BIRTH-RELATED WOUNDS

RISK, PREVENTION AND MANAGEMENT OF COMPLICATIONS AFTER VAGINAL AND CAESAREAN SECTION BIRTH

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EWMA

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Introduction

Childbirth is one of life's great miracles. It is a time of joy and at times fear, exhilaration and relief, with the spectrum of human emotions for some women experienced simultaneously. Notwithstanding the physical toll childbirth takes on the female body, wound complications related to the birth can occur, often an unfortunate result of multiple factors related to injury to skin and deeper tissues. Birth wound complications, such as trauma to the perineum and vagina (and, in the event of birth by caesarean section, breakdown and/or infection of the surgical wound), have a considerable impact on a woman's physical and mental wellbeing. Despite advances in our knowledge of asepsis, midwifery, obstetric surgery and wound healing, birth-related wound complications still occur. The greater challenges faced by healthcare professionals are in the clinical management of tissue trauma and the physical and emotional wellbeing of the mother.

Wound-related complications after delivery may last for many years, with the more serious consequences requiring reconstructive surgery and patient rehabilitation. Attention is also required to address a woman's needs in reducing physical and psychological pain and distress arising from birth-related wounds and infection-related complications. This is especially relevant, as we enter an era of antimicrobial resistance where reliance on life-saving antibiotics to prevent or treat infections may no longer be guaranteed as an effective line of defence. Overuse, as well as misuse, of antibiotics is now a serious concern globally. Moreover, the economic costs of wound care impose a considerable burden on healthcare systems, which require strategies to improve wound assessment and underpin the rationale for evidence-based treatment.

This document originated from a growing interest by many EWMA stakeholders in the science and clinical management of birth-related wound complications. An expert group was established to produce an evidence-based consensus document for healthcare workers. The group consists of representatives from the EWMA Council and EWMA Cooperating Organisations. Based on a literature search conducted by the document authors and the EWMA secretariat, together with input from key EWMA stakeholders, a short description of the document aim, objectives and scope was developed during the first quarter of 2019.

The opinions expressed in this document have been reached by consensus of the author group based on professional, clinical and research expertise, as well as the experience and expert review by peers. The clinical guidance provided in the document is based on critical analysis and synthesis of published guidelines, literature reviews and evidence-based recommendations as well as consensus-driven expert opinion.

Definitions

For the purpose of this document, birth wound complications are reviewed as arising from:

- Childbirth-related perineal trauma (CRPT) spontaneous trauma and/or surgical cut (episiotomy) to the perineal tissues during vaginal childbirth
- Surgical incision of superficial and deep tissue of the lower abdomen in the performance of planned or emergency caesarean section.

Scope

This document is intended for healthcare practitioners with an interest in the care and

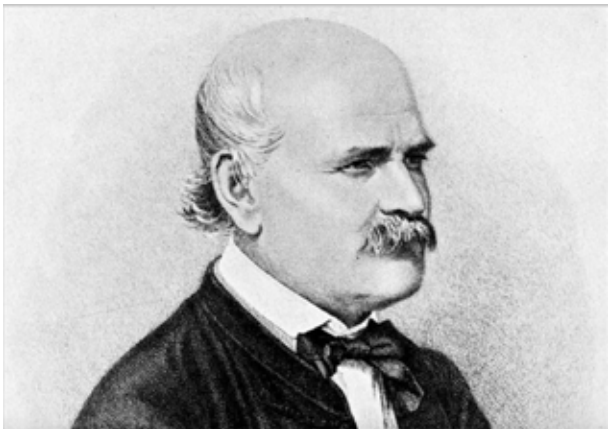
management of women before, during and after childbirth. It is anticipated that the readership will primarily be qualified hospital-based as well as community-based midwives, wishing to consolidate their knowledge, as well as to update their practice. Among the wider healthcare community, the document will be of interest to undergraduate and postgraduate students as well as experienced healthcare professionals in leadership roles, where the strategic vision of the department is to close gaps in knowledge and to assist in policy decisions for the delivery of evidence-based healthcare.

This document informs readers about the key issues relating to birth-wound complications and their management by providing:

- A brief historical overview of complications in childbirth
- Aetiology of birth-related complications
- Discussion of risk factors and the impact of wound infection
- Clinical management strategies
- Wound dressings
- Personal 'vignettes' from women about the experience and impact to wellbeing of birth-related wound complications.

Childbirth through the ages

Childbirth, also known as labour or delivery, is where a pregnancy ends by the delivery of one or more babies passing through the vagina or by caesarean section.[2] Historically, the mother was supported by other women during the labour, and delivery and was exclusively the domain of women.[3] The presence of physicians and obstetricians was rare and was only called for if the midwife had exhausted all measures.[4] Midwifery training began in European cities during the 1400s with the advent of obstetrics as a medical speciality occurring during the late eighteenth century.



Dr Ignaz Semmelweis, aged 42 in 1860[1]

Ignaz Semmelweis observed that hand washing in chlorinated lime solution between autopsy work and the examination of patients reduced the occurrence of puerperal fever in the obstetric clinic at Vienna General Hospital over a period of a year (1847). He subsequently published his findings and is a recognised pioneer of antiseptic policy.

Historical accounts of the practice of midwifery are recorded as early as the Ebers Papyrus (circa 1550 BC) and describe birthing attendants assisting in delivery.[5]

During the middle ages, women would often prepare their last will and testament before giving birth.[6] The most common cause of death after childbirth was childbed fever. Early accounts of childbed or puerperal fever were documented by Hippocrates in the fourth century.[7] One of the first interventions to successfully reduce mortality rates of childbed fever during the eighteenth century was improved hospital cleanliness.[8]

In 1843, Oliver Wendall Holmes collated information about puerperal fever and formulated eight measures to prevent it.[9] However, in 1847 Ignaz Semmelweis, a Hungarian physician and scientist discovered the infectious nature of puerperal fever and its transmission route to women in labour from the hands of physicians working in Vienna General Hospital. There were two obstetric wards in the

hospital: one was a teaching ward for physicians and medical students, and the other was managed by midwives. Semmelweis observed that the mortality rate in the teaching ward was three times higher than that in the midwives' ward. Whereas physicians conducted examinations of women who had died of childbed fever and then attended women in their lying-in clinic after simply washing their hands with soap and water, midwives did not conduct postmortems. After introducing hand scrubbing with chlorinated lime solution following autopsies, the mortality rate of women in the teaching ward subsequently reduced to a rate comparable with that of the midwives' ward.[10] These observations led to the foundations of contemporary antiseptic policy. Importantly, it was not until the late 1800s, after the establishment of the germ theory and the work of Joseph Lister, that practitioners understood how to halt contamination and spread of infection through hand washing and the use of carbolic acid for antisepsis in surgery. Antisepsis is now the central tenet of infection control globally. Preventing hospital-acquired infections (HAIs) presents a major challenge to health systems.

The health and economic impact of obstetric infections and complications

Across the world, healthcare costs are rising. The focus for healthcare systems must be on sustainability as well as person-centred care. In high-income countries with lower birth rates, the cost of care in hospital and the community has escalated with birth-related healthcare-associated complications, the unintended sequelae of birth. While birth rates are falling in high-income countries,[11] the greatest challenge for low middle-income countries (LMICs) with high birth rates is to provide good quality care within the economic climate of the nation.[12] Furthermore, with the rising number of women of childbearing age with chronic diseases, obstetric complications and poor psychological wellbeing is becoming more prevalent,[13] demanding care from a multidisciplinary team of specialists. Complications, both physical and psychological can arise as a consequence of the birth itself, whether by vaginal delivery or by caesarean section. In the event of tissue damage leading to a wound, be it a surgical wound infection, dehiscence or due to CRPT, all such complications are potentially preventable. When SSIs occur as a result of caesarean section, they impose an incremental financial burden on healthcare resources.[14] With close to 141 million births reported globally during 2015,[15] typically in hospital in higher income countries,[16] or at home with an attendant providing support in lower-income countries,[17] infections during childbirth present a significant risk for mothers.

Birth-related infection in the 21st century

Unfortunately, puerperal sepsis or postpartum infection is still the leading cause for morbidity and mortality after childbirth.[18] Although the risk of death in childbirth in developed countries is now 40–50 times lower than in the early years of the 20th century (and before the introduction of antibiotics),[19] most of the estimated 75,000 maternal deaths occurring worldwide each year are a result of infections recorded in low-income countries.[20–22] Global estimates for 2017 indicate that 810 women died every day from pregnancy- or childbirth-related complications,[23] with infection the third highest cause of maternal mortality after haemorrhage and hypertensive disorders.[24]

Childbirth, whether by vaginal birth or by caesarean section can bring significant psychological problems and functional morbidity as a consequence of lingering and, often, distressing symptoms, many of which originate with a wound that later becomes infected. Understanding the care and management of women with wounds arising as a consequence of giving birth should be underpinned by knowledge of pelvic anatomy and function, a first step in the appreciation of the aetiology of perineal trauma.

Pelvic anatomy and pelvic function

The pelvic floor

The function of the pelvic floor muscle group (Fig. 1) is to support the pelvic organs and maintain both urinary and faecal continence. The pelvic floor also plays a part in providing spinal stability and has a role in sexual function.[25] However, this muscle group is often injured during childbirth, and can cause deterioration in muscle function.[26] Extensive perineal trauma also increases the risk of wound infection.

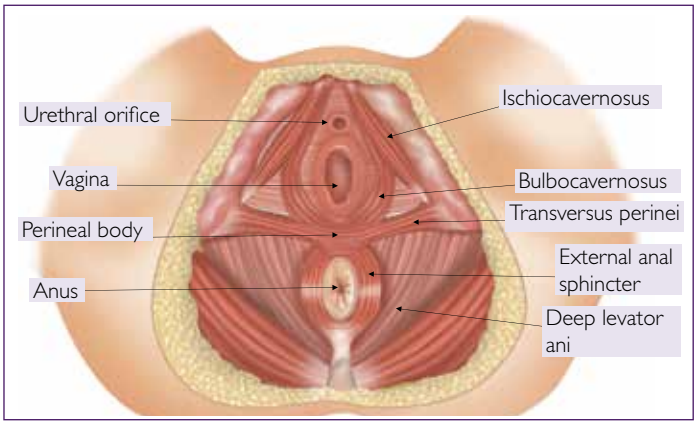


Fig 1. Anatomy and principle muscles of the pelvic floor

Impaired pelvic floor function

The integrity of the perineal body, the pelvic floor muscles as a whole, including the internal and external sphincters, is often compromised during childbirth. Perineal wound infection, especially when coupled with wound dehiscence, results in scarring and muscle dysfunction. Faecal incontinence can be a devastating consequence of childbirth. More than one in 10 women may experience some form of faecal incontinence after childbirth. A survey of 21,824 women in Oregon, US, with 8,774 respondents, reported 46% of all women, following vaginal delivery, experienced postpartum fecal incontinence, with 38% reporting incontinence of flatus.[27] Almost half (46%) of all women with postpartum faecal incontinence reported incontinence of stool, and 38% reported exclusively incontinence of flatus. Approximately 46% reported onset of incontinence after delivery of their first child.[27]

Perineal wounds: tears, lacerations and episiotomy

A perineal wound can occur as a result of a tear or laceration inside the vagina, the vulva, clitoris and labia (Figs 2 and 3). Approximately 85% of vaginal births are affected by childbirth-related perineal trauma (CRPT), either spontaneously or as a result of an episiotomy (www.rcog.org.uk/en/patients/tears/tears-childbirth/).[28]

Tears and lacerations can be superficial as well as deep; the latter involving acute muscle trauma, oedema, avulsion injury and haematoma.[29] Injuries due to perineal tears are classified on the basis of severity, from first to fourth degree (Fig. 2, Table 1). A first-degree tear involves vaginal mucosa and connective tissue only, while second-degree tears involve the underlying perineal muscles of the superficial pelvic floor muscle group, and include bulbospongiosus, and the superficial and deep transversus perinei.

Third- and fourth-degree tears are classed as an obstetric anal sphincter injury (OASI).[30] In a third-degree tear there is a partial or complete disruption of the anal sphincter muscles, which may involve either the external anal sphincter (EAS) and/or the internal anal sphincter (IAS) muscles. A fourth-degree tear is defined by a complete rupture of the anal sphincter muscles also involving the rectal mucosa (Fig. 2). All CRPT should be immediately examined and repaired, with OASI requiring surgical repair in theatre under spinal anaesthetic, with follow-up by specialist postnatal services dedicated for women with perineal wounds.[30]

The overall prevalence of third- and fourth-degree tears is approximately 4–5% among primiparous women.[31] A prospective observational

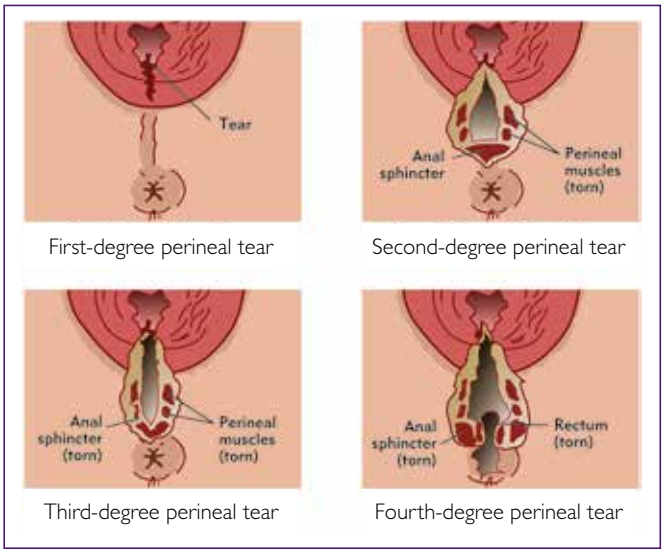


Fig 2. Grades of perineal tears. Redrawn from: Sydney Pelvic Floor Health (http://bit.ly/2sGWu16)

study by Smith et al[32] of 2754 women having a singleton, vaginal birth showed that multiparous women (birth of more than one child) were more likely to have an intact perineum (31.2%, 453/1452) compared to nulliparous women (9.6%, 125/1302).[32] The risk of spontaneous perineal tears at subsequent deliveries increases with the presence and the severity of perineal trauma at the first delivery.[33] While the incidence and causes of CRPT are known, the subsequent acute complications that occur are not so well reported. Without standardised treatment protocols or national guidelines, and with limited published research into the management of CRPT wounds, there remains a lack of knowledge and, consequently, no consensus on the care of perineal trauma for this group of women.

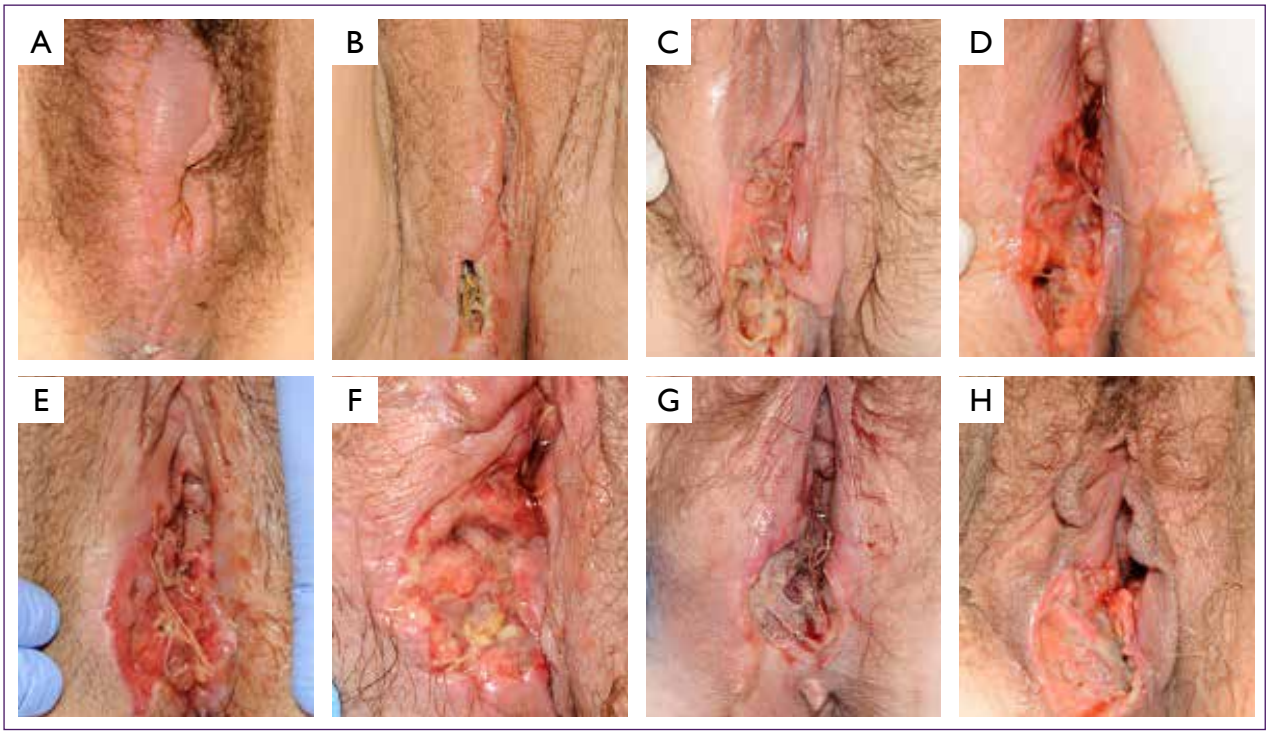


Fig. 3. Perineal trauma due to childbirth. (A) Acute postnatal injury showing swelling and haematoma. (B) Acute injury and associated infection; (C) and (D) Postnatal wound dehiscence and infection. (E) Episiotomy and wound dehiscence with suture material visible. (F) Poor perineal wound healing. (G) Acute trauma of perineum with wound dehiscence and infection. (H) Delayed healing episiotomy

Table 1. Perineal tears and lacerations during childbirth

Degree	Definition
First	Injury to vaginal mucosa or perineal skin only
Second	Injury to vaginal mucosa or perineal skin and superficial perineal muscles
Third	Injury to anal sphincter muscles and subdivided into: • 3A: <50% of external anal sphincter muscles are injured • 3B: >50% of external anal sphincter muscles are injured • 3C: External and internal sphincter muscles are injured
Fourth	Injury involving external and internal anal sphincter muscles and anal epithelium

Source: Royal College of Gynaecologists and Obstetricians[30]

By contrast to accidental lacerations and tears during vaginal birth, an episiotomy is a deliberate surgical incision of the perineum and the posterior vaginal wall. It is usually performed by an obstetrician during the second stage of labour during instrumental birth. Episiotomy provides a rapid additional space within the birth canal (Fig. 3).

While vaginal birth remains the major mode of delivery, caesarean section can be a planned (elective) or emergency procedure.

Caesarean-section birth

Caesarean section is the most common surgery among women worldwide, with the global rate rising.[34] In a recent meta-analysis, Sobhy et al[35] reported the risk of maternal death after caesarean section at 7.6 per 1000 procedures (95% CI 6.6–8.6) with the highest burden in sub-Saharan Africa. In LMICs, one in every 100 women dies after caesarean section whereas in high-income countries, there are eight maternal deaths per 100,000 caesarean sections. Maternal mortality in LMICs is 100 times greater than in high-income countries.[35] This is further reflected in the infant mortality rate, with close to 8% of newborns failing to survive beyond 1 week.[22]

The Organisation for Economic Co-operation and Development (OECD) highlights that while caesarean delivery is required in some circumstances, the benefits of caesarean versus vaginal delivery for normal uncomplicated deliveries are debatable. Caesarean delivery results in increased maternal mortality and maternal and infant morbidity.[36] It is also associated with increased complications for subsequent deliveries, as well as increased financial costs. This raises questions about the appropriateness of caesarean births without evidence of significant health benefit for the woman if not medically required.[37] OECD data systems as well as the literature indicate that the number of caesarean sections performed worldwide is increasing (Fig. 4).[34]

Methods for caesarean section incision

Caesarean section surgery involves an incision to the skin and underlying tissues to facilitate the delivery of a baby. Early accounts of birth by this method attribute the term 'caesarean' to Julius Caesar's decree that 'the body should be cut open' in an attempt to deliver the baby of a dead or dying women.[38] Caesarean section operations on living women were performed during the 19th century to save the life of the mother as well as the baby. Today, caesarean section is performed as an emergency life-saving operation either for mother and/or infant, or as a planned procedure.

There are a number of incisions that can be used in the abdominal region for caesarean section (Fig. 5). The more commonly used method of incision during the 20th century was vertical (from just below the navel to just above the pubic bone); however, this is usually reserved for breech or preterm babies. A lower (uterine) segment caesarean section (LSCS) is the most common

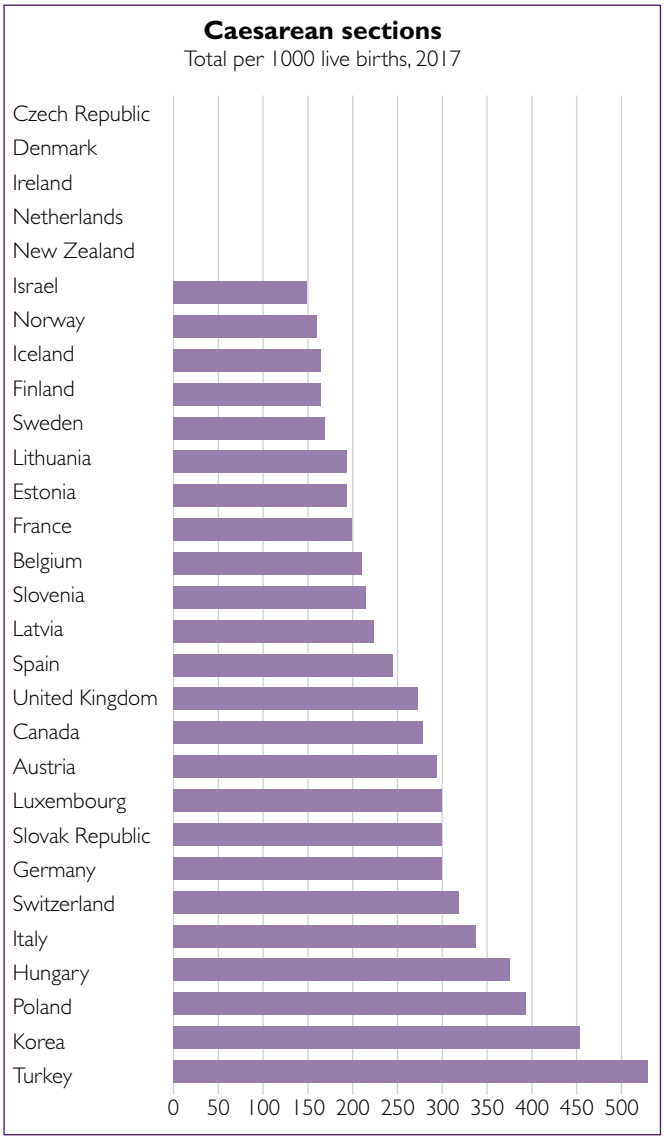


Fig. 4. Total caesarean sections performed by country. Data source: OECD[39]. Reproduced with permission

type of surgical incision to deliver the baby. This type of incision results in less blood loss.[40]

A review conducted by Saha et al (2013)[41] of two surgical incision methods, the Pfannenstiel and Joel-Cohen technique, revealed that the Joel-Cohen incision, originally described for hysterectomy, and later adapted for caesarean section, had some advantages: less fever, reduced pain and analgesic requirements, less blood loss, and a shorter duration of surgery and hospital stay.[41] The curvilinear incision, below the arcuate, in the Pfannenstiel technique produces a lower positioned scar. From a cosmetic viewpoint, its advantage is that it leaves an almost imperceptible scar because it lies in a skin crease.[42]

Risk factors for wound complications

Risk factors for complications of caesarean section incisional wounds

Wound healing is distinctly shorter, more efficient and organised when achieved through the process of primary intention.[43] Wound complications are multifactorial resulting in wound separation without infection,[44] superficial and deep wound infection[45] and rarely, necrotising fasciitis.[43] Infection, inhospitable characteristics of the host (such as vascular or chronic disease), suboptimal perioperative conditions (hypothermia), and surgical technique that injures tissue can all impede the normal phases of wound repair. Here, risk factors for post-caesarean wound complications will also impede wound healing.[43] Poor wound healing, due to the onset of infections, seroma, abscesses and haematoma, is often associated with multiple risk factors, some of which are modifiable and others that are not.[46–52]

Broadly, risks for wound complications include patient and procedural-related factors and circumstances that should be incorporated into the risk assessment plan (Fig. 6). Evidence-based interventions should be implemented in clinical practice to reduce wound complications after caesarean section, but short stays in hospital, typically 1–2 days, mean that many women who develop a post-surgical birth wound complication do so in the community.[53,54]

Surgical risk factors

It has been reported that obstetrician experience may be related to SSI risk, particularly where the lead obstetrician performing the procedure was not a consultant.[56] There are several publications with evidence-based recommendations for prevention.[56,57] While national guidelines for SSI[58] exist with recommendations for assessing the wound for signs of infection, there remains no 'gold standard' or consensus for this aspect of clinical care.

Other risk factors include the type of anaesthesia, duration of surgery, lack of antibiotics or inappropriate timing or choice of prophylaxis, suture materials, operating room temperature, obstetrician experience and the surgical techniques used. Risk factors such as incision length, corticosteroid administration and pre-pregnancy body mass index (BMI) have also been studied.[46]

Life-style factors and pre-existing comorbidities

Patient-level risk factors such as pre-existing comorbidities and lifestyle factors, which may be modifiable, include diabetes, obesity, hypertensive disorders of pregnancy, previous caesarean delivery and tobacco use. Recognising that some risk factors may not be modifiable presents a challenge for the obstetrician and the clinical management team. For example, in a large multicentre cohort study of 15 hospitals participating in the UK Health Protection Agency (HPA) Surgical Site Infection Programme, Wloch et al[56] observed an overall SSI rate of 9.6%, with obesity representing an independent risk factor for SSI. The odds ratio for infection more than doubled for those with a BMI 30–35kg/m^2, and a BMI >35kg/m^2 presented the highest risk for SSI (OR 2.4; 95% CI 1.7–3.4 and OR 3.7; 95% CI 2.6–5.2, respectively). The risk of SSI for women with diabetes was also high at 15.6% (95% CI 11.0–21.1%) compared with the overall rate of 9.6% (95% CI 8.7–10.6%). Thus, the impact of obesity is a significant determinant of health outcomes for women who develop an SSI.

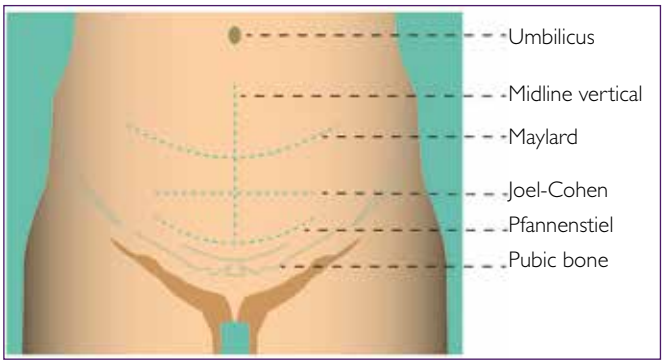


Fig. 5. Methods for surgical incisions used in caesarean section. Redrawn from https://www.stepwards.com/?page_id=3610

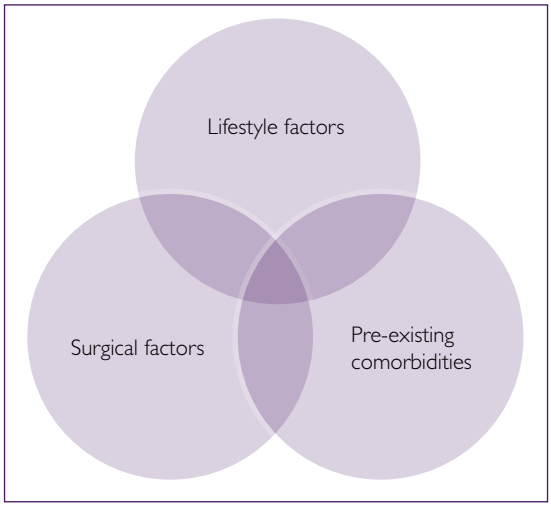


Fig. 6. Conceptual framework for surgical wound complications.[54]

The impact of obesity postpartum

The prevalence of obesity (BMI >30kg/m^2) is increasing worldwide and poses a major challenge to public health.[60] In Europe, over 50% of women are overweight, approximately half of whom (23%) are obese.[62] Obesity prevalence rates are estimated to be as high as 30% in pregnant women. Research has shown that the proportion of pregnant women with obesity has doubled over the past decade,

from around 22% in 2010 to 44% in 2018.[63] In addition, approximately 40% of women gain an excessive amount of weight during pregnancy in Western countries.[62] The high level of maternal obesity has implications for maternity and neonatal service provision. The risk that obesity imposes for outcomes after surgery is widely recognised across the specialty.[64,65] A study[53] of obese women (BMI ≥30kg/m^2) who gave birth by caesarean section, found that presentation to the community physician with signs of superficial wound infection occurred 6–24 (median 18) days after surgery. In this cohort of high-risk women, 28% received a clinical diagnosis of wound infection with a prescription for antibiotics. Wound swabs taken at the time of the community visit were, in the majority of cases, negative for pathogenic micro-organisms. However, for those women with a clinical diagnosis of SSI, anaerobes (typically heavy growth) were noted in laboratory reports. It is not clear whether anaerobes had a role in SSI because pathology laboratories do not usually undertake full characterisation of the organism as they are difficult to grow, identify and to perform antibiotic susceptibility testing. If anaerobes are reported in swabs taken from caesarean section wounds (and this applies also to CRPT), clinicians will usually prescribe metronidazole as there are few suitable antibiotics available. In the presence of a breach of the skin barrier, together with localised vascular insufficiency, anaerobes can lead to surgical wound infection.[66] The relevance of anaerobe species to wound infection are discussed more fully below.

Pregnancy-related risk factors that are generally not modifiable include emergency or unscheduled caesarean section delivery.

Childbirth-related perineal trauma and infection

Risk factors for CRPT complications (Table 2) and infection[67] include midline or mediolateral episiotomy[68,69] and, in a small study only, prolonged rupture of membranes,[70] use of catgut to suture the tear[70] and experience of the practitioner.[70] Johnson et al (2012)[67] concluded that operative vaginal births (forceps or vacuum-assisted) and episiotomy may predispose women to perineal wound infection. Breakdown of a laceration or episiotomy was more likely with OASI, operative vaginal births, and meconium-stained liquor.[71–73]

For higher order lacerations (third- and fourth-degree tears/laceration), Jallad et al[74] found smoking, nulliparity, operative delivery, repair by a midwife and use of chromic sutures were independent risk factors for breakdown of a perineal laceration repair after vaginal delivery. Wilkie et al[75] found that chorioamnionitis was a risk factor for higher-order lacerations, while forceps deliveries, episiotomy and the need for narcotic pain medications postpartum were risk factors for perineal wound breakdown. Gommesen et al[31] found that BMI >35kg/m^2 was associated with a seven-fold risk of CRPT infection, while episiotomy was associated with a three-fold risk.

The reported prevalence of dehiscence in perineal tears ranges from 4% to 20%. The large variation may be explained by the lack of standardised definitions of postpartum perineal wound infection and dehiscence.[31]

Natural microbial flora of the skin

The skin is not a sterile structure. It has an indigenous microbiota dominated by Gram-positive bacteria. These include the genera *Staphylococcus*, *Micrococcus*, *Corynebacterium*, *Propionibacterium* (now called *Cutibacterium*), *Brevibacterium* and *Dermobacterium*. Additionally, the Gram-negative *Acinetobacter* and a yeast (*Malassezia*) are also part of the normal

community.[76] Often these communities exist as biofilms. This complex flora is influenced by diverse factors, with commensals helping to protect against potentially pathogenic organisms.[77] Studies of the skin microbiome indicate that the commensal bacteria play an important role in modulating the host immune system.[78] *Staphylococcus aureus*, for example, is carried by up to 30% of healthy individuals on the skin without detriment. Coagulase-negative staphylococci (particularly *Staphylococcus epidermidis* and *Staphylococcus hominis*) seem to play an important role in suppressing *Staphylococcus aureus* by producing antimicrobial peptides. One major inhabitant of the skin is *Corynebacterium,* which although considered to be non-pathogenic, has been found increasingly in chronic wounds.[79]

The diversity within the skin microbiome differs between individuals.[77] As an example, molecular techniques used to compare the microbiome at skin sites in women who were either obese or non-obese, before and after caesarean delivery, showed significant differences.[80] Incision sites before surgery in women who were obese carried a higher bacterial load with lower diversity than in women who were not obese. Genera of anaerobic bacteria such as *Anaerococcus*, *Peptoniphilus*, *Finegoldia*, *Prevotella* and *Porphyromonas* were increased, while commensals such as *Staphylococcus* and *Corynebacterium* were reduced in women who were obese. For women who were obese, antisepsis with chlorhexidine at the incision site reduced bacterial load to that of women who were not obese; however, biofilms were still detected in 75% of skin biopsies of women in the obese group.[80] Vaginal load was similar in both groups of women. After caesarean delivery, there was increased bacterial DNA found on obstetricians' gloves and at incision sites following wound closure, which indicated that sterility was not maintained throughout the procedure. Findings suggested that obese women were at higher risk of SSI due to their unusual skin flora at the incision site before surgery, together with the carriage of vaginal flora to closed wound sites on obstetricians' gloves.[80]

Table 2. Risk factors for CRPT complications[64]

Modifiable risk factors	Reference
Episiotomy	67–69, 71–74
Third or fourth grade tears	71–74
Assisted vaginal delivery	312, 67, 71–74
Smoking	74
Repair by a midwife	74
Experience of the practitioner	70
Chromic suture	74
Catgut suture	70
BMI >35kg/m^2	31
Prolonged rupture of membranes	67, 70
Non modifiable risk factors	
Maternal age (older age)	31
Meconium-stained fluid	71–73
Birth weight (higher weight)	31
Primiparity	74

Natural microbial flora of the female genital tract

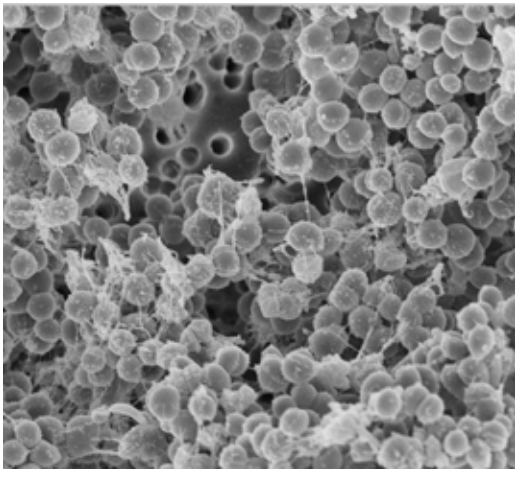
The indigenous microbiota is a relatively complex, dynamic community comprising aerobic/facultative species and strict anaerobes, and dominated by lactobacilli.[81] Conventional culture determined that genera present included *Lactobacillus*, *Staphylococcus*, *Corynebacterium*, *Streptococcus*, *Enterococcus*, *Candida albicans*, *Bifidobacterium*, *Gardnerella vaginalis*, *Cutibacterium*, Gram-positive anaerobic cocci, Bacteroides, *Porphyromonas*, *Prevotella*, *Clostridium*, *Fusobacterium*, *Veillionella*, *Ureaplasma* and *Mycoplasma*.[76] Additional colonising bacteria are Gram-negative rods such as *Escherichia coli, Klebsiella*, *Enterobacter* and *Proteus*. Anaerobic

bacteria significantly outnumber aerobic bacteria in colonising the cervix of healthy women.[82] Culture-independent investigation of vaginal flora in healthy women identified five distinct groups whose flora was dominated by either *Lactobacillus iners*, *L. crispatus*, *L. gasseri*, *L. jensenii* or mainly strict anaerobes. For all groups, the production of lactic acid was considered to be an important factor in protecting the vagina against infection.[83]

One commensal that has attracted much attention is *Streptococcus agalactiae*, which is a group B haemolytic streptococcus (GBS). Colonisation by this bacterium is a known risk factor for pregnant women. It was first identified as a human pathogen in 1938[84] and has been implicated in cases of maternal and neonatal sepsis. Although there are limited data on the global burden of GBS,[85,86] a clone carrying the resistance determinant for tetracycline has caused many fatalities.[87]

Microbial species were traditionally thought to be confined to the lower genital tract, but sampling at six sites throughout the female reproductive tract has revealed an entirely non-sterile environment with distinct microbial communities in the cervical canal, perineal fluid, uterus and fallopian tubes that differed from that of the vagina.[88] The placenta has also been shown to carry a distinct microbiome composed of non-pathogenic commensals similar to that of the human oral microbiome.[89] Implications for postpartum infections are not yet understood.

Fig 7. The skin has a diverse microbiota dominated by Gram-positive bacteria. Scanning electron micrograph of *Staphylococcus aureus*. Image from www.dreamstime.com



Common pathogens of the female genital tract

The skin and mucous membranes of the genital tract and abdomen provide a mechanical barrier to the environment. However, breaches caused by traumatic injury (vaginal delivery) and elective surgery (episiotomy or caesarean section) generate wounds that allow the ingress of microbial species that can give rise to infection.

In wound infections associated with childbirth the main endogenous reservoirs of infection are the vagina and skin, and to a lesser extent, the gastro-intestinal tract. The causative agents may be part of the natural flora of the maternal host (endogenous) or derived from other patients, healthcare staff, relatives, medical equipment or other environmental surfaces (exogenous).[81]

Until the 21st century, investigations of microbial flora were performed by culturing human specimens to isolate and identify individual species. These studies were limited by the culture conditions used, and fastidious organisms are likely to have been underestimated because of their inability to grow on the media chosen and their low population densities.[78] More recently, culture-independent molecular techniques relying on gene cloning and sequencing have become available and the presence of a much broader range of species, some previously not described, in human hosts has been demonstrated. Molecular techniques also provide an accurate means to

estimate bacterial numbers. Despite extensive study, the complex interactions between hosts and invading microbes that result in infection are still not entirely understood.

Postpartum wound infections

The epidemiology of postpartum wound infections is not easily collated. Signs and symptoms usually present after discharge from hospital and the patient may then report to a different healthcare service. Infection associated with wounds during childbirth can be divided into perineal/episiotomy infections and surgical site infections following caesarean section. A comprehensive study of postpartum infection conducted in Denmark included 32,468 births and the prevalence of wound infection was calculated as 5% after caesarean section and 0.08% for vaginal births, more than 75% of which were recorded after hospital discharge.[90]

Infections associated with perineal tears and episiotomy

Perineal infection in childbirth-related perineal trauma is associated with perineal pain, wound dehiscence and/or purulent discharge.[91] Information concerning postpartum infections following traumatic injury during vaginal birth in published studies is limited. A systematic review by Jones et al[28] found that in 23 studies (11 cohort, two case control and 10 reporting incidence), the reported incidence of CRPT wound infection ranged from 0.1% to 23.6% and wound dehiscence from 0.21% to 24.6%. Quality assessment of the included studies exposed inadequacies in several methodological areas. Heterogeneity among the studies was observed, particularly regarding perineal wound infection definition and confirmation, making effective synthesis of the data almost impossible.[28] The prevalence of perineal infection following CRPT at operative vaginal birth in the ANODE trial was >15%.[92] Episiotomy has been shown to triple the risk of perineal infection.[31] Microbes implicated in wound infection include species of streptococci, staphylococci, Gram-negative enteric bacteria and anaerobes, although normal flora have also been recovered from wound swabs.[93] One case of toxic shock syndrome caused by methicillin-resistant *Staphylococcus aureus* (MRSA) in a perineal infection has been reported.[94] Further research is warranted particularly in the sphere of wound assessment.

Wound assessment

There are several frameworks for wound assessment and wound bed preparation. These include TIME (tissue, inflammation/infection, moisture balance and wound edge),[95–97] modified to TIMERS,[98] to include regeneration of tissue and social factors. Others include DOMINATE (debridement, offloading, moisture, infection/inflammation, nutrition, arterial insufficiency, technical advance and (o)edema)[99] or Triangle of wound assessment,[101] as well as wound assessment tools (WAT).[101] All are intended to help clinicians to assess a wound and develop a care plan in a concise and systematic way. However, most WATs published to date have been developed for hard-to-heal wounds rather than perineal wounds and so the literature is limited.

The WUWHS position document[100] indicates that optimal wound management requires attention to three critical elements:

- Determining aetiological factors, followed by interventions to correct or ameliorate those factors
- Assessing systemic factors affecting wound repair, with measures to optimise the repair process
- Assessing the wound, including the wound edge and the peri-wound skin status, as a basis for topical therapies to promote healing.

Greatrex-White and Moxey[101] studied how well different wound assessment tools met the needs of nurses in carrying out general wound assessment and whether current tools were fit for purpose. They showed that of 14 selected WATs, the Applied Wound Management (AWM)[102] and National Wound Assessment Form (NWAF)[103] best met nurses' needs in carrying out wound assessment.

Assessment of perineal wounds

Examining perineal wounds requires that the woman adopt a position that facilitates inspection of the entire perineum. This will ensure the efficient assessment of the wound and progress to healing as well as early detection of signs of delayed healing. At each postnatal contact, women should be offered a thorough perineal assessment if they have any concerns about their perineal wound, including perineal pain, discomfort or offensive odour. Any signs or symptoms to suggest infection, inadequate repair or wound dehiscence should be acted upon promptly and appropriately.[25] Specifically, for perineal wounds, two wound assessment tools have been developed: the Perineal Assessment Tool (PAT) and the Redness, Oedema, Ecchymosis, Discharge, Approximation (REEDA) scale (Table 3).[104,105]

These scales use similar categories and descriptors to assess the same items. However, their main difference is that the PAT operational settings are less objective than the REEDA scale, and therefore, the PAT has low reliability. The PAT scale[106] has also been used to assess problems regarding incontinence-associated dermatitis rather than perineal wounds following childbirth.

The REEDA scale

The REEDA wound assessment scoring tool was designed to facilitate measurement of healing of an episiotomy using five components of the healing process that may suggest infection, such as increase in pain, oedema, excessive/offensive discharge, feeling unwell, pyrexia, wound dehiscence or abscess formation.[104] REEDA scoring proved valuable with students as a method of increasing their observational skills for perineal wound healing complications and assisting with reducing associated pain during the postnatal period. However, in another study, the REEDA tool had poor inter-rater reliability on some components and needed further enhancement.[107] This suggests that the REEDA scale may be helpful for an individual patient when used by one physician or midwife during follow-up of the healing process, but care should be taken with the interpretation when comparing assessments of different observers.

Despite this known limitation in its validity, in the absence of any other scale, the REEDA has been used to investigate interventions that aimed to assess perineal suture techniques[108], perineal pain in the suture,[109,110] postpartum perineal care,[109] the effect of laser irradiation on perineal pain[110] and wound healing with regard to tearing of superficial perineal muscles[112]. However, the systematic review by Jones et al[28] of the incidence of CRPT infection highlights the lack of a standardised, validated assessment tool for CRPT and a lack of consensus regarding definition of outcomes, with 71% of studies having no definition of infection.

The impact of wounds on the patient

Pain

Little is mentioned to the expectant mother regarding postnatal recovery and too many women who experience extensive injury are ill prepared for the discomfort and effects that this pain has on their ability to cope with the pressures of being a new mother.[114] Everyday activities are a challenge. Their ability to cope with the day-to-day care of their baby often

Table 3. Assessment categories, descriptors and score comprising the REEDA scale

Score	Redness	Oedema	Ecchymosis	Discharge	Approximation
0	None	None	None	None	Closed
1	Mild Less than 0.5cm from each side of the wound edges	Mild Less than 1cm from each side of the wound edges	Mild Less than 1cm from each side of the wound edges	Serum	Skin separation 3mm or less
2	Moderate 0.5cm to 1cm from each side of the wound edges	Moderate 1cm to 2cm from each side of the wound edges	Moderate 1cm to 2cm from each side of the wound edges	Serosanguinous	Skin and subcutaneous fat serparation
3	Severe More than 1cm from each side of the wound edges	Severe More than 2cm from each side of the wound edges	Severe More than 2cm from each side of the wound edges	Purulent	Skin and subcutaneous fat and fascial layer separation
Total					

Source: Davidson[104]

requires extended assistance from loved ones and additional visits from midwives. It affects the ability to sit, not ideal when trying to establish breastfeeding. The mother, already sleep deprived, will be in low spirits, and the addition of pain and the possibility of incontinence contributes to the increased risk of postnatal depression. Postpartum depression (PPD) affects approximately 10–20% of mothers, making it the most common serious postpartum disorder.[115] Unfortunately, the rate of diagnosis and treatment is low, due to a lack of recognition by the healthcare provider.[116]

Long-term consequences

Acute pain as a result of soft tissue trauma should resolve quickly with the correct treatment, management and support from healthcare providers. However, it is possible that pain returns in a different guise: from overgranulation of tissue, scar pain or nerve pain. Delayed recovery from childbirth is common in women who experience perineal wound and caesarean section infection or dehiscence. Mobility may be compromised, preventing women from resuming activities of daily living, shopping, visiting friends and attending new mothers' groups. Women can feel extremely isolated during this time.[117]

Granuloma and overgranulation tissue after CRPT

Prolonged inflammation can impair healing as a result of the accumulation of macrophages, fibroblasts and collagen to create granuloma.[118] Granuloma is commonplace, whether due to infection, inflammation around suture material or possibly due to friction at, or close to, the perineum. The patient may experience an initial improvement in perineal discomfort only to find that pain returns. This is a difficult problem to manage. No guidelines exist for the management of overgranulation of the perineum. The use of silver impregnated applications is controversial due to breast feeding and the possibility of breastmilk being affected. The resumption of intercourse is often delayed and may not be possible at all. The reasons for this are likely to be multifactorial, but fear and the formation of tight, stiff scar tissue are likely to be causes. The scar may benefit from perineal massage to make it more malleable.

Counselling regarding the whole event of childbirth is useful for a couple. To debrief allows women to understand the process and why injuries occur, therefore it is imperative that women have knowledge of, and access to, this type of service. Difficulty with sexual intercourse and dyspareunia may affect as many as 30% of all women 3 months after the birth.[25] In one study, dyspareunia was reported by 44.7%, 43.4%, 28.1% and 23.4% of women at 3, 6 12 and 18 months postpartum, respectively.[119] The second major consequence of birth trauma relates to the incisional, caesarean section wound and the risk of subsequent wound complications, such as infection.

Complications associated with the caesarean section incisional wound

Surgical site infection (SSI) is defined as 'an infection that occurs within 30 days of the operation and involves the skin and subcutaneous tissue of the incision (superficial incisional) and/or deep soft tissue (for example, fascia, muscle) of the incision (deep incisional) and/or any part of the anatomy during an operation (for example organ/space) that was opened or manipulated during an operation'.[45] Since caesarean section involves incision into the abdomen and uterus, it is classified as clean-contaminated surgery.[119] Although much has been published on the microbial species causing SSIs in general, there is less information concerning pathogens implicated in caesarean section wound infections. For example, in one study, 939 wounds in post-caesarean patients were followed prospectively and investigated if signs of infection developed.[120] Wound morbidity was detected in 65/939 wounds (cumulative incidence of 6.9%) and 45/939 yielded positive culture results. *Ureaplasma urelyticum* was isolated most frequently, with coagulase-negative staphylococci and *Enterococcus faecalis* less frequently. Genital mycoplasmas were, therefore, most often isolated from this cohort of patients.[120] Pathogens also associated with SSI after caesarean sections are *Staphylococcus epidermidis*, *Staphylococcus aureus*, *E. coli*, *Proteus mirabilis*, group B streptococcus (GBS) and anaerobes.[121] A systematic review of SSIs globally examined the epidemiology of GBS and noted its involvement in a substantial proportion of invasive SSI post-caesarean section.[122] GBS is considered to be a leading contributor to adverse outcomes for both mothers and neonates.[123]

Invasive infections affecting deep tissue and organ space

Necrotising fasciitis

Necrotising fasciitis is a potentially fatal, rapidly developing invasive infection that causes necrosis of subcutaneous tissue and fascia. It has been reported as an infrequent complication following caesarean delivery, with an incidence of 1.8%.[22] Type I necrotising fasciitis is characterised by a polymicrobial infection of aerobic and anaerobic bacteria; type II is caused by a single pathogen. Synergistic combinations isolated from infected patients in one study included *Staphylococcus aureus*, *Enterobacter agglomerans*, *Acinetobacter baumannii* and two strains of *Enterobacter cloacae*.[125] In another study, *Staphylococcus aureus,* streptococci, enterococci, *E. coli, Bacteroides fragilis* and clostridia were implicated.[126] Pathogens linked to type II were group A streptococci or MRSA.[127] Rapid diagnosis and intervention with sharp debridement and broad-spectrum antibiotics are required for successful outcomes with this infection.[125]

Postpartum depression (PPD) affects approximately 10–20% of mothers, making it the most common serious postpartum disorder.[113]

Endometritis

Originally known as puerperal fever, endometritis is an infection of the upper genital tract, including the endometrium, myometrium and surrounding tissue. It is caused by bacteria translocated from the vagina or abdominal skin into the uterus. It can occur following vaginal delivery but is at least five times more likely to arise following caesarean section and affects between 2% and 16% of women.[128] The first pathogen implicated in puerperal fever was *Streptococcus pyogenes*.[129] In 1933, streptococci were divided into groups on the basis of the components in their cell walls and *Streptococcus pyogenes* was allocated to group A and is known as a group A streptococcus, or GAS.[130]

Before the antibiotic era, GAS were associated with significant morbidity and mortality in puerperal fever, but incidence reduced between 1940s and 1980s. Since the 1990s, sporadic cases of invasive GAS infection (iGAS) have occurred. In 2010, iGAS became a notifiable disease in England and Wales. GAS was recognised as a leading cause of maternal sepsis,[131] with 61% and 1% of cases associated with the genital tract and caesarean section wound site, respectively.[131] Polymicrobial infections involving aerobes, anaerobes and genital mycoplasmas were implicated in endometritis, with Gram-negative bacteria found in 10-20% of cases following caesarean section.[132] *E. coli* was the most frequent isolate followed by *Klebsiella pneumoniae*, *Proteus mirabilis* and *Enterobacter* spp.[132] In another study, coliforms, streptococci, anaerobic cocci, bacteroids and *Ureaplasma urealyticum* were associated with post-caesarean section endometritis.[133] In Finland, vaginal colonisation by group C or G streptococcus was associated with endometritis.[134] Until recently these bacteria were not considered to be pathogenic. One case of necrotising endomyometritis caused by multidrug-resistant *E. coli* was been reported, highlighting the problems of the continued emergence of antibiotic-resistant pathogens.[135]

General treatment principles and clinical management options

Perineal injuries

- Assess the wound for signs of infection and take a wound swab for culture and sensitivity if an infection is suspected. Guidelines are available.[136]
- If signs of infection are present, commence a broad-spectrum antibiotic (co-amoxiclav) with the aim of reducing the risk of wound dehiscence.
- Clean and debride the wound using sterile water or isotonic saline, taking time and great care not to inflict further injury and reduce discomfort. If the woman is breastfeeding, silver-based products are contra-indicated.
- Continue to review patients on a regular basis to ensure healing is progressing or to identify those who require expert management.

As perineal wounds may overgranulate due to friction or infection,[137] there will be an absence of scab formation. The wound, therefore, remains moist, and, due to the site, typically difficult to apply a dressing. The community physician should be contacted with a request for topical preparations (e.g. silver-containing agents). Such topical treatments can be commenced in the outpatient setting. In contrast, excessive scar-tissue formation or poor alignment of tissues in the initial repair may require additional reconstructive surgery, for example, perineal refashioning, perineorrhaphy (suturing of the perineum) or a modified Fenton's procedure to widen the introitus if there is excessive scarring.[138]

Caesarean section wounds

Dressings and advanced wound technologies

There are so many dressings available on the market that the choice may be overwhelming to the novice and expert alike. Table 4 provides a summary of the characteristics and dressing properties of most categories available at the time

of writing. The primary principles for dressing use in the management of birth wounds are to:

- Protect the wound site
- Prevent contamination of the wound site
- Create an environment that is conducive to wound healing
- Promote comfort for the postpartum mother

When a complication, such as infection or dehiscence, occurs, the use of dressings plays a different role, and can be used to manage exudate, infection, generate tissue granulation or create a moist wound healing environment. Correct assessment and diagnosis of the wound healing stage is key to ensure that the most appropriate dressing is used to facilitate optimum healing. A high standard of documentation, including a wound care plan that is designed for the patient, should be used and shared among all healthcare providers to ensure continuity of care.[59]

Wound aids in the form of an abdominal binder (or compression belt) to encircle the abdomen, providing support to the incision, may be of value after caesarean section, although there is a paucity of evidence. Elastic binders are considered to speed recovery and to promote wound healing. A systematic review of their use after abdominal surgery revealed a (non-significant) tendency to reduce seroma formation after laparoscopic ventral herniotomy and a non-significant reduction in pain.[139] The quality of evidence of the reviewed papers was rated as poor. Gustafson et al[140] reported significantly lower average postoperative pain scores when compared to a control group. However, in a randomised controlled trial, Chankhunaphas and Charoenkwan[141] showed that there was no significant between-group difference in quality-of-life dimensions, overall health status and postoperative complications. The positive effects of elastic abdominal binder use following caesarean delivery could not be demonstrated in this study. Therefore, the effects of binders on wound healing after caesarean section is unclear.

The use of wound care dressings and the scientific and clinical evidence base

While there are a large number of wound care dressings available, it is important to consider the evidence base for their indicated use. Although there is limited evidence on the use of modern interactive dressings for preventing surgical site infections,[142] the National Institute for Health and Care Excellence (NICE) in the UK recommends covering surgical incisions with an appropriate interactive dressing at the end of the procedure.[58]

The World Health Organization guidelines for the prevention of surgical site infection also recommends 'not using any type of advanced dressing over a standard dressing on primarily closed surgical wounds for the purpose of preventing SSI'.[58] This recommendation is based on the absence of high-quality evidence to support this indication. A meta-analysis of 16 trials yielded no differences between different wound dressings and prevention of SSI.[143] Another systematic review investigated the timing of postoperative dressing removal and revealed no statistically significant difference between early versus delayed dressing removal in the prevention of SSI.[144] Whereas, the findings of a randomised controlled trial comparing early and late dressing removal following caesarean section, revealed that women were pleased and satisfied with early dressing removal.[145] The study also revealed that more complications were experienced in the early removal group compared with the standard removal time group, although this was not statistically significant.[145] Stanirowski et al[146] revealed a reduction in SSI rates following caesarean section when using a dialkylcarbomyl chloride (DACC) impregnated dressing compared with controls. A two-arm, parallel-group, pilot

feasibility randomised controlled trial in a vascular cohort, yielded similar findings in the prevention of SSI using DACC impregnated dressings compared to controls.[147]

While there is a growing body of evidence to address key questions about prevention and management of SSI, dressing use should be based on current evidence and guidelines,[58,59,148] local policies and clinical judgement, which may be guided by Table 4.

At the time of writing, there is considerable discussion about the efficacy of negative pressure wound therapy (NPWT) for the prevention of SSI after caesarean section. Several systematic reviews provide conflicting evidence for the effectiveness of this advanced dressing as prophylaxis for prevention of SSI.[152–154] Moreover, the World Health Organization guidelines clearly state that, while this type of dressing may be used, there is low-grade, poor-quality evidence to demonstrate effectiveness of SSI prevention.[58] Consequently, there remains uncertainty with regard to the use of NPWT for prophylaxis of SSI in the obstetric population. More evidence from systematic review or meta-analysis of all relevant RCTs (level one research) is required to investigate the benefits, both health-related and economic, of NPWT and other advanced dressing use in obstetrics and maternity care.

Topical issues and controversies

Today, clinical practice is largely based on objective evidence. Normally well designed, appropriately powered, double blinded, randomised controlled clinical trials provide data that contribute to systematic reviews and meta-analysis, from which clinical guidelines are constructed and informed decisions made by practitioners. Wound infection, endometritis and urinary tract infections following childbirth contribute to maternal morbidity and demand effective antimicrobial treatment. Antibiotics have been used in the successful treatment of infections during the past 70 years, but the widespread use and overuse of antibiotics has allowed the emergence of resistant strains of microbial species. Furthermore, organisms may possess resistance to antiseptics, to multiple antibiotics or exhibit resistance to both antibiotics and antiseptics. Now antimicrobial resistance (AMR) has become a global problem[155] that requires global action.[156] This threat to effective management of wound infection has been noted[157] and the need to use antibiotics judiciously has been recognised.[158–160] With limited hope of finding new antibiotics, it is important to increase efforts to prevent infections and to conserve the therapeutic value of existing antimicrobial interventions as indiscriminate use facilitates the continued emergence of resistant strains. Alternative approaches to wound care are being explored, for example the role of medicinal honey in wound management.

The role of honey in wound care

Honey is an ancient wound remedy that has been re-introduced into modern wound care. There is some evidence that it might be useful in managing birth-related wounds, but larger studies will be needed to inform current practice. Lower rates of each of wound infection[161,162] and wound dehiscence[158] and faster healing rates[163,164] have been observed in women whose caesarean section incision sites were treated with honey compared to conventional interventions. Faster wound healing for episiotomies were reported with honey compared to placebo, but there was no reduction in pain.[165] An adhesion model in rats has shown that honey significantly reduced the severity of postoperative peritoneal adhesions compared to isotonic saline.[166] Further studies are required to determine the full clinical and cost-efficacy of honey in birth wound complications. The more

conventional approach to treating wound infections is the use of antibiotic medication; however, there is now global concern about the development of resistance to antibiotics, reducig their efficacy, which carries the risk of significant morbidity.[156] Failure to treat and manage patients with wounds will have a significant bearing on health system resources and ultimately the economy.

The impact of birth-related wounds on the economy

It is widely recognised that after caesarean section the risk of SSI is high, especially in women with obesity.[64] While the majority of surgical wounds heal by primary intention within 7 days, a proportion do not. Incised wounds that are slow to heal, rupture or become infected require ongoing treatment, inflating the initial healthcare costs. Wloch et al[56] estimated the healthcare costs for SSI after caesarean section in England, taking into account that while the majority of infections are superficial (88%), a proportion are severe and in some cases fatal. Cost-analysis data for 2010–2011 from one hospital that carried out 800 caesarean sections had an estimated infection risk of 9.6%. Costs of SSI were an estimated £18,914 (95% CI 11,521–29,499), £5370 (28%) of which were for community care. Extrapolated nationally and with inflation to 2019 prices, this equates to an estimated cost of £5 million for all caesarean sections performed in England for period 2018–2019.[56,57]

These data, extrapolated globally and updated to current treatment costs represent a significant drain on healthcare resources for what is an avoidable birth-related complication.

Orlovic and colleagues[167] used hospital episode statistics (HES) for 2010–2011 and 2013–2014 and estimated the overall economic burden of inpatient third- and fourth-degree obstetric tears to the NHS (England) at £10.7 million and £1.5 million, respectively. Despite initiatives to improve maternity care, the incidence of severe perineal lacerations leading to OASI is increasing.[168] Improvements in maternity care to enhance the wellbeing and safety of women is recognised as an issue of national concern,[169] particularly when, for women who had a third- or fourth-degree tear during their first birth, recurrence of the injury was 7.2% compared with 1.3% for women without a tear.[170] The rise in the number of these CRPT events may lead to other related, longer-term conditions that further impact on the physical and emotional wellbeing of women who have lingering obstetric problems that require further healthcare services over periods of time lasting from 4 to 8 years.[171]

Within the wound care community, there is recognition of the escalating costs of unhealed surgical and hard-to-heal wounds. The cost of the estimated 2.2 million wounds in England is £4.5–5.1 billion, with predicted acute and chronic wound prevalence growing year on year at 9% and 12%, respectively.[172] Finding new ways to achieve best practice in assessment, diagnosis and rational management strategies for patients will reduce costs. Here, the use of antibiotics in childbirth, especially antibiotic prophylaxis is now under intense scrutiny.

The use of antimicrobials after childbirth

Antimicrobial agents are routinely prescribed prophylactically during childbirth, particularly for caesarean section. Robust reviews of the clinical evidence of the efficacy of antimicrobial prophylaxis for women undergoing vaginal delivery (Table 5) or caesarean section (Table 6) have been published and have been incorporated into various international and national guidelines. Currently WHO guidelines recommend routine antibiotic prophylaxis for elective and emergency caesarean section, third- and fourth-degree perineal tears, but not for episiotomy,

Table 4. Wound dressings for the management of surgical wounds (after NICE[145] and WHO[56])

Dressing category	Dressing characteristics	Wound characteristics*/ healing intention	Primary clinical indications	Phase of management
Advanced (interactive)				
Vapour-permeable films	Permeable to water vapour and oxygen, but not to water or microorganisms. They are normally transparent	Superficial Minimal exudate Primary intention	Facilitate optimum healing environment (moist wound healing) and provide a barrier to bacteria/protect incision site	Intra-operative (in theatre) Post-operative Community/home-care settings
Hydrocolloid dressings	Vary significantly in their composition and physical properties. In general, they consist of a self-adhesive gel-forming mass applied to a carrier, such as a thin polyurethane film or a foam sheet. They contain colloidal particles, such as quar, karaya, gelatic, sodium carboxymethylcellulose, gelatin and pectin, in an adhesive mass usually made of polyisobutylene. In their intact state, hydrocolloids are virtually impermeable to water vapour. By trapping wound exudates, hydrocolloids create a moist environment that softens and lifts dry eschars. They also favour granulation tissue formation and re-epithelialisation	Superficial Low exudate Primary and secondary intention	Facilitate wound hydration and optimum wound healing environment. Promote autolytic debridement and proteolytic digestion	Post-operative (usually) Community/home-care settings
Hydrogels or fibrous hydrocolloid dressing	Consist of 80–90% water and insoluble cross-linked polymers, such as polyethyleneoxide, polyvinyl pyrollidone, acrylamide or carboxymethylcellulose, with hydrophilic sites that interact with aqueous solutions, absorbing and retaining significant volumes of water	Superficial or deep Low–moderate exudate Secondary intention	Rehydration of tissues and some absorption of exudate. Facilitate optimum healing environment and protect incision site. Some absorbency potential.	Intra-operative (occasionally) Post-operative Community/home-care settings
Polyurethane matrix hydrocolloid dressing	Consist of two layers: a polyurethane gel matrix and a waterproof polyurethane top film designed to act as a bacterial barrier	Superficial or deep Low–moderate exudate Primary and secondary intention	Indicated for clean, granulating/sloughy or necrotic wounds. Limited absorbency capacity: the amount of exudate that a hydrocolloid dressing can absorb is dependent on the MVTR of the backing layer	Intra-operative Post-operative Community/home-care settings
Alginates	Manufactured from salts of alginic acid (source: brown seaweed). On contact with wound exudate, ionic exchange occurs in the alginate and a hydrophilic gel forms. The nature of this exchange is dependent on the amount of guluronic (g) and mannuronic acid (m) used in manufacture. The amount of g and m acid in the dressing also determines its ability to absorb exudate, retain its shape and how it will be removed from the wound. Available in sheet/rope/cavity filler form	Superficial or deep Low–moderate–high exudate Secondary intention	Absorbency of exudate; maintains a moist wound surface and promotes the removal of cellular debris/slough from the wound surface (bed)	Intra-operative (occasionally) Post-operative Community/home-care settings

Polyurethane foams	Made of polyurethane and available in a variety of forms: simple foam sheets, film-backed foam sheets, polyurethane foam gels (hydro polymer) and cavity fillers (tube dressings). One variety has additional additives, e.g. glycerine and a surfactant	Superficial when used as a primary dressing or deep when used as a secondary dressing Low–moderate–high exudate Secondary intention (usually)	Absorbency of exudate; maintains the optimum healing environment and can minimise the risk of trauma at the wound surface at the time of dressing change (dependent on product chosen)	Intra-operative Post-operative Community/home-care settings
Bacteria- and fungi-binding dressings				
Dialkylcarbamoyl chloride (DACC) coated dressings	Facilitate the binding of micro-organisms to the dressing as a result of the specific surface characteristics using the principles of hydrophobic interaction. Common wound microorganisms, including MRSA, bind to the dressing surface from the wound bed and are removed at dressing change	Superficial–deep Low–high exudate Primary and secondary intention	Can be used both for infection prevention as well as for treating already-infected surgical wounds. No known mechanism of resistance development. Suitable for prolonged duration of treatment	Intra-operative Post-operative Community/home-care settings
Antimicrobial dressings	Should not be used routinely for prophylaxis (i.e. to prevent infection). However, some antimicrobial products may contribute to the reduction of SSI risk in some surgical patients. Clinicians should make their decision to use any antimicrobial product prophylactically in view of their knowledge of the properties of the product being considered; the evidence available to support its proposed use, and their own previous experience with the product/dressing			
Polyhexametylene biguanide (PHMB) dressing	Common antiseptic used in a variety of products, including wound care dressings and wound cleansing solutions, perioperative cleansing products, contact lens cleansers and swimming pool cleaners.	Superficial or deep Moderate–high exudate Secondary intention	Wound cleansing; wound bed preparation—the stimulation and influence of specific cells involved with the immune system and the management of wound infection in conjunction with appropriate systemic therapy.	Post-operative (usually) Community/home-care settings
Silver-impregnated dressing	Silver provides extensive coverage against bacteria, fungi and viruses, including nosocomial pathogens, MRSA and VRE, making it a valuable adjunct in the prevention and treatment of infection. Silver has both bactericidal effects via oxidation of the cell membrane and bacteriostatic effects by inhibiting bacterial replication through damage to DNA	Superficial or deep Moderate–high exudate Secondary intention	Wound cleansing; wound bed preparation—the stimulation and influence of specific cells involved with the immune system and the management of wound infection in conjunction with appropriate systemic therapy	Post-operative (usually) Community/home-care settings
Povidone iodine impregnated dressings	Iodine is an antiseptic that targets a broad spectrum of bacteria and other pathogens. It has been used successfully, without complications, for the management of many chronic wounds; however, there is currently little evidence to support its use for the prevention and long-term management of SSI	Superficial wounds Minimal exudate Secondary intention	Iodine is an oxidising agent and its bactericidal activity is inorganic with essentially no development of resistance by microorganisms	Post-operative
Advanced (active)				
NPWT dressings	Primarily designed to prevent exudate collection while simultaneously preventing desiccation of the wound	Deep Low–moderate–high exudate Secondary intention	These dressings increase oxygen tension in the wound, improve blood flow to the wound bed, decrease bacterial count, increase granulation formation and minimise shear forces on the wound surface	Intra-operative Post-operative Community/home-care settings

Basic wound contact layers				
Absorbent dressing pads	These are non-occlusive permeable dressings that allow moisture to be absorbed and to evaporate into the atmosphere. Many comprise a soft viscose, polyester-bonded pad that may or may not have an external polyethylene contact layer. 'Superabsorbers' consist of absorbent polymers (some of which expand on absorption of fluid); however, this is a comparative not absolute term	Superficial Low exudate Primary or secondary intention (when used as a secondary dressing) Superficial Low–moderate exudate Secondary intention (usually, when used as a secondary dressing)	Additional absorbency of exudate over another primary dressing or a low adherent wound contact layer (see below).	Not generally recommended in theatre or the immediate post-operative phase. May be used as a secondary dressing (occasionally)
Low-adherent wound contact layers (traditional)	Consist mainly of a fine mesh gauze impregnated with moisturising, antibacterial or bactericidal compounds. Either non-medicated (e.g. paraffin gauze dressing) or medicated (e.g. containing povidone iodine or chlorhexidine). As the dressing dries, fibrin from the wound bed causes temporary bonding of the dressing to the wound, permitting healing beneath it	Superficial Low exudate Primary intention (usually)	Widely used, primarily as interface layers between the wound surface and a secondary absorbent dressing. Usually made of cotton gauze to prevent adherence to the wound surface and avoid trauma on removal	Intra-operative (occasionally) Post-operative Community/home-care settings
Low-adherent silicone wound contact layers		Superficial but can be used to line a deep wound, as in combination with NPWT Low exudate (usually) when dressing used for its primary clinical indication Primary intention (usually), can be secondary when used in combination with NPWT	Minimise risk of trauma at wound surface and patients' pain experience during dressing changes	Intra-operative (occasionally) Post-operative Community/home-care settings

*Exudate is a generic term used to identify liquid produced from wounds.[146,147] Bates-Jensen[148] attempted to qualify the levels of exudate in relation to the terms often used by clinicians to describe the same
Low (minimal or small) exudate: wound tissues wet, moisture evenly distributed in wound, exudate affects 25% of dressing; moderate exudate: wound tissues saturated, drainage may or may not be evenly distributed in wound, exudate involves 25–75% of dressing; high (or large) exudate: wound tissues bathed in fluid, drainage freely expressed, may or may not be evenly distributed in wound, exudate involves 75% of dressing
MRSA: methicillin-resistant *Staphylococcus aureus*; MVTR: moisture vapour transfer rate; NPWT: negative-pressure wound therapy; VRE: vancomycin-resistant enterococci
Reprinted with kind permission from Stryja et al[57].

uncomplicated vaginal birth or operative vaginal birth. Antiseptics are recommended for skin preparation prior to incision at caesarean section and povidone iodine is recommended for vaginal cleansing. Chlorhexidine is not recommended for vaginal cleansing.[173]

Antimicrobials associated with vaginal delivery

Routine antibiotic prophylaxis to prevent infection after operative vaginal delivery is not recommended at present.[173] A multicentre randomised controlled trial, ANODE, on prophylactic antibiotics in the prevention of infection after operative vaginal delivery, reported the benefit of a single intravenous dose of amoxicillin and clavulanic acid in preventing postpartum infection.[92] The study was conducted at 27 obstetric units in the UK, and women were randomly assigned to receive either amoxicillin and clavulanic acid (number of women=1719) or placebo (number of women=1798) following operative vaginal birth at 36 weeks' gestation or longer. Confirmed or suspected infection was significantly lower in women receiving amoxicillin and clavulanic acid compared with those in the placebo group, indicating a benefit for a single intravenous dose of amoxicillin and clavulanic acid and a potential need for revision of the WHO guidelines.[92] The need for further research has been documented.[174] If the guidelines were changed to recommend routine prophylaxis following operative vaginal delivery, as in the ANODE trial, it would increase the burden of antibiotic use initially, but the potential benefit could be the prevention of 432,000 infections globally every year.[175] Further research is needed to determine whether oral antibiotic prophylaxis would be as effective as a single intravenous dose.

Clinical evidence of the efficacy of antiseptics during childbirth is limited (see Tables 5 and 6). With the emergence of resistance to chlorhexidine,[176,177] povidone iodine may be preferred.

With the emerging threat of antimicrobial resistance and the unlikely discovery of new antibiotics, existing infection control precautions such as hygiene and cleaning must be emphasised. It is better to prevent an infection than to treat one. One simple measure may be for obstetricians to change gloves after caesarean delivery but before suturing to minimise translocation of microbial flora from the vagina to the incision site.[80] Alternative means of preventing infection should be sought, including the possibility of vaccinating women against GBS in the late second or early third trimester has been considered.[178]

Perioperative antibiotic use for caesarean section

Systematic reviews of antibiotic prophylaxis for caesarean section (Table 6) began during the mid 1990s. For recently updated systematic reviews, clinical evidence has been collated from studies ranging from 1968 to 2017, many of which were published in the 1980s. Generally, the quality of the evidence has been low to very low, or of insufficient quantity. The most reliable recommendation is that prophylactic antibiotics should be administered intravenously before caesarean section incision.[184] Despite guidelines endorsing the prophylactic antibiotic use for women undergoing caesarean section, implementation has not been uniform.[182]

At the time of writing, there is evidence to suggest that there is no significant difference between the different classes of antibiotics used prophylactically before caesarean section. However, only immediate postoperative infections have been researched and data relating to late infections (up to 30 days postpartum) are not available.[183] Cephalosporins and penicillins have

Table 5. Summary of Cochrane reviews concerning prophylaxis as a means to prevent maternal infection after vaginal birth

Intervention	Evidence search	Number of studies (participants)	Risk of bias	Quality of evidence (GRADE)	Conclusions	Ref
Antibiotic prophylaxis for 3rd and 4th degree perineal tears during vaginal birth	Aug 2014	1 (147)	Low	Moderate	Antibiotic prophylaxis seems to prevent wound disruption and purulent discharge but evidence is limited to one small trial with high loss to follow-up	179
Antibiotic prophylaxis for episiotomy repair following vaginal birth	July 2017	1 (73)	High	Very low	Insufficient evidence to assess the clinical benefits or harms of routine antibiotic prophylaxis for episiotomy repair following normal birth	180
Antibiotic prophylaxis for operative vaginal delivery	March 2020	2 (3813)	Unclear	Low	Further research is needed to decide whether antibiotic prophylaxis after operative vaginal delivery is useful in preventing postpartum maternal morbidity	174
Antibiotic prophylaxis for normal vaginal delivery	August 2017	3 (1779)	High	Low to very low	Well designed and high powered studies are needed to evaluate the effects of routine antibiotic prophylaxis in preventing maternal morbidity after normal vaginal delivery	181

mostly been used,[183] but macrolides are required for women with penicillin allergy. A role for their use in preventing wound infection and endometritis in caesarean deliveries has been suggested.[188]

Concern over the use of broad-spectrum antibiotics for preventing postoperative surgical site infections following caesarean section has been raised in a study comparing the efficacy of ampicillin to ceftriaxone.[189] Incidence of SSI for women treated prophylactically with either antibiotic did not differ and the authors argued that the cheaper alternative (ampicillin) should be favoured. Interestingly, antibiotic resistant bacteria were recovered from some infected patients' wounds.[189]

A review of antimicrobial prophylaxis for caesarean section in China demonstrated that five different classes of antibiotic were being used, and that between four and nine different agents were prescribed to each woman.[190] In light of antimicrobial resistance and the need to use antibiotics conservatively, this is a concern.

The midwife is key to education and the giving of information to women both before and after the birth with respect to any drugs administered, as well as maternal care, treatment and surgery.

The role of the midwife

Many midwives do not receive any formal training on the assessment of perineal wounds

Table 6. Summary of Cochrane reviews concerning antibiotic prophylaxis as a means to prevent maternal infection after caesarean section (CS)

Intervention	Date of search	Number of studies (participants)	Risk of bias	Quality of evidence (GRADE)	Conclusions	Ref
Routine or no antibiotic prophylaxis for preventing infection after CS	July 2014	95 (>15,000)	Unclear	Moderate	Routine antibiotic prophylaxis to all women undergoing CS recommended to prevent infection	182
Different classes of antibiotic given to women routinely for preventing infection at CS	Sept 2014	31 (7697)	Low or very low	Low	Cephalosporins and penicillins have similar efficacy at CS in preventing immediate postoperative infections. Data for late infections (up to 30 days) is not available	183
Timing of intravenous prophylactic antibiotics for preventing postpartum infectious morbidity in women undergoing CS	March 2014	10 (5041)	Low	High	Preoperative intravenous antibiotics decrease risk of infectious morbidity compared to administration after cord clamp	184
Routes of administering antibiotics for preventing infection after CS	January 2016	10 (1354)	Unclear or high	Low to very low	No clear difference between irrigation and intravenous antibiotic prophylaxis in reducing the risk of endometritis after CS	182
Skin preparation for preventing infection following CS	Nov 2017	11 (6237)	Low	Low or very low	Insufficient evidence to fully evaluate different agents and methods; unclear what sort of skin preparation most effective at preventing post-operative surgical site infection	185
Vaginal preparation with antiseptics before CS for preventing postoperative infections	July 2017	11 (3403)	Low	Moderate	Vaginal preparation with antiseptics (povidone iodine or chlorhexidine) before CS reduced the risk of endometritis and post-operative wound infection	187

and the actions to be taken if infection or a wound breakdown is suspected. The NICE postnatal care guidance[148] advises that 'signs and symptoms of infection, inadequate repair, wound breakdown or non-healing should be evaluated (urgent action)'. However, there is significant variation in practice on how this referral process is perceived. Women can often be uncomfortable or in pain for days while a plan of care is formulated with the general practitioner (GP) or the attending obstetrician.

With continuing emergence of antimicrobial resistance and the unlikely discovery of new antibiotics, existing infection control precautions such as hygiene and cleaning must be emphasised.

Midwifery staff must be appropriately trained to identify and refer women who have suspected perineal wound complications and/or infection to allow direct and prompt access to appropriate services. A streamlined referral system with direct access into a women's health physiotherapy (WHP) service, that is equipped to offer women immediate specialist care at the first suspicion of wound breakdown or infection, helps to provide personalised care and the rehabilitation necessary to restore function for women who sustain perineal

trauma at birth. WHP services liaise with the appropriate multidisciplinary team if needed to ensure best possible recovery.

Antenatal education

Midwives take a leading role in providing information and educating women during the antenatal and immediate postnatal period on the prevention of perineal trauma and the care of perineal wounds.

Antenatal care guidelines[148] recommend that women are offered advice on pelvic floor exercises from the start of pregnancy. There is no standardised method for teaching pelvic floor exercises within maternity services. Women who can attend physiotherapy services have access to specialised care, but access is not universal. Many women have no access to services that help them to prepare physically for the birth by learning how to correctly engage the pelvic floor and core muscles during pregnancy, labour and birth. NICE antenatal care guidelines[148] recommend that all women are offered information on 'postnatal self-care' at 36 weeks, but no further information is offered.

Postnatal education

While there is a guideline and an accepted pathway of care with routine follow-up after OASI there is no pathway for other CRPT.[30] No Cochrane reviews relate to care after CRPT. The NICE guidance on postnatal care up to 8 weeks after birth[191] recognises the importance of evaluation of CRPT with the recommendation 'signs and symptoms of infection, inadequate repair, wound breakdown or non-healing should be evaluated'. WHO guidance also recommends assessment of perineal healing[192] but neither guideline has evidence to inform how this should be done, or how women with complications should be cared for.

Going home

Women are usually discharged home from hospital within 24 hours of the birth. Because routine community visits may not occur, information for women on wound healing processes, how to care for the perineal wound and signs and symptoms of wound infection is especially important.[193]

For women to care for themselves effectively, they need to understand the basic physiology and anatomy of the pelvic region. Educational programmes are required to teach women about the physiological changes that occur during pregnancy, the impact that birth may have on the pelvic floor and perineal body, and to understand how to care for these areas as a part of normal or routine care. Women need a clear understanding of what pelvic floor exercises are and they should be confident to undertake such exercises during and after pregnancy. Antenatal exercise programmes that focus on pelvic floor health are recommended as a routine part of antenatal care to women.[148,194]

Educating women in personalised care

It is likely that following hospital discharge, advice to women with caesarean section, especially those going home shortly after surgery, will be provided with post-delivery advice. Some examples of frequently asked questions (FAQs) are provided in Appendix 1.

On discharge, women should be advised to examine their perineum to check for signs of infection or dehiscence, and be encouraged to continue pelvic floor muscle training (PFMT). During the first days, gentle muscle contraction followed by complete

> Midwifery staff are to be appropriately trained to identify and refer women that present with signs and symptoms of having a perineal wound breakdown or infection. Access to services in a timely manner is essential.

relaxation, supports revascularisation and enhances healing. Once a woman feels more comfortable, active PFMT will improve pelvic floor function.[195]

Signs and symptoms of perineal wound infection are an increase in pain, oedema, abscess formation cellulitis, excessive or offensive discharge, feeling generally unwell, pyrexia and wound dehiscence.

In the case of possible perineal dehiscence or infection the following should be considered:

- Is the perineum bruised? Note that discolouration may take a few hours to become apparent.
- Is there excessive swelling? Oedema may be apparent in the labia but is not often observed in the perineum.
- Is there pain on palpation around the tissues surrounding the wound? Is there tension on palpation in these tissues? Tension often indicates extensive bruising with possible haematoma. By using a visual analogue scale, it is possible to determine the level of pain that the women is experiencing. Is there an increase in perineal pain? Note perineal pain is very intensive during firsts days postpartum, however it should decrease over the fifth day postpartum.[196]

The following information is an example of 'take home' advice for women:

- Keep perineal wounds as clean as possible.
- Shower daily and, after going to the toilet, dry, using paper towels or a clean towel, from front to back (i.e. ureter to anal area), is very important.
- Always maintain good hand hygiene. Always wash hands before and after touching the injured perineum.
- No soaps or body washes should be used to clean the injured area.
- Allow air to get to the wound.
- Use maternity pads only (no plastic backed pads) until the wound has closed. Plastic-backed pads cause sweating, which can add to the possibility of infection.
- When passing urine or opening the bowels women should always wash with water. This helps to remove any urine or soiling that might have remained on the skin. Tepid water in a jug poured with the passing of urine will help reduce stinging.
- When opening the bowels, support the perineum with a pad of tissue paper or a warm flannel held over the wound, relaxing onto the tissue paper without bearing down.
- The use of appropriate analgesia should be prescribed immediately to enable the women to mobilise and look after her baby.[198,199]
- The use of a stool softener is useful to prevent the occurrence of hard dry stools building up in the pelvic cavity, further adding to pain and tension of the perineum.
- Regular periods of rest should be encouraged to allow the injured muscles of the pelvic floor to recover and reduce perineal oedema, particularly in the first 48 hours. Avoid activities that increase intra-abdominal pressure for 6–12 weeks after the birth.
- Introduce pelvic floor muscle contractions at regular intervals throughout the day in order to improve circulation and aid muscle recovery and prevent muscle wastage.[195]
- Good nutrition is essential in order to promote speedy healing, healthy scar tissue and a normal bowel habit. Encourage a healthy balanced diet, high-fibre food and drinking 1.5–2 litres of water, especially if laxative or iron therapy has been prescribed.

Women should also be aware of the signs and symptoms relating to infection. If suspected, women should be encouraged to make contact

with their designated healthcare professional in the event of wound odour, increased pain, swelling, feeling unwell or rise in temperature.[191]

Maternal mental health

The impact of perineal trauma on maternal physical and mental health must not be overlooked, the physical and psychological trauma that women experience following birth can affect women for many years. In some cases, perineal trauma can lead to long-term pelvic floor dysfunction, sexual dysfunctional that impacts on a woman's self-esteem, and can even lead to relationship breakdown.

Women have reported feeling unable to bond with their baby due to the pain and discomfort they experienced in the weeks and months following the birth, unable to breastfeed due to discomfort, feeling unable to leave the home, resulting in isolation, developing low mood leading to postnatal depression.[200–202]

The lived experience for women who suffer perineal trauma, particularly those who experience a wound breakdown, may involve a long recovery with long-lasting impact on their family life.

Patient portraits

Patient narratives are an important and powerful way to communicate the impact of a medical treatment or intervention on an individual. The following patient narratives reveal the significant health and wellbeing concerns of women who experienced birth-related wound problems.[203]

Ellen's story

What women say about perineal wounds

This narrative recounts the problems encountered, and the personal and family impact of a perineal wound infection.

During a difficult induced labour, I suffered an episiotomy and second-degree vaginal tear. I had a number of stitches, developed a large haematoma and the wound became infected. In the days following the birth of my first child, the prescribed pain relief and exhilaration of a healthy baby seemed to mask the severity of the injuries I had sustained during labour. As a first-time mother I had nothing to compare my experience to and understood my pain to be a standard consequence of giving birth. As a result, when initially questioned by a physiotherapist in the recovery ward, I underplayed the pain and discomfort I was feeling and inadvertently sidestepped the referral I needed. Thankfully the community midwife recognised my need for follow-up treatment and I was referred to the physiotherapist team 7 days after giving birth.

I underwent 7 weeks of physiotherapy treatment. The first weeks were hard—holding and breastfeeding my newborn baby were especially painful, and I felt extremely concerned about my future health. I was finding it difficult to look after my newborn and the worries about my future physical activity levels meant I felt quite low and found it difficult to bond with my baby.

My baby is now 8 weeks old and I feel a huge amount better. I can now hold and feed my baby without pain and have started to introduce a small amount of activity into my day. I am still suffering from stress incontinence, but I hope that continuing with pelvic floor exercises will result in a full recovery.

I am thankful for the vigilance and conscientiousness of my community midwife and to the physiotherapy team's treatment and care. I am now starting to enjoy my time with my baby and feel far more positive about my future health.

Loretta's story

Physical and psychological impact of episiotomy and lacerations

In August 2016, at 41 years of age, I went into labour with my first child. It had been a normal pregnancy and I was feeling really positive about the whole process. I'd educated myself at any available opportunity; went on an National Childbirth Trust antenatal course and to all the NHS information days on offer. Nothing I had seen (*One Born every Minute*) or read about births made me feel comfortable—but even so, none of the courses I took, or books that I read, even mentioned the perineal trauma that was possible after birth.

My labour didn't progress quickly, so I had membranes ruptured and was given drugs to speed things up. I also had an epidural at that point. Once fully dilated, I pushed and pushed. I was keen to push the baby out as I knew the alternative was going to be forceps. I asked during second stage, when the baby was stuck, if a caesarean section was an option. I was told it was too late for that. After the birth, I was stitched up and sent to the ward with my baby. At this stage, I felt we were both OK and, so while it wasn't what I'd hoped for, it was definitely a good outcome.

The first night was OK, and the next day, but the second night I felt feverish and swollen in the episiotomy and then there was a lot of pain in that area. The round doctor saw me and decided not to discharge me but to observe. She said there was an infection in the wound (acknowledged in my notes), but antibiotics were not prescribed. It was now a weekend and the women's health physio team that would normally have started treating the wound and haematoma were not back in until Monday. So, I was left with no treatment at all for an infection, which then went rampant. I became more and more ill and was in severe pain. I couldn't feed the baby easily and I couldn't stand or walk or sit, all I could do was to lie on my side. One midwife told me later when I was leaving hospital that they were so concerned because they could smell the stench of the infection when they entered my room. A doctor finally came down to see me at 5am on the Monday morning. When he did see the wound, it was clear that it was in a very bad way. They drew around the edge of the red swollen area with a marker, and the line was out around my buttocks. I started oral antibiotics and a blood transfusion was also ordered. They took new swabs, which took a day or so to produce results that showed the bacteria were resistant to the antibiotics they were using. I was switched to IV antibiotics of a much stronger kind. I had laser treatment from the women's health physio team every day, and again their faces were a sign of how bad the wound was. They told me that the wound had totally broken down, so now it had to heal by secondary intent. I was also told I would probably need cosmetic/functional surgery to the perineum once the wound healed, no-one could or would estimate a time-scale for the healing. I was never given a date for discharge, because it was a case of seeing how the wound was responding to the antibiotics, but finally, after 12 nights, it was deemed to be under control. My husband had slept next to my bed in a chair for all the 12 nights, getting up when the baby woke to bring her to me to feed because, if I stood for more than a minute, I would start to bleed on the floor and the pain would be excruciating. I was quite terrified of leaving the hospital because I didn't know how I would cope at home: there was only myself and my husband, we have no family who could help out. I was also really scared the infection would get worse again and no-one would know.

After discharge, I was on oral antibiotics for another 2 weeks, and taking tramadol for the pain. I had to go to the outpatients physio every other day for laser treatment to the wound. I saw the physios for something like 2 months, several times a week for

the first weeks and then once per week after that. At home I could only feed my daughter lying on my side because of the pain when trying to sit. I was really confined to my bed, I couldn't comfort her by walking or rocking (even her tiny weight was too much to hold), I couldn't hold her to wind her easily. I didn't feel like I was being her mother. I desperately hoped she would feed quickly and then go back to sleep because I was so tired myself. I never spent any time in those first weeks or months actually enjoying her or bonding with her; I was just terrified of the demands she made on me when I was so physically drained and in pain. I plummeted into postnatal depression and commenced antidepressants to aid my mood.

In the months and years following I have had a posterior vaginal wall repair and two episodes of Botox for an anal fistula. I remain concerned for the future: I can't jump on the trampoline with my daughter, or pick her up and carry her when she's tired or hurt. She sees me as boring and not adventurous, when I used to be anything but.

So even though my wound did heal eventually (after 4.5 months), the aftermath will seemingly be with me for life.

Victoria's story

What women say about caesarean section wounds

This narrative demonstrates the need for improvements in early assessment and prognosis of surgical wound infection. The narrative reveals the adverse impact of antibiotics on infant feeding as well as on the pain and sadness of not being able to continue with breast feeding.

I first noticed there was a problem 10 days after surgery. My wound had still been a bit painful to touch but I noticed that two areas were more painful, looked like they were starting to open and the area around them was starting to get quite red around. The next day (Saturday) I checked again and the larger of the two areas had some discharge, so I phoned the community midwife. She told me to go to Jessops (Jessop Wing, Hospital for Women, Sheffield Teaching Hospital NHS Trust, South Yorkshire, UK) to have it checked. I was seen first by a midwife who thought it looked fine and was healing nicely but would get one of the doctors to check. When the doctor came they weren't too sure either because the rest of the wound looked so healthy. They thought the small amount of discharge was serous fluid. However, she decided to 'play it safe' and take a swab. On the Thursday I got a phone call from one of the doctors at Jessops as the results of the swabs were back and were positive for two types of bacteria, and I needed two types of antibiotics. Luckily, I think I spotted the signs of infection early enough that it didn't cause me too many problems in terms of healing although those two sections took longer to heal and I probably took painkillers longer because of the pain and discomfort from the delayed healing.

I was lucky that I had extra help to look after my older child (3 years old) and so someone else did the nursery run for me so that I didn't have to worry about getting out. The main impact I feel that it had on me was in relation to breastfeeding (baby was combined fed due to other issues but always breastfed first). After taking a couple of antibiotic doses, I felt my daughter was not feeding as well as she usually did. When expressing, there was definitely a reduction in the amount of milk. After a day or two, my daughter would not latch and would not feed expressed milk either. The health visitor said that this could be due to the antibiotics affecting the taste. Once I'd finished the antibiotics, I worked with

the infant feeding workers and health visitor to improve milk supply (I had continued to express during the course of antibiotics but it hadn't been used) and this helped me feed a little longer, but ultimately, it led to me moving to just formula feeds much earlier than I wanted, which I am disappointed with and it did make me feel quite bad about myself at the time.

Key points

1. There are two categories of birth-related wounds. Childbirth-related perineal trauma (CRPT) occurs as a result of perineal tears/lacerations and episiotomy. Incisional wounds, typically Pfannenstiel incisions, occur after caesarean section. Both forms of tissue trauma can result in significant morbidity in women after childbirth.

2. Infection at the surgical incision site, called a surgical site infection (SSI), is most commonly of the superficial layers. Rare, but catastrophic, infective complications occur as a result of necrotising fasciitis.

3. Risk for infection after caesarean section includes patient and procedural factors linked to the physiology and health status of the woman, as well as to factors linked to the surgical procedure (including surgeon rank/expertise).

4. Understanding the elements contributing to risk helps to avoid, as well as mitigate, damage to tissue.

5. Birth-related wounds acquire infectious agents from exogenous and endogenous sources. Maternal reservoirs of infection are skin, genital tract and gastrointestinal tract.

6. Microbial communities within the female genital tract are polymicrobial. Distinct flora are located not only within the vagina, but in the cervix, perineum, uterus, fallopian tubes and placenta.

7. The Centers for Disease Control (CDC) continues to be regarded as a 'gold standard' as the global reporting definition for surgical site infection. A number of wound assessment tools (e.g. REEDA, TIMERS, DOMINATE) are available, but have not been validated for all types of birth-related wound infections. Other grading systems, for example by the World Union of Wound Healing Societies (WUWHS) Sandy SWD grading system[204] for surgical wound dehiscence is the first to provide a clinical grading system.[205]

8. Visual inspection of perineal wounds and incisional wounds, with assessment by healthcare workers, and any signs or symptoms to suggest infection, slowed healing or wound dehiscence should be reported promptly.

9. Controversies in care and clinical management after both vaginal and caesarean section birth exist, notably in the use of antimicrobial prophylaxis. Current WHO recommendations are to use antibiotic prophylaxis for elective and emergency caesarean section and third- and fourth-degree perineal tears, but not episiotomy.

10. Multiple courses of antibiotics after caesarean section increase the risk of antimicrobial resistance, especially in light of evidence of antibiotic resistant bacteria recovered from infected caesarean section wounds

11. Antibiotic stewardship now must play a key role in CRPT and caesarean section care pathways.

12. There is currently limited high-quality evidence to support the use of negative pressure wound therapy (NPWT) for the prevention of SSI following caesarean section.

13. Results of several systematic reviews comparing the effectiveness of wound dressings in the

prevention of surgical site infection suggest no clear benefit of one type of dressing over another.

14. Significant physical and emotional problems occur for many women after vaginal and caesarean section birth. There is clear need for CRPT to be placed at the forefront of care and improved education of midwives and, consequently, women.

15. Complications during pregnancy increase for women with obesity. They are at a higher risk for a caesarean section, and caesarean section is an independent risk factor for wound infection. Overall 62% of women in England are overweight or obese.[206]

16. Globally, there is an increasing trend for people to be overweight (pre-obese; BMI 25.0–29.9) and obese (BMI ≥30),[207] including women of childbearing age. Improvement in pre- and postnatal education on avoidance of risk requires greater emphasis on assessment, screening and rational interventions.

Summary and future perspectives

This document has been produced, with the support of EWMA, to bring together two spheres of maternal healthcare that have traditionally been addressed separately. Assessment of the mother pre- and postnatally can improve postnatal care and healing outcomes. For most women, the impact of having an open perineal wound or an infected caesarean section wound infection is distressing, painful and disruptive to normal life. It is a shocking and unexpected reality and impacts on the wellbeing and mental health of the mother. This document attempts to provide the latest evidence for healthcare professionals for guiding care of the postpartum woman for optimum healing outcomes.

Wound complications for the postpartum mother may be due to a number of factors, including infection, and are a result of a breakdown in the skin and muscle integrity. They incur significant additional healthcare-related costs and an additional burdern for the workforce.

Childbirth-related wound complications affect the family and the mother and may be devastating if ill health, pain and immobility prevent the mother's ability to nurture and bond with the newborn infant.

Investment in maternity services research is essential for our understanding of the extent of wound-related complications for the postpartum mother and improved clinical pathways for wound management. A shared model of care with the mother at the centre of the model is required to ensure optimal wound healing outcomes. Future therapies for prevention and management of birth-related wound complications require extensive research and rapid translation into healthcare settings for maximum patient benefit.

Appendix 1. Patient guide: FAQs about SSI

This patient guide is reprinted with kind permission from Stryja et al.[59]

What is a surgical site infection?

A surgical site infection (SSI) is an infection that occurs after surgery in the part of body where the surgery took place. Surgical site infections can be msot commonly superficial, involving only the skin. Other SSI can be more serious; involving deeper tissues under the skin; organs of the body affected by the procedure, or implanted material.

When should I be concerned?

SSI generally appears within a month after surgery. However, if an implant, e.g. a prosthetic joint or graft is left in the body during surgery, an SSI may develop very slowly and not become apparent for several months.

What are the symptoms of SSI?

They include redness and increased pain around the area where you had a surgery, drainage of green/yellow, cloudy fluid from the wound and fever.

Can SSIs be treated?

Yes, most SSIs can be treated with antibiotics. Sometimes patients with SSIs also need another operation to treat the infection. Your healthcare professional will provide guidance on how to manage your wound.

What can I do to help to prevent SSI?

Here are some things that you can do to help reduce the risk that you will develop a SSI:

Before surgery:

- Tell your physician about other medical problems you may have. Give up smoking as patients who smoke get more infections.
- Clean your skin thoroughly by having a shower before you have your operation.
- Do not remove hair from the area where the incision will be made. If necessary, this will be done by the operating team using electric clippers rather than razors as close to the time that the incision is made as possible.

After surgery:

- Make sure you understand how to care for your wound before you leave the hospital.
- Be sure to ask your healthcare worker how to clean the area of the wound 48 hours after surgery.
- Always clean your hands with soap and water before and after caring for your wound.
- If the wound starts to look red, leak green/yellow fluid, become more painful or the edges of the skin split apart, then contact your doctor who can assess whether there might be an infection.

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