness of the adipose layer (Irvine and
immediately post-operatively. Dressings to be used in Caesarean section patients was introduced as the standard dressing under Caesarean deliveries. A simple infection rate across all patients instance wound care practice was changed Caesarean section deliveries. In the first mitigate against the risk of SSI following implement an improvement programme to Wilkinson, Burns and Wan (2014).

Surgical site infection (Bullough, with wound dehiscence as a result of Excessive tension on the incision is also likely to be problematic which may cause wound dehiscence and result in infection. Caesarean section procedures, which creates friction and moisture around the wound site. There is a large pannus or overhanging area, as may be the case in Caesarean section procedures. The wound is also at risk if there is a large pannus or overhanging area, as may be the case in Caesarean section procedures, which creates friction and moisture around the wound site. Excessive tension on the incision is also likely to be problematic which may cause wound dehiscence and result in infection.

Within the Wrightington, Wigan and Leigh NHS Trust, an audit in 2011 revealed an overall SSI rate in Caesarean section patients of 12%, higher than the 9.6% UK rate uncovered by Wloch et al (2013). In one group of patients in the audit, those with BMI>35, it was noticed that 3-4 patients per month were readmitted with wound dehiscence as a result of surgical site infection (Bullough, Wilkinson, Burns and Wan 2014).

The findings prompted the Trust to implement an improvement programme to mitigate against the risk of SSI following Caesarean section deliveries. In the first instance wound care practice was changed to help reduce the overall surgical site infection rate across all patients undergoing Caesarean deliveries. A simple transparent, film dressing (OpSite Post-Op Visible (Smith and Nephew, Hull)) was introduced as the standard dressing to be used in Caesarean section patients immediately post-operatively. Dressings were to remain in place for at least 48 hours and, if possible, for up to seven days.

In order to reduce the overall infection rates and prevent readmissions in the high BMI group, a new single-use negative pressure wound therapy system (NPWT) (PICO, Smith and Nephew, Hull) was implemented for this patient group. There is an increasing body of evidence to suggest that NPWT can be effective in reducing the risk of post-operative wound complications, including SSI (Karlakki et al 2014).

Studies in orthopaedic trauma, cardiothoracic, Caesarean section, and hip and knee revision patients have demonstrated reduced wound complications in high risk patients when using negative pressure wound therapy to manage the incisions (Karlakki et al 2014). One recent study (Harris 2013) from the United States has identified that using disposable NPWT as part of a programme to reduce complications following Caesarean section procedures has had a dramatic effect on infection rates.

Wrightington, Wigan and Leigh Trust ran an initial feasibility study, introducing disposable NPWT into practice for women with BMI>35 undergoing Caesarean section procedures. The initial experience on the first fifty patients resulted in no infections. This paper reports an analysis of the first two years experience of using PICO disposable NPWT system following Caesarean section deliveries in women with a BMI>35.

Method
In order to reduce the wound infection and readmission rates in the patients with BMI of 35 or more, the PICO system was applied immediately after the surgical procedure, in theatre. PICO is a canister-free, single-use NPWT system for closed surgical incisions. It has been designed to be simple to use and to enable the patient to be mobile following surgery – the small device can fit in a patient’s pocket or bag. Each PICO kit includes two dressings and provides the entire seven day therapy for a patient with no need for additional components, such as canisters, to manage fluid from the incision. The innovative dressing has an airlock layer to ensure negative pressure is distributed across the dressing and also a silicone wound contact layer to enable gentle removal of the dressing. With the fluid handling capacity of 300mls across both bacteria proof dressings in the PICO kit, the therapy will continue to manage and protect the incision until removal.

In all cases, the NPWT system was applied in theatre onto closed wounds, following suturing. PICO therapy was applied in theatre immediately following the operation and was left in situ for one week only. Midwives had undergone wound management training and

![Fig. 2a shows the number of C-Section operations per month in high BMI patients.](image)

<table>
<thead>
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<th>Table 1: Demographic data</th>
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<td><strong>Age (years)</strong></td>
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<td><strong>BMI (Kg/m²)</strong></td>
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<th>Table 2: Patient history</th>
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<td><strong>C-Section Details</strong></td>
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<tr>
<td>1st C-Section</td>
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It is essential that we do all we can to help minimise the risk of infection for patients undergoing Caesarean section procedures.
education on the application and management of the PICO therapy.

Post-discharge surveillance was completed and patients were monitored for 30 days post-operatively. Infections were confirmed with both clinical observation and microbiological investigation. Wound assessment of infection would be carried out according to the criteria set out by Wilson, Treasure, Sturridge and Gruneberg (1986). The ASEPSIS scoring tool set out to provide a less subjective method of assessing wound infection. Criteria included the level of infection, superficial, deep or organ space, the presence of erythema and or cellulitis. In addition, the level and type of exudate, whether serous haemoserous or purulent in nature is monitored and recorded.

**Results of the evaluation**

**Demographic data**

Over a 30 month period between February 2012 and July 2014, the Trust conducted 1644 Caesarean deliveries. The average age of the patients undergoing a Caesarean section was 30.2 years (median 30, range 18-42 years). The average Body Mass Index of the patient undergoing a Caesarean was 39.4 Kg/m² (median 37, range 35-70). Of these, 239 Caesarean deliveries were conducted on women with a BMI>35. Almost one third of these patients (32.6%, n=78) had a BMI greater than or equal to 40. (See figure 4). In all cases, patients with a BMI>35 were treated with the PICO NPWT system while those with a BMI<35 were treated with the post-operative film dressing. (Table 1) shows the demographic data for the patient group including BMI.

**Caesarean details**

Information was available for the type (elective/emergency) of Caesarean in 233/239 PICO treated cases; 119 (51.1%) were elective and 114 (48.9%) were emergency (see table 2).

Details of patient history were available from 190 patients; in 125 (64.7%) cases the Caesarean was the patient’s first Caesarean, in 60 (31.6%) it was the patient’s second Caesarean section, in 4 (2.1%) it was the patient’s third Caesarean and in 3 (1.6%) it was the patient’s fourth Caesarean, (see table 2).

**SSI outcomes**

In all patients (n =1644) there were 52 recorded wound infections from February 2012 until July 2014 (~3.2%). This represents an overall reduction of 73.3% from the previous rate of 12% identified in the Trust during an audit in 2011. All infections identified were recorded as superficial infections and no patients had an infection or wound dehiscence requiring readmission. In the patient group with BMI<35 (n = 1403), who were treated with Opsite Post-Op Visible, there were 51 confirmed infections, giving a rate of 3.6%. There were no wound dehiscences and no patients were readmitted as a result of infections in this group. In women with BMI>35 treated with PICO (n = 239), only one patient developed a wound infection (0.4%). The patient who developed an infection had gestational diabetes and was having her second Caesarean section. The infection was superficial in nature and the patient was not readmitted to hospital for treatment.

**Discussion**

Obesity is strongly associated with the risk of developing an infection. Whether superficial, deep or organ/space, the risk of infection increases the more overweight the woman is (Health protection Agency, 2009).

Those patients who are overweight (BMI 25-30) are 1.6 times more likely to develop an infection, obese women (BMI 30-35) are 2.4 times more likely and those with a BMI over 35, 3.7 times more likely. According to Wloch et al (2015), patients with a high BMI were shown to have an SSI rate post Caesarean section of 19.2%, almost double the average.

Analysis of data from a single hospital Trust in England confirmed that women with high BMI were at increased risk of post-operative wound complications and readmission. The audit findings from 2011 indicated an overall infection rate of around 12%. Having put steps in place to improve the management of post-

![Fig. 2b Number of C-section operations per year in high BMI patients, showing procedure type.](image)
operative wounds following Caesarean sections, the Trust has witnessed a notable improvement in patient outcomes. This analysis reports on a case series of 239 women with BMI ≥ 35 who underwent Caesarean section procedures. A baseline audit conducted by the Trust suggested that they were experiencing 3-4 patient readmissions as a result of wound complications prior to the introduction of the steps described herein. Furthermore, applying data derived from the national audit, we would anticipate around almost 20% (~45 of these women) might be expected to experience a surgical site infection. In the case audit findings reported here, we identified only one infection in the PICO group. The one patient who developed the wound infection in this evaluation also had diabetes, which according to Wloch et al (2013) correlates with a higher than normal wound infection rate of 15.6% in Caesarean section patients.

This not only has important patient benefits but also economic implications for the Trust. The recent study by Jenks et al reported an average cost per SSI following Caesarean section procedures of approximately £3,700. Based on the predicted number of 45 infections, discussed above, the Trust could have expected to incur a treatment cost of around £165,000 had they not implemented the protocols described herein.

In addition to the clinical and economic benefits the changes to practice described have also resulted in meaningful patient benefits. Infections following Caesarean sections can be painful and traumatic for women at a time when they want to focus on caring for their newborn. The avoidance of these is therefore a highly desirable outcome. Other authors have also noted how NPWT provides a 'stenting' effect at the surgical incision and anecdotal reports from women treated with PICO suggest that it provides women with a degree of security that their surgical incision is being supported.

**Limitations of the study**

The authors are keen to highlight the limitations of the findings reported herein. The findings are derived from an audit of routinely collected data. Such an approach also faces challenges of missing data as was the case in the current analysis. It is also important to note that we compared our findings to historic controls also reported from routine data. As such, this cannot be considered a comparative study. It is also true that other variables may have changed over the course of the 2-3 years during which new post-operative wound management protocols were put in place and that these too may have contributed to any improvements identified.

However, while these are all shortcomings of the current evaluation, it should also be noted that the data presented are derived from routine data on patients managed in a real world setting. The patients treated were not subject to eligibility criteria as might be the case in a clinical trial and treatment reflected day-to-day practice in the hospital. In light of this, it could be argued that the findings should be more readily reproducible than a clinical trial.

**Conclusion**

It is essential that we do all we can to help minimise the risk of infection for patients undergoing Caesarean section procedures. One way to do this is to identify criteria which may deem a patient at higher risk of wound complications either due to their body weight or their relative health at the time of surgery. The next step is to get all staff to buy in to the process. In this case, tissue viability, infection control, obstetricians, midwives and ward managers were all involved in the changes being implemented. For the majority of patients negative pressure wound therapy may not be necessary; however, for the high risk patients it would appear that this should be considered as an alternative to traditional dressings.

This study demonstrates that using PICO NPWT on closed incisions in high risk patients can potentially reduce wound complications, readmission rates and may reduce the overall incidence of wound breakdown in this vulnerable patient group. In addition, the positive impact on the patient and families’ well-being during a very important time in their lives cannot be ignored.

More importantly, this project identified the need for improved staff education, a better understanding of wound care issues and encouraged all staff to take ownership of this problem. The additional cost of the dressing is significantly off set by the reduction in re-admission rate suggesting this protocol is extremely cost effective.

The authors point out that this evaluation is not a randomised trial but a case series/evaluation intended to show a reduction in wound infection when utilising a new therapy. The numbers are not high enough to show significance. Despite this, however, there are encouraging indications that the therapy may have a beneficial role to play in the incision management of high risk patients.

**Conflict of interest**

This work was not funded by Smith and Nephew; however, support was provided by the company in relation to training and education of staff in the application of the therapy. Assistance was also provided in writing up the results of the evaluation.
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Paul Truman, Nephew Healthcare, (Literature search and editorial support); Paul Truman, Nephew Healthcare, (Literature search and editorial support); Paul Truman, Nephew Healthcare, (Literature search and editorial support).

References

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