FOGSI FOCUS 2024

REVOLUTIONIZING

C-section Recovery and Wound Healing in High-Risk Patients

Protecting time to bond

PICO◊ sNPWT reduced the incidence of SSIs by 50% in women with ≥ 30 BMI following C-sections compared with standard dressings[1]

Smith+Nephew

PICO◊
Single Use Negative Pressure
Wound Therapy System

The PICO System is proven to reduce the risk of surgical site infections (SSIs)[2]* - which enables early mother and baby bonding, prompt discharge, and positive impacts on the patient's emotional wellbeing.[3]

IND-A-38-2024

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Message from the President

India has witnessed a substantial increase of up to 7-fold in the rate of cesarean deliveries from the 1990s till now! Obesity is one of the risk factors for carrying out cesarean section (C-section) deliveries. As per the National Family Health Survey (NFHS), around 40% of Indian pregnant women were found to be obese, probably attributed to the old Indian belief that in pregnancy women need to 'eat for two', coupled with the sedentary lifestyle in modern times.

Apart from the surgical challenge of closure of the deep subcutaneous layer, there may be several postsurgical complications such as wound infection, wound dehiscence, hematoma formation, and prolonged wound healing. The risk factors for postsurgical complications following C-section delivery include obesity, history of smoking, gestational diabetes, multiple pregnancies, previous C-section, history of wound dehiscence, rupture of membranes, etc. Wound complications may range from superficial infections to the formation of seroma and are observed in up to 15% of the patients. In a few cases, wound complications may be associated with significant morbidity and mortality. It also imposes a considerable financial burden due to repeated hospital visits and readmissions. These factors also impact the new mother's psychological well-being due to the disturbance in stress-free bonding time with the newborn, along with a lifetime memory of an ugly scar due to delayed wound healing and repeated interventions required.

Proper care for closed surgical incisions after high-risk surgeries and open wounds can significantly reduce the risk of surgical site infections (SSIs). Implementing best practices helps ensure complete wound closure and minimizes the likelihood of complications at the incision site. This approach also facilitates early bonding between the mother and the baby, allows for prompt discharge from the hospital, and positively impacts the patient's emotional well-being and the overall appearance of scars.

In this FOGSI FOCUS issue, we present an overview of the C-section surgeries in high-risk patients, understanding the wound complications, risk stratifications for SSIs, recommendations for post-operative wound management, key evidence on single-use negative pressure wound therapy (sNPWT) in high-risk patients and clinical case scenarios demonstrating the beneficial use of sNPWT in Indian patients. Studies on sNPWT dressing in high-risk C-section surgeries have shown promising results in managing closed surgical incisions. Several guideline recommendations have supported the prophylactic use of this therapy in high-risk patients with closed surgical incisions. However, there is a paucity of data on Indian patients; this is especially important as the patient profile in India is diverse, necessitating more individualized care. The wide adoption of this therapy in practice at both public and private centers will be one step towards improving maternal health and nurturing the positive experience of motherhood.

Dr. Jaydeep Tank

President, FOGSI

Message from the Secretary General

In the journey of motherhood, a stitch in time prevents infection, and every precaution taken is a step towards a smoother recovery for every new mother!

Surgical site infections (SSIs) are the most important cause of delayed wound healing, increased hospital visits, readmissions, and increased financial burden. The prophylactic use of efficient surgical wound dressings is the first step in preventing SSIs. In this FOGSI FOCUS issue, an amalgamation of the evidence around the beneficial effect of single-use negative pressure wound therapy (sNPWT) in reducing the incidence of SSIs and complications as well as case-based approach has been effectively presented.

I am hoping that this "review article" will be a ready reckoner for healthcare practitioners dealing with obstetric care to manage the challenges of SSIs and complications in high-risk patients.

I commend the authors for diligently compiling this insightful account of this important aspect of better maternal care. With advancements in wound healing, we can ensure that new mothers have a positive experience without postoperative complications, allowing them to embrace this special phase of life completely.

Dr. Madhuri Patel

Secretary General, FOGSI

Message from the Vice-Presidents





C-section surgery is a standard procedure for female patients. While weight can often be managed effectively after the delivery, delayed wound healing remains a significant concern that affects the quality of life for these patients. The main emphasis in this "FOGSI FOCUS" issue is reducing the risk of surgical site complications and time for wound healing, which are crucial to ensure that the recovery process does not interfere with the critical bonding time between the new mother and her newborn.

It is an honor to present this FOGSI FOCUS—2024 edition, **"Revolutionizing C-section Recovery and Healing in High-Risk Patients."** This timely publication highlights the personalized and evidence-based care for high-risk patients during C-section procedures so as to improve the quality of life and well-being of the new mother. The authors have emphasized the need to give special attention to preventing surgical site infections (SSIs) and wound complications in high-risk patients undergoing C-sections. They have elaborately described the need for enhanced postoperative wound care with insights into Indian surgical practices. They have explored the role of single-negative pressure wound therapy (sNPWT) in reducing surgical site complications.

The findings of the case report series indicate a remarkable reduction in the risk of SSIs and hospitalizations and improved wound healing at the site of C-section in high-risk patients, as opposed to the standard dressings, which is quite reassuring! **We would like to specially congratulate Dr. Gayathri Karthik, Dr. P. Vairamala, Dr. Niveditha Bharathy, Dr. Neha Pawar, Dr. Yashica Gudesar, and Dr. Shachi Joshi,** for their contributions towards the generation of data on improved wound healing with the use of sNPWT in Indian patients, by sharing their real-life case scenarios. We extend our heartfelt gratitude to Dr. Jaydeep Tank, President, FOGSI, for guiding our dedicated team, and the contributing authors for their unwavering commitment to advancing incision care and improving the post-operative recovery.

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Foreword

Revolutionizing the Standard of C-section Incision Care and Wound Recovery in High-Risk Patients

I take immense pleasure in drafting the Foreword for this issue on The efforts of the entire FOGSI team and all the involved authors are highly appreciated for their comprehensive skills in data mining and reviewing, which have enabled us to bring out this special issue successfully. This issue of FOGSI FOCUS is a step towards reducing the burden of complications post-cesarean section surgery, improving post-operative recovery and facilitating a smooth journey of motherhood for the new mother about bonding, with the newborn in high-risk patients undergoing C-sections.

Even if surgery is successful and the incision can be closed properly, the surgical procedure itself may still lead to post-operative complications. These complications at the surgical site include infection, seroma, hematoma, abnormal scarring, local skin ischemia and necrosis, dehiscence, and delayed healing. Such complications can prolong the healing process and result in significant morbidity, and mortality, and impose a significant socioeconomic burden. Improving outcomes for patients with closed surgical incisions by reducing the rates of surgical site complications could have a significant impact on the patients' lives. Single-use negative pressure wound therapy (sNPWT) is a promising technology in the management of closed surgical incision wounds. An overview of the benefits of sNPWT in reducing surgical site complications, drawn from clinical case scenarios, controlled clinical trials and observational studies, has been presented. The findings of these studies have confirmed the beneficial effects of sNPWT, *viz*, a significant reduction in surgical site infections and hospitalizations, along with improved wound healing at the C-section site, especially in high-risk patients, compared to traditional dressings.

Once this device is adopted in Indian settings, there will be a significant transformation in the clinical management of closed surgical incision care. I hope that this "review article" will be a ready reckoner for healthcare practitioners dealing with obstetric care to manage the challenges involved in closed surgical incision management in patients who are at high risk of developing surgical site complications. I am sure that such advancements in wound healing will ultimately help the surgeons and other clinicians to improve patient outcomes.

Dr. Jaydeep Tank

President, FOGSI

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Dr. Manjula A Patil, Dr. Ajay Mane, Dr. Suvarna Khadilkar, Dr. Janmejaya Mohapatra, Dr. Indrani Roy, Dr. Anupama Sethi Arora, and Dr. A Charmila

1.1 Background of C-section surgeries

A cesarean section (C-section) involves delivering a fetus through an incision in the abdomen (laparotomy) and the uterus (hysterotomy). The first documented C-section occurred in 1020 AD, and the procedure has significantly evolved.[1] According to the World Health Organization (WHO), a C-section is a major life-saving surgical obstetric procedure that is highly effective in saving the lives of both, the mother and the fetus, but is undertaken for medical reasons.[2,3] Globally, C-section accounts for 1 in every 14 surgeries.[4,5] In India, the rate of C-section deliveries has significantly risen from 17% (2015–16) to 21.5% (2019–21).[6,7] This increase in the C-section rate can be attributed to medical or related factors such as increasing obesity, advancing age of the mother at delivery, and the prevalence of pregnancy complications.[7]

A pregnancy that poses increased health risks or complications for the mother, fetus, or both during pregnancy and childbirth is termed a high-risk pregnancy (HRP).[8] All pregnancies carry risks at any stage—during pregnancy, childbirth, and afterward. High-risk pregnancy is characterized by pre-existing or current conditions that increase the risk for the mother, fetus, and newborn.[9]

Rising prevalence of HRPs

Globally, 10–30% of the pregnancies are regarded as 'at risk'. In India, 20–30% of the pregnancies are considered as high-risk category.[9]

Factors leading to HRPs

High-risk pregnancies are categorized into mild, moderate, and severe, based on the associated risk factors. These factors are determined by past obstetric history, current pregnancy conditions, and medical and surgical illnesses.[9] Several clinical studies have substantiated the presence of one or more risk factors leading to HRPs.[8] Obstetric risk scoring is a method used to recognize, document, and analyze antepartum and intrapartum factors that help predict potential complications for the mother, fetus, and infant. This system assigns scores to various risk factors based on past obstetric history, current pregnancy, and any medical or surgical conditions, with each factor given a score relative to its risk level. Identifying a HRP early is crucial for implementing effective intervention strategies to manage complications. A modified Coopland's scoring system (Table 1) is used to score the pregnancies, identify HRPs, and correlate the degrees of risks with perinatal outcomes.[10]

Role of antenatal care in reducing risk factors of HRPs

Regular maternal and fetal surveillance ensures the best possible outcomes for the mother and the baby. Identification of patients at high risk of pregnancy-related complications is the fundamental aspect of good antenatal care. Additionally, recognizing HRPs benefits the healthcare system by optimizing the use of medical resources and allowing timely referrals to tertiary care facilities for those in need while managing low-risk pregnancies with minimal intervention.[10]

Early detection, regular follow-up, and quality antenatal, intranatal, and postnatal care are essential in preventing high rates of morbidity and mortality from pregnancy-related complications.[8]

Table 1. Modified Coopland's scoring system

Parameter			Score	Parameter			Score
Risk factor	Age (years)	<18	2	Present pregnancy conditions	Bleeding before 20 weeks of gestation		1
		18–35	0		Bleeding after 20 weeks of gestation		3
		>35	2		Anemia	Hb 6–10 g%	1
	Parity	0	1			Hb <6 g%	2
		1–4	0		Rh isoimmunization		3
		≥5	2		Malpresentation at term		3
Medical/ surgical conditions	Chronic hypertension		2		Multiple pregnancies		3
	Pregestational diabetes mellitus		2	Present pregnancy conditions	Hypertension		2
	Chronic renal disease		2		Eclampsia		3
	Heart disease (NYHA III or IV)		3		Gestational diabetes		2
	Heart disease (NYHA I or II)		1		Placenta previa		2
	Previous gynecological surgery		2		PROM		2
	Other significant medical illnesses: TB, asthma, epilepsy, autoimmune disease		1–3		PPROM		3
Past obstetric history	History of infertility		1		Polyhydramnios (amniotic fluid index >24)		2
	History of 2 or more first-trimester abortions		1		Oligohydramnios (amniotic fluid index <5)		2
	History of second-trimester abortions		2		IUGR (fetal weight <10th centile for gestational age)		3
	Previous childbirth weight <2.5 kg or >4 kg		1		Abnormal Doppler		3
	Previous cesarean section		1	Modified Coopland score			
	History of PPH or manual removal of placenta		1				
	Previous stillbirth or neonatal death		3				
	Prolonged/difficult labor		2				
	Gestational hypertension/ pre-eclampsia		2	Total score	Low-risk		0–3
	Eclampsia		3		Moderate-risk		4–6
	Gestational diabetes		2		HIgh-risk		≥7

Note. NYHA: New York Heart Association; TB: Tuberculosis; PPH: Postpartum hemorrhage; PROM: Premature rupture of membranes; PPROM: Preterm premature rupture of membranes; IUGR: Intrauterine growth restriction; Rh: Rhesus Adapted from "High Risk Scoring in Pregnancy using Modified Coopland's Scoring System and its Association with Perinatal Outcome," by S. S. Pillai, *et al.,* 2021, *Int J Reprod Contracept Obstet Gynecol. 10(4), p.*1608-13.

1.2 Understanding obesity-associated complications

Obesity is considered a modern epidemic, together with other lifestyle diseases that cause metabolic disturbances.[11,12] Fat deposition and high caloric diet intake are the contributing factors that lead to overall weight gain during pregnancy.[11] Maternal obesity refers to a pre-pregnancy BMI of >30 kg/m^2; it is associated with several complications during pregnancy and labor, as well as complications in the fetus.[13]

Obesity and associated medical complications

Pregnant obese women face similar inherent risks of obesity, which are followed by various medical complications such as varices, cholecystolithiasis, thrombotic complications, anemia, urinary infections, intertriginous type of skin disease, exertional dyspnea, bronchitis, hypoventilation, and breathlessness.[11]

Antenatal problems

Obesity-associated complications include infertility, pre-eclampsia, miscarriages, hypertension, pregnancy-induced hypertension, pedal edema, sleep apnea, hypoventilation, gestational diabetes, and type II diabetes.[14] These complications are represented by increased incidence of low-birthweight and macrosomic babies, prematurity and post-maturity, and hypoventilation and hyperventilation, and fetal malformations.[11,12,14]

Complications during progression of labor

Prolonged first- and second-stage labor, early maternal exhaustion, and poor bearing down efforts lead to increased instrumental deliveries. Soft tissue obstruction, malpresentation, and macrosomia are the mechanical problems in head delivery in pregnant obese women.[11]

Complications in third stage of labor and puerperium

Postpartum hemorrhage and lactation failure are common in obese pregnant women.[11]

Complications and challenges during C-section

Maternal overweight and obesity impacts negatively and causes major complications during pregnancy.[15] Weight gain exceeding the Institute of Medicine guidelines raises the risk of C-section deliveries regardless of the pre-pregnancy BMI.[16] Technical problems of administration of spinal, general, and epidural anesthesia are common in obese pregnant women. Macrosomia, thick abdominal wall, malpresentations, and poor exposure make the delivery of the baby difficult.[11] Reduced cervical dilation rate, higher induction rate, comorbid conditions, shoulder dystocia risk, and excessive pregnancy weight gain contribute to the high C-section delivery rate in obese women. Obstetric challenges in obese women, starting with labor initiation difficulties, are linked to excess pelvic soft tissue obstructing the birth canal. Cervical dilation rate inversely correlates with maternal weight.[16]

In obese pregnant women, the risk of wound infection is increased, with infection risk rising proportionally with BMI. The combined presence of obesity and diabetes amplifies this risk by 9.3-fold.[16] The challenges in obese patients undergoing C-sections are as follows:

- Closure of the subcutaneous tissue layer with a depth of more than 2 cm is associated with wound complications.[13]
- Placement of drain.[13]
- Postnatal complications following abdominal delivery in obese women include wound infection, wound dehiscence, atelectasis, and pulmonary embolism.[12]

1.3 Wound complications in C-section surgeries

Overview

C-section surgeries are generally safe for both, the mother and the fetus; however, wound complications including superficial infection and fluid collections following a C-section occur in 3–15% of the cases.[17,18] Risk factors for wound complications are as under:[18]

- Premature rupture of membranes
- Presence of panniculus
- Tensions in sutures
- Pre-eclampsia
- Raised maternal BMI
- Diabetes
- Anemia

- Malnutrition
- Use of corticosteroids
- Subcutaneous tissue thickness

The wound infection continuum

Wound infection arises when microorganisms infiltrate a wound, proliferating to a degree that elicits a local, spreading, or systemic host response. These pathogens multiply within the wound, producing virulence factors that weaken host defenses, causing tissue damage and hindering the healing process. The International Wound Infection Institute Committee - Wound Infection Continuum (IWII-WIC) framework provides a structured approach to understanding the microbiological dynamics of wound infection, incorporating expert consensus and clinical manifestations to elucidate the impact on the host and wound healing progression.[19]

The continuum includes five conceptual stages, namely contamination, colonization, local infection of the covert or overt stages, infection spreading, and systemic infection. As the microbial proliferation on the wound increases, the initial contamination proceeds further to systemic infection, increasing the wound and infection burden (Figure 1).[19]

Types of wound complications

- Superficial infection is one of the surgical site infections (SSIs) occurring within 30 days of the surgery and complicates 1–5% of C-section surgeries.[17]
- Complications of disruption and fluid collection i.e., hematoma and seroma occur in 2–5% of C-section deliveries. These complications lead to the development of dehiscence and promote the development of wound infections.[17]
- Surgical wound dehiscence is a significant postoperative wound complication defined as the separation or splitting of the margins of a closed surgical incision in the skin. It occurs in 3–4% of women postoperatively and is often associated with SSIs and/or wound collection.[18]

Figure 1. The conceptual stages of the wound infection continuum and its advancements

Contamination
- Presence of microbes in the wound, but no proliferation
- No significant host reaction
- No clinically visible delay in wound healing

▼

Colonization
- Limited proliferation of microorganisms, with no significant host reaction
- No clinically visible delay in wound healing

▼

Local wound infection
- **Covert:** Characterized by bleeding and granulation, epithelial bridging and pocketing in the granulation tissue, increase in exudates, and delayed wound healing beyond expected rate
- **Overt:** Characterized by erythema, local warmth, swelling, purulent discharge, enlargement and breakdown of wound, increasing pain, and malodor

▼

Infection spreading
- Extended thickening and hardening of the skin, spreading erythema, and inflammation >2 cm from wound edge
- Crepitus, wound dehiscence with or without satelite lesions, and swelling of the lymph glands

▼

Systemic infection
- Malaise, non-specific general deterioration, loss of appetite, fever/pyrexia, severe sepsis, septic shock, organ failure, and death

Note. Adapted from "International Wound Infection Institute (IWII) Wound Infection in Clinical Practice," 2022*, Wounds Int, p.* 9.

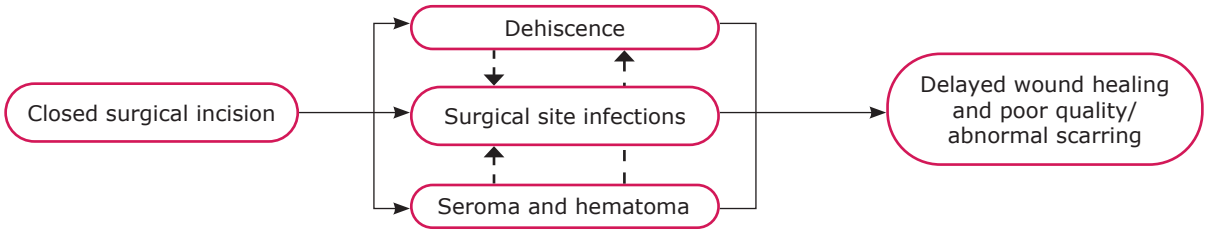
Surgical site infections (SSIs) in C-section surgeries

The rate of SSIs ranges from 3% to 20% worldwide. Additionally, it is associated with a 3% maximum rate of maternal morbidity and mortality.[5] Post-operative SSIs and wound complications are among the most common and costly issues following cesarean delivery, affecting approximately 10% of these procedures.[20] In general, SSIs are responsible for 19.5% of the hospital readmissions. Though primary closure after a C-section is achieved, the incision itself causes post-operative complications including infection, seroma, hematoma, local skin ischemia, necrosis, dehiscence, and delayed wound healing.[21]

The Centers for Disease Control and Prevention (CDC) defines SSI as an infection occurring within 30 days of the surgery in the area where the procedure took place.[21]

- **Superficial incisional SSI:** An infection occurring within 30 days post-operatively if it involves only the skin and subcutaneous tissue of the incision, and is accompanied by purulent drainage, identification of organisms from the incision or subcutaneous tissue, or if the incision is deliberately opened without microbiologic testing.
- **Deep incisional SSI:** An infection occurring within 30 or 90 days after the procedure if it involves deep soft tissues of the incision and is accompanied by purulent drainage from the deep incision or a deep incision that dehisces, is deliberately opened or aspirated, with organisms identified through microbiologic testing for clinical diagnosis or treatment.
- **Organ/space SSI:** An infection occurring within 30 or 90 days after the procedure involves any part of the body deeper than the fascial/muscle layers manipulated during the operation, and is indicated by purulent drainage from a drain placed in the organ/space, identification of organisms from aseptically obtained fluid or tissue by microbiologic testing, or evidence of an abscess or infection in the organ/space detected through anatomical, histopathologic, or imaging tests.
- Closed surgical incision is associated with various surgical complications (Figure 2).[21]

Figure 2. Closed surgical incision and its associated wound complications



Note. Adapted from "Closed Surgical Incision Management: Understanding the Role of NPWT," by World Union of Wound Healing Societies, 2016, *Wounds Int, p.* 5.

Burden of SSIs in patients with C-section surgeries: A literature overview

The objective of this literature search was to capture the emerging evidence focusing on the impact of obesity and wound complications, particularly SSIs, after C-sections in global and Indian patient scenarios.

The literature search was performed using databases including PubMed, Google Scholar, and the Cochrane Database of Systematic Reviews, as well as a focused internet search. The search strategy included keywords such as "Cesarean", "C-section", "Wound complications", "Obesity", "High-risk", "Surgical site infections", and "Surgical site complications". The search was limited to articles published between January 1, 2015 and August 3, 2024.

Surgical site infections after C-sections have an enormous impact on the mother and the healthcare system globally (Table 2) and in India (Table 3).

Surgical site infections significantly impact patients, hospitals, and society by increasing morbidity, mortality, and healthcare costs. These infections can result in substantial economic burdens, with costs potentially doubling to six times higher for affected patients, depending on the surgery, healthcare setting, and type of infection.[22] The impact is not only on the health of the patient, but also on the economy of the nation. The health, economic, and combined effects of SSIs are summarized in Table 4.

Table 2. Global epidemiological studies for post-C-section SSIs

Author and study year	Study details	Participants and intervention	Key findings	Conclusion
Mezemir *et al.*, 2023[23]	Prospective observational cohort study to determine the incidence, bacterial profile, and associated risk factors of SSI	741 pregnant women who underwent C-sections	♦ Incidence of SSIs: 11.6% ♦ Risk factors for increased SSI: 2–3 antenatal care visits, delayed antenatal booking, membrane rupture, multiple vaginal examinations, and procedures in public hospitals	To reduce SSI rates, targeted intervention programs should focus on post-discharge surveillance and risk identification.
Gomaa *et al.*, 2021[24]	Observational case-control retrospective study to determine the incidence, risk factors, and management of SSIs following C-sections	828 cases of SSI developed out of the 15,502 C-sections performed	♦ Incidence of SSI: 5.34% ♦ Significant risk factors for SSI: Chorioamnionitis, PROM, blood loss >1000 mL, emergency C-section, duration of C-section >1 hour, no ANC visits, duration of labor ≥24 hours, DM, obesity, high parity, hypertension, and gestational age <37 weeks ♦ Mortality rate due to SSI: 1.33%	Multiple significant risk factors associated with SSIs following C-sections were identified and the mortality rate due to SSIs was 1.33%.
Jasim *et al.*, 2017[25]	Retrospective, cross-sectional study aimed to determine the incidence of SSIs and identify associated risk factors	400 women who underwent C-sections	♦ Incidence of SSIs: 18.8% ♦ Significant risk factors: ✦ Higher BMI (≥30 kg/m²) (p = 0.044) ✦ Increased blood loss during surgery (≥500 mL) (p = 0.034) ✦ Prolonged hospital stay (≥4 days) (p = 0.002) ✦ Use of spinal anesthesia (p = 0.021) ✦ Breech baby presentation (p = 0.046) ✦ Use of intrathecal analgesia (p = 0.001)	SSIs are prevalent in patients undergoing C-sections with higher BMI as one of the significant risk factors.
Gelaw *et al.*, 2017[26]	Hospital-based cross-sectional study to assess the magnitude of SSIs after C-sections and associated risk factors	Retrospective review of 384 medical records	♦ Incidence of SSIs: 6.8% ♦ Identified independent risk factors: ✦ Duration of labor ✦ Rupture of membranes before C-section ✦ Abdominal midline incision	Independent risk factors for increased risk of SSIs included prolonged labor, rupture of membrane before C-section, and types of abdominal incision.
Jenks *et al.*, 2013[27]	Hospital-based study to determine the clinical and economic burden of SSI over 2 years	14,300 episodes included for further analysis	♦ Median LOS due to SSI: 10 days (95% CI: 7–13 days), resulting in a total loss of 4,694 bed-days over 2 years ♦ Median additional cost attributable to SSI: £5,239 (95% CI: £4,622–£6,719), with the total extra cost amounting to £2,491,424 over the study period	SSIs cause a significant clinical and economic burden.

Note. SSI: Surgical site infection; CI: Confidence interval; PROM: Premature rupture of membranes; ANC: Antenatal care; DM: Diabetes mellitus; BMI: Body mass index; LOS: Length of stay.

Table 3. Epidemiological studies for post-C-section SSIs in India

Author and study year	Study details	Participants and intervention	Key findings	Conclusion
Bano *et al.*, 2024[28]	Prospective, observational study aimed to determine the frequency of SSI and contributing factors in women undergoing C-section	The study included a total of 1,157 women who developed post C-section SSI during their hospital stay or within 30 days post-surgery.	♦ A total of 53 cases (4.5%) recorded a post C-section SSI. ♦ Associated risk factors included: ✦ Previous C-section: 56.6% ✦ Anemia: 81.13% ✦ Hypertensive disorder: 13.2% ✦ Urinary tract infection: 3.77% ♦ *Klebsiella* was the most isolated organism.	The most common risk factors for SSIs included infrequent antenatal visits, emergency C-sections, anemia, and a history of previous C-sections
Hashim *et al.*, 2023[29]	Analysis of the clinical presentation of SSI, causative organisms, and the associated maternal morbidities in patients undergoing C-section surgeries	A total of 153 post C-section SSIs were included.	♦ All the patients experienced wound discharge and pain. ♦ 94.4% of the patients reported pain and induration. ♦ 44.4% of the patients had fever and wound discharges detected between Days 6 and 10 (mean: 8.78 days). ♦ The highest incidence of SSI was superficial incisional (94.4%), followed by deep incisional (5.6%). ♦ *Staphylococcus aureus* was the most common organism isolated (50%).	Early identification and appropriate treatment of SSI can reduce maternal morbidity and improve reproductive health in women.
Basany *et al.*, 2023[30]	Prospective hospital-based study to determine the incidence of post-cesarean SSI following single-dose antibiotic prophylaxis as recommended by the WHO	A total of 2,015 women who underwent cesarean delivery were included.	♦ SSIs developed in 92 participants (4.6%, 95% CI: 3.7% to 5.6%). ♦ Types of SSI: ✦ Superficial infections: 91 participants (98.9%) ✦ Deep infections: 1 participant (1.1%) ♦ Risk factors for SSI: ✦ Obesity: aRR: 2.5 (95% CI: 1.4 to 4.6; power 99.9%) ✦ Age 25 years or younger: aRR: 2.3 (95% CI: 1.1 to 4.7; power 100%)	Young women and obese women were at higher risk of developing SSI.
Sharma *et al.*, 2023[31]	Retrospective observational study aimed at SSIs in patients undergoing C-sections, focusing on infection rates and common causative organisms	A total of 800 patients who had undergone LSCS surgeries were included.	♦ Wound infections were observed in 50 (6.25%) patients. ♦ The most frequent clinical manifestation of SSI was purulent discharge (26%). ♦ Spontaneous superficial dehiscence was noted in 17 women (34%), while 6 women (12%) required deliberate wound opening for pus drainage. ♦ Bacterial growth was noted in 78% of the infected cases.	SSIs following C-sections represent a significant burden on both patients and the healthcare system due to their impact on morbidity and resource utilization.
Jain *et al.*, 2022[32]	Analytical cross-sectional study to determine the prevalence and risk factors for SSIs after C-section, and the common causative organisms	A total of 1,895 women who underwent LSCS surgeries were included.	♦ A total of 280 women developed SSIs (14.7%). ♦ Majority of the women who developed SSIs were of advanced age (≥37 years).	Significant risk factors associated with SSIs included emergency cesarean delivery, severe anemia, lack of preoperative antibiotic use, high BMI, preexisting diseases, and a previous history of C-section.

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Author and study year	Study details	Participants and intervention	Key findings	Conclusion
Hirani *et al.*, 2022[22]	Prospective observational case-control study to determine the incidence and impact of SSIs post-C-section	A total of 2,024 patients who had undergone C-sections.	♦ 114 patients experienced ISSI, with an incidence of 5.63%. ♦ The total cost of illness due to post-cesarean ISSI was almost 3-times higher compared to the non-infected matched control group (p <0.0001). ♦ The average hospital stay for patients with ISSI was 10 days longer than that of the control group (p <0.0001). ♦ The total LOT in patients with ISSI was almost 3-times higher than in the control group (p <0.0001).	Post-C-section SSIs impose a significant clinical and financial burden, necessitating effective preventive measures.
Prajapati *et al*., 2022[33]	Prospective study aimed to investigate the risk factors and microbial agents responsible for SSI in LSCS and the impact of SSI on perinatal outcomes	The study included 324 pregnant women undergoing LSCS.	♦ The incidence of SSI in the study was 8.02%. ♦ 46.2% of the cases had a BMI of ≥25 kg/m². ♦ *Staphylococcus aureus* was the most identified microorganism. ♦ Significant risk factors included BMI, PIH, PROM, emergency LSCS, multiple vaginal examinations (>3), perioperative blood glucose levels ≥110 mg/dL, duration of surgery ≥60 minutes, and history of LSCS.	The presence of significant risk factors such as high BMI increases the incidence of SSIs in C-section surgeries.
Gupta *et al.*, 2021[34]	Non-interventional prospective observational study to assess the incidence and risk factors of SSI in LSCS surgeries	A total of 611 patients undergoing elective and emergency C-sections were included.	♦ The rate of SSIs was 10.3 per 100 surgeries. ♦ Superficial SSIs were the most common (66.7%). ♦ There was a significant association of SSIs with inappropriate antibiotic prophylaxis, anemia, previous LSCS surgeries, intra-operative blood transfusion, and comorbidities such as heart disease, hypothyroidism, and chronic liver and kidney disease. ♦ Gram-negative bacterial isolates were a predominant cause of SSIs (55.3%).	The study reported high rates of SSIs after LSCS surgeries and highlights the need for strict monitoring of modifiable risk factors during antenatal visits.
Mhaske *et al.,* 2020[35]	Retrospective analytical study to assess the incidence and risk factors associated with SSIs following cesarean deliveries	The study involved 1,269 patients who underwent LSCS surgery.	♦ 56 (4.4%) patients developed SSI. ♦ Risk factors for SSI included anemia, history of C-section, and prolonged surgery.	The development of post-C-section SSIs highlighted a significant burden on the patient and the healthcare system.
Dutta *et al.,* 2019[36]	Retrospective randomized case-control study in women undergoing LSCS	A total of 370 women who underwent C-sections were studied.	♦ Incidence of SSIs: 7.74% ♦ Risk factors for wound complications: High premature rupture of membranes, number of pelvic examinations, prolonged labor, increased surgical time, and increased BMI	Increased wound complications increase the hospital stays, and subsequently increase the financial burden on patients and hospitals.
Dahiya *et al.,* 2016[37]	Prospective, observational study that involved pregnant women who underwent C-sections	A total of 300 women who underwent either emergency (n = 150) or elective (n = 150) C-section surgeries.	♦ Incidence of SSIs: 9% ✦ Superficial SSIs: 96.2% ✦ Deep SSIs: 3.7% ♦ Most infections (62.96%) occurred in women from a low socio-economic class. ♦ Women with unbooked status, irregular antenatal visits, and leaking per vaginum for more than 24 hours, and those undergoing surgery lasting more than 1 hour (92.59%, p = 0.001), were more prone to SSIs.	Proper assessment and modification of risk factors that predispose individuals to SSI can help in reducing SSI rates.

Note. aRR: Adjusted relative ratio; LSCS: Lower segment cesarean section; CI: Confidence interval; ISSI: Incisional surgical site infection; PIH: Pregnancy-induced hypertension; PROM: Premature rupture of membranes; LOT: Length of antimicrobial therapy; SSI: Surgical site infections.

Table 4. Impact of surgical site infections on patient health and economy

Impact on patient health	Combined impact on patient health and economy	Impact on economy
♦ Pain ♦ Anxiety faced by the doctor and patient ♦ Impact on bonding ♦ Psychological stress on the patient ♦ Post-partum blues ♦ The aesthetic appearance of scars after healing by secondary intention is not good ♦ Worsening of comorbidities like diabetes and nemia ♦ Decreased quality of life	♦ Delayed recovery ♦ In case of intensive care unit admissions: Pain, anxiety, and cost of tests ♦ Need for formula substitution ♦ Risks of neonatal infections ♦ Daily dressings after discharge ♦ Commute to the hospital every day with the baby ♦ Waiting time in the hospital with or without the baby and the exposure of the neonate to hospital infections	♦ The need for an attendee to accompany the patient ♦ Economic impact of repeated dressings, antibiotics, out-of-pocket expenses, and loss of income to family and the nation ♦ Medicolegal implications

Key takeaways

- C-sections are major life-saving surgical obstetric procedures that are highly effective in saving the lives of both, the mother and the infant, and are undertaken for medical reasons.[2,3]
- Maternal obesity, defined as a pre-pregnancy BMI >30 kg/m², is associated with increased risks of pregnancy complications, labor difficulties, and higher anesthetic and surgical risks during C-sections.[13]
- Surgical site infections account for 19.5% of the hospital readmissions. Despite primary closure after a C-section, post-operative complications can occur at the incision site and include infection, seroma, hematoma, local skin ischemia, necrosis, dehiscence, and delayed wound healing.[21]
- Higher BMI is one of the significant risk factors for SSIs (p = 0.04).[25]
- Surgical site infections are associated with longer hospital stays (p <0.0001)[22] and increased morbidity and mortality.[24,29]
- Post C-section SSIs can result in substantial economic burdens, with costs potentially escalating by 2 to 6 times higher for the affected patients, depending on the surgery, healthcare setting, and type of infection.[22]
- Post C-section SSIs impose a burden on the healthcare system and healthcare resource utilization.[31]

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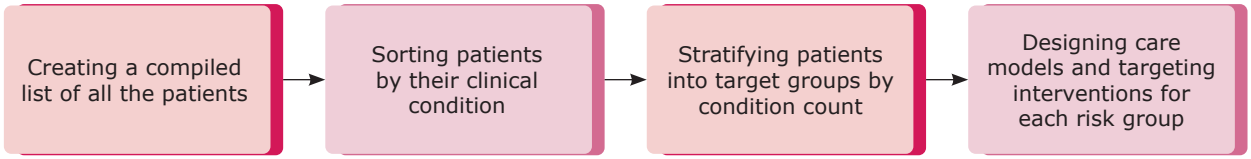
Risk Stratification Strategies for SSIs in Patients Undergoing C-Section Surgeries

Dr. Gayathri Karthik

2.1 Need for risk stratification

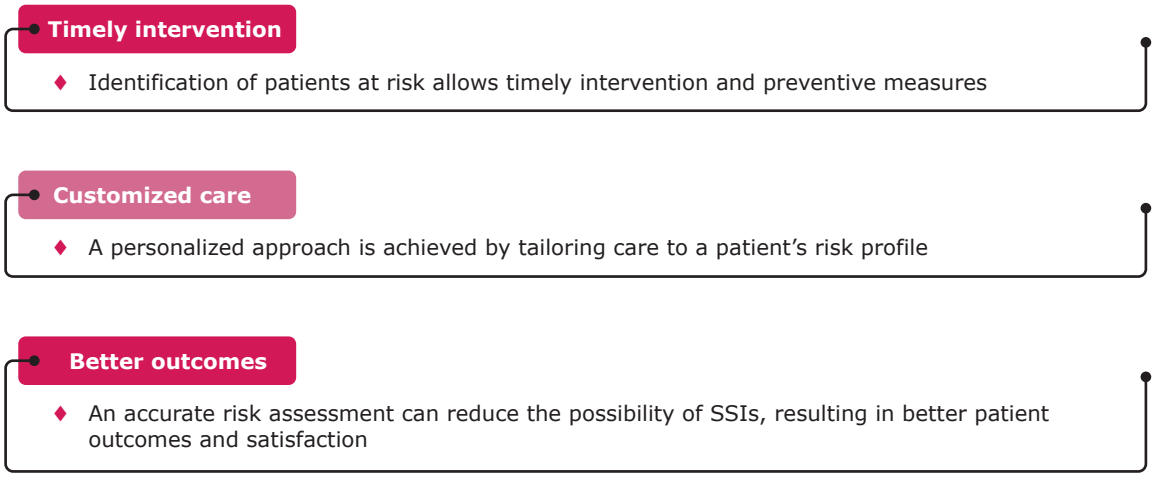
Risk stratification is a technique by which patients are categorized into groups of similar complexity and care needs. The steps for risk stratification are described in Figure 1. The patients are segregated into low-, moderate- and high-risk groups for assessing their risk of developing complications. By using this information, the right level of care can be identified, and overall health outcomes can be improved.[1] In patients undergoing C-section surgeries, there is a need to assess the risk for providing timely intervention, customized care, and better outcomes (Figure 2).[2]

Figure 1. Risk stratification steps



Note. Adapted from "Population Health Management. Risk Stratification," by National Association of Community Health Centers, 2022.

Figure 2. Need for risk assessment in C-section surgeries



Note. Adapted from "Identifying At-Risk Patients: A Crucial Step in Prevention. Protecting Time to Bond," by Smith & Nephew, 2024.

2.2 Identification of patients at risk of SSIs

It is important to identify patients at risk of surgical site infections (SSIs) after undergoing C-sections to provide them with the highest level of care. Risk assessment is an essential preventive measure that can significantly improve patient outcomes.[2]

Identification of patients at high risk allows certain additional steps to be taken to prevent morbidity associated with SSIs after a C-section. Puerperium is the valuable time for bonding between the mother and the baby; it is sacrosanct and should not be marred by the pain inflicted by SSIs and the need for multiple hospital visits and additional antibiotics (which may have an impact on the baby as well).

2.3 Risk stratification of patients undergoing C-section surgeries

The risk factors for SSIs are heterogeneous, with pre-operative, intra-operative, and post-operative factors influencing the risk of developing an infection.[3] The risk of developing an SSI after surgery depends on the surgical procedure- and patient-related factors (Table 1).[3,4] In the Indian setting, certain other risk factors like advanced maternal age, socio-economic status, education level, anemia, religion (Jehovah's Witness), infections, including bacterial infections (e.g., tuberculosis) and viral infections (e.g., human immunodeficiency virus infection), asthma, abnormal labor, recurrent pregnancy losses, and higher prior births should be considered for evaluation of the risk of developing SSIs after C-section surgery. The presence of just one major risk factor or two or more moderate risk factors places the patients at risk of SSIs.[4]

Table 1. Risk stratification of patients undergoing C-sections for developing SSIs

Category	Risk factors	
	Patient-related	**Surgery-related**
Major risk*	♦ BMI ≥40 kg/m² or ≤18 kg/m² ♦ Uncontrolled insulin-dependent diabetes mellitus ♦ Renal dialysis ♦ Premature rupture of membranes, >18 h ♦ Chorioamnionitis ♦ Abnormal labor ♦ Meeting the low-risk criteria$, but the presence of two or more minor risk factors	♦ Extended duration of surgery† ♦ Emergency surgery ♦ Hypothermia
Moderate risk**	♦ ASA physical status >II ♦ BMI 30–39.9 kg/m² ♦ Diabetes mellitus ♦ Immunosuppression ♦ Smoking ♦ Using steroids for a chronic condition ♦ Renal insufficiency ♦ Pre-existing infection at a body site far away from the operative site ♦ Asthma	♦ Anemia ♦ Dual antiplatelet treatment ♦ Suboptimal timing or omission of prophylactic antibiotics ♦ Tissue trauma/large area of dissection/large area of undermining ♦ High wound tension after closure
Minor risk#	♦ BMI 25–29.9 kg/m² ♦ Extended pre-operative hospitalization or residency in a nursing home ♦ Peripheral vascular disease ♦ Tobacco and substance abuse ♦ Insufficient prenatal care (<5 visits) ♦ Late care (>20 weeks gestational age at first visit) ♦ Severe hypertension, including pre-eclampsia	♦ Failure to obliterate dead space ♦ Previous surgery ♦ Location of incision ♦ Surgical drains ♦ Length of surgery >60 min ♦ Excessive blood loss (>1,000 mL)

Note. *Presence of 1 major risk factor indicates a high risk of SSI. **Presence of ≥2 moderate risk factors indicates a high risk of SSI. #Presence of any minor risk factor indicates an increased risk of SSI. †Defined as >T (hours), which is dependent on the type of surgical procedure, and is the 75th centile of the duration of surgery for a particular procedure, e.g. coronary artery bypass graft has a T of 5 hours and C-section has a T of 1 hour. $The low-risk group criteria included the absence of major risk factors and the presence of 0 or 1 minor risk factor. The high-risk group criteria included the presence of 1 or more major risk factors or the presence of 2 or more minor risk factors.
ASA: American Society of Anesthesiologists; BMI: Body mass index; SSIs: Surgical site infections. Adapted from "A Risk-Stratified Peri-Operative Protocol for Reducing Surgical Site Infection after Cesarean Delivery," by G. T. Talbot, *et al.*, 2021, *Surg Infect, 22(4), p.* 409-414.

Key takeaways

Forewarned is forearmed! Hence, if patients at a high-risk for development of SSIs are identified and appropriate measures are taken, a patient will remain healthier, with lesser complications and a lesser financial burden on the family and the country. Most importantly, a greater and stronger bonding between the mother and child can be ensured!

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Guiding Principles in Closed Surgical Incision Management and Understanding the Role of sNPWT

Dr. Neerja Bhatla, Dr. Kunal Doshi, Dr. Meenakshi Ahuja, Dr. Anjila Aneja, and Dr. Dibyendu Banerjee

3.1 Preventing SSIs: Essential strategies for better outcomes

Closed surgical incisions are common and associated with various complications, including surgical site infections (SSIs), dehiscence, seromas, hematomas, delayed healing, and poor or abnormal scarring. Enhancing patient outcomes by minimizing the incidence of these SSIs could greatly benefit patients and reduce societal and healthcare expenses.[1]

Post-cesarean infection is a major contributor to maternal death related directly to pregnancy. It is estimated that up to 60% of the SSIs could be prevented using an evidence-based SSI care bundle.[1] Achieving optimal surgical results is a primary focus for the surgeons, requiring meticulous patient selection, detailed pre-operative planning, thorough evaluations, and careful postoperative management, alongside proficient surgical skills and techniques.[2] Additionally, identifying the risk factors—especially those that are modifiable and related to the patient, pregnancy, or the surgical method—and employing strategies to prevent infections promptly is crucial for minimizing the incidence and impact of SSIs.[2]

The clinical practices used to minimize the rate of SSIs can be divided into two categories based on the time of intervention: Pre-operative (Table 1)[3–6] and post-operative (Table 2)[6,7] practices.

Table 1. Recommendations on pre-operative care to prevent SSIs

Source	Strategies	Good clinical practices
WHO 2016; NICE 2019; ACOG 2018	Pre-operative bathing	Patients should bathe or shower before the surgery. Use either plain or antimicrobial soap, with chlorhexidine preferably.
WHO 2016	Surgical site and hand preparation	Alcohol-based antiseptic solutions containing chlorhexidine should be used for skin preparation. Perform hand preparation with antimicrobial soap or alcohol-based hand rub.
ACOG 2018	Surgical site preparation	Alcohol-based preparations or chlorhexidine-alcohol should be used for abdominal skin preparation. For vaginal procedures, use only povidone-iodine and avoid high-concentration chlorhexidine.
FOGSI 2014	Operation theatre preparation	It is essential to regularly check Boyle's apparatus, blood pressure apparatus, pulse oximeters, cautery, suction machines, and gas supplies. Newborn care requires a suction machine, sterile tubing, laryngoscope, endotracheal tubes, and an overhead light or warmer.
WHO 2016	Nutritional support	Consideration should be given to oral or enteral nutritional formulas for underweight patients undergoing major surgery to prevent SSIs.
WHO 2016	Blood glucose control	It is required to implement protocols for intensive perioperative blood glucose control in both, diabetic and non-diabetic patients to reduce the risk of SSIs.
WHO 2016	Drapes and gowns	Sterile, disposable non-woven, or reusable woven drapes and gowns should be used. Plastic adhesive incise drapes should be avoided and iodophor-impregnated drapes should be used if needed.

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Source	Strategies	Good clinical practices
NICE 2019	Surgical incision	It is required to avoid using diathermy for surgical incisions to lower the risk of SSIs.
WHO 2016; NICE 2019	Incisional wound irrigation	It is essential to consider irrigation with aqueous PVP-I for clean and clean-contaminated wounds. Avoid routine use of antibiotic irrigation.
WHO 2016	Prophylactic negative pressure wound therapy	It is required to use prophylactic negative pressure wound therapy for high-risk wounds with primarily closed incisions while considering resource availability.
WHO 2016	Surgical antibiotic prophylaxis	It is required to administer prophylactic antibiotics within 120 minutes before the incision. Repeat the dose if the duration of surgery exceeds the half-life of the antibiotic.
WHO 2016	Advanced dressings	Avoid the use of advanced dressings over standard dressings on primarily closed surgical wounds.
WHO 2016	Antimicrobial prophylaxis with drain	It is essential not to continue pre-operative antibiotics in the presence of a wound drain. Remove the drain as clinically indicated.

Note. WHO: World Health Organization; ACOG: American College of Obstetricians and Gynecologists; NICE: National Institute for Health and Care Excellence; FOGSI: Federation of Obstetric and Gynecological Societies of India; PVP-I: Povidone-iodine; SSIs: Surgical site infections.

Table 2. Clinical practice recommendations for post-operative care

Strategies	Good clinical practices
Monitoring	It is critical to monitor the vital signs and renal, cardiovascular, and respiratory functions, and carry out laboratory tests.
Fluid management	Administer intravenous fluids and blood products if needed. Management is based on deficits, maintenance, and abnormal losses, if any.
Antibiotic prophylaxis	Administer single-dose prophylactic antibiotics 15 to 60 minutes before the incision; continue only if needed.
Pain and anxiety relief	Provide adequate analgesia and psychological support.
Post-operative nausea/vomiting	Administer prophylactic antiemetics and treat nausea/vomiting with appropriate medications.
Nutritional support	Optimize nutritional status for better wound healing and recovery. Early feeding (within 6 hours) may be encouraged, starting with clear fluids and low-residue diet.
Physiotherapy	Limb and chest physiotherapy and early ambulation
Thromboprophylaxis	Administer as per VTE score, if indicated

Note. Adapted from "FOGSI FOCUS Consensus Statement for Cesarean Section", 2015, and Venous thromboembolism risk score during hospitalization in pregnancy: Results of 10,694 prospective evaluations in a clinical trial," by V. I. Barros, A. M. Igai, F. S. Baptista, et al., 2023, Clinics, 78, p. 100230.
VTE: Venous thromboembolism.

3.2 Recommendations for post-operative wound management

NICE recommendations

The National Institute for Health and Care Excellence (NICE) in the United Kingdom has issued recommendations for managing postoperative wounds to prevent or reduce the incidence of SSIs (Figure 1). These recommendations include cleaning and dressing the wound, administering antibiotics, and debriding the wound.[8–10]

Figure 1. Strategies for managing post-operative wounds to prevent the incidence of SSIs[8,9]

Cleaning and dressing

- Surgical wound healing by secondary intention requires interactive dressings, with advice from a healthcare professional on the appropriate dressings.
- Antiseptics should be used for dressing changes without touching the wound. After the surgery, wounds should be left untouched for 48 hours, and cleaned only with sterile saline.
- Gentle irrigation with a syringe is preferred for cleaning wounds to avoid trauma and maintain a healing environment, but excessive cleaning can delay healing.
- Effective dressings maintain a moist environment, remove excess exudate, prevent bacterial contamination, and are easy to remove without causing trauma.

Treatment with antibiotics

- If a SSI such as cellulitis is suspected due to a lack of response to initial treatment, antibiotics are prescribed as the preferred option. The choice of antibiotic should be based on its effectiveness against the most likely causative organisms, taking into account both, microbial test results and local resistance patterns.

Debridement

- Minor dehiscence can be managed with secondary closure and debridement, while deep wounds may require negative pressure dressings and continuous tension devices.
- For surgical site debridement, gauze, eusol solution, and enzymatic treatments are recommended.

Enzymatic debridement

- It involves use of proteases from bacterial, plant, or animal sources to remove the necrotic tissue from the wounds. It is effective for infected wounds, does not require complex equipment, and is quicker and less labor-intensive than autolytic treatments.
- Commonly used proteases include bromelain (from pineapple), papain (from papaya), and bacterial collagenases.
- Besides direct enzymatic debridement, proteases are used for anti- or pro-coagulation and in non-specific wound healing.
- Secretions from the species of fish such as *Netuma barba, Channa striatus,* and *Clarias gariepinus* enhance wound healing, significantly reducing healing time in various animal models and humans.
- Toxins from snakes such as *Bothrops moojeni*, *B. atrox, B. alternatus,* and *B. jararaca* are effective in promoting wound healing through coagulation and epithelial cell migration.

Use of antiseptics

- Antiseptics are disinfecting solutions. When applied to open wounds or intact skin, they have an antibacterial effect that either kills or inactivates the microorganisms. While some of them work well against multiple pathogens, others are only effective against one or two microorganisms.
- Silver nanoparticles are recognized as a highly effective way to combat bacterial resistance and as a good substitute for conventional antibacterial disinfectants.
- Possible modes of action of silver include irreversible cytoplasmic disintegration and damage to the bacterial cell wall, modification of membrane permeability and damage, modification of intracellular ATP levels and microbial respiration, and inhibition of DNA replication.

Note. ATP: Adenosine triphosphate; DNA: Deoxyribonucleic acid; SSIs: Surgical site infections. Adapted from "An Updated Guidelines on Post-Operative Wound Management" by Nimbalkar SS, et al. 2021. IJMBS, 5(11); p. 01-06, "Practical context of enzymatic treatment for wound healing: A secreted protease approach" by Isabella A et al.,2020, Biomed Rep,13(1), p. 3-14, "Atlas of Wound Healing: A Tissue Regeneration Approach," by S. Kordestani, 2019, Elsevier, p. 31-47.

Enhancing post-operative wound care: Insights into Indian surgical practices

- It is important to optimize care at surgical sites to ensure proper wound closure, prevent complications, and enhance both, aesthetic and functional outcomes.[8]
- Obstetricians should monitor wound healing and use dressings with long wear times and transparency to facilitate early detection of issues and minimize the impact on patients and costs.[8]
- The Government of India prioritizes controlling antimicrobial resistance by optimizing antimicrobial use to prevent misuse. Antimicrobial misuse can lead to higher costs and worse patient outcomes.[11]
- The National Centre for Disease Control is working with the World Health Organization (WHO) to address such issues and develop strategies to prevent infections.[11]

3.3 Harnessing negative pressure therapy for optimal wound healing

Tracing the evolution: The journey of NPWT

- Negative pressure wound therapy (NPWT), as a post-operative dressing, is one of the recommended options included in this SSI care bundle.[12]
- Fleischmann initially described vacuum sealing, and in 1988, Russian researchers explored its use for managing pus-filled wounds. They treated 338 patients, comparing traditional methods with vacuum therapy. The results showed that vacuum therapy accelerated healing and reduced the treatment time.[13]
- In 1985, Jeter developed a novel negative pressure system for wound care using gauze and wall suction. Jeter and Chariker found that their closed suction system significantly improved the treatment of enterocutaneous fistulae in abdominal wounds (Table 3).[13]
- Negative pressure wound therapy is a versatile system that enhances wound healing by applying sub-atmospheric pressure, which helps reduce inflammatory exudate and promote granulation tissue.[12]
- It is used to manage both, acute and chronic wounds, including open fasciotomy wounds, diabetic foot ulcers, and closed surgical incisions.[12]

Table 3. History of key developments in NPWT[12,13]

Period	Key developments
19th century	Prof. August Bier defined cupping with alcohol-ignited glass and a rubber tube, enhancing vacuum therapy.
1907	Dr. E. Klapp used a suction pump to remove infectious materials from tuberculosis lesions.
1970	NPWT was used in the former Soviet Union for postsurgical tissue repair and wound fluid removal.
1985	Jeter and Chariker developed a closed suction wound drainage system, revolutionizing enterocutaneous fistulae management.
1989	Chariker *et al.*, introduced the "Chariker-Jeter technique" using gauze and wall suction for wound healing.
1999	Philbeck Jr. *et al.,* showed that the combination treatment with controlled-suction drains accelerated healing and reduced costs.
Recent years	Continued progress in the advancement of NPWT*, with ongoing technological innovations.

Note. *Since its first recorded use in the 19th century, NPWT has significantly evolved. The current NPWT system uses a porous foam dressing with continuous or intermittent suction applied through an electronic device to achieve a sub-atmospheric pressure of –80 to –125 mmHg.

Recommendations for closed surgical incision management

World Health Organization[1]

- The WHO advises the use of prophylactic NPWT for adult patients with primarily closed surgical incisions in high-risk wounds to prevent SSIs, while also considering available resources.

National Institute for Health and Care Excellence[14]

- There is evidence to support the use of single-use negative pressure wound dressings for closed surgical incisions as they are linked to a lower incidence of SSIs and seromas compared to the standard wound dressings.
- Single-use negative pressure wound dressings should be considered for patients with closed surgical incisions, who are at high risk for SSIs.
- Cost modeling indicates that single-use negative pressure wound dressings offer additional clinical benefits at a comparable overall cost to standard wound dressings.

World Union of Wound Healing Societies (WUWHS)[1]

- The 2016 WUWHS Consensus Document advocates NPWT for high-risk patients, surgeries with a high incidence of complications, and those with severe consequences if complications occur.
- The 2018 WUWHS Consensus Document recommends NPWT for managing dehisced wounds of all grades.
- It also highlights the increasing use of single-use NPWT to prevent surgical wound dehiscence and considers its use for patients with risk factors for surgical site complications.

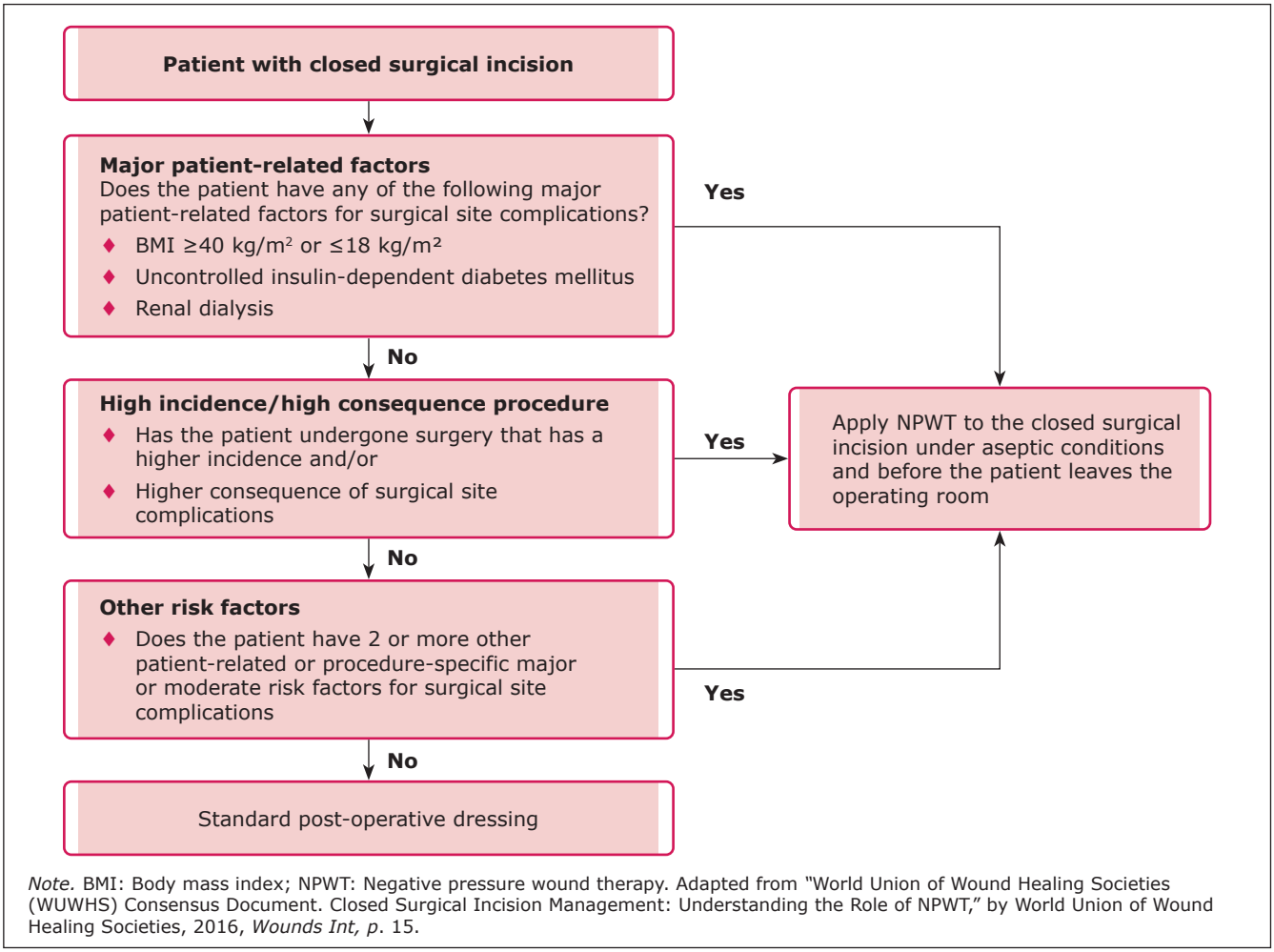
WUWHS recommendations for NPWT application[15]

- **Before surgery:**
  - Describe, demonstrate, and discuss NPWT with the patient/carer.
- **During surgery:**
  - Consider incision and surgical drain to accommodate the NPWT dressing.
  - In devices with a port, ensure that there is no pressure damage, if relevant for the NPWT device in use.
  - Place drains in a lower position (NPWT over closed incisions does not replace the need for surgical drains where indicated).
  - Ensure the patient's skin is hair-free and dry before applying the dressing to ensure good adhesion and seal formation. Gel strips may help in difficult areas.
  - Apply the dressing under aseptic conditions and according to the manufacturer's instructions.
  - Avoid placing the dressing over the drains.
  - Consider the zone of tissue injury around the incision and select a wide NPWT dressing.
  - Regularly inspect the dressing, canister (if present), and power unit.
- **After surgery:**
  - Leave the dressing in place for up to 5–7 days as per the manufacturer's instructions and availability of outpatient clinic access, unless new concerns arise.
  - If the incision is closed and dry upon removal of the dressing, reapplication of NPWT or a conventional dressing is not necessary.
  - Use an aseptic technique if the there is a need to change the dressing.
  - Provide the discharged patients with written instructions on care of the NPWT system and contact information of the healthcare professionals.
  - If signs of SSI occur, follow local SSI management protocols and evaluate the appropriateness of continuing NPWT.

WUWHS recommendations on NPWT in closed surgical incision care to prevent complications

The Expert Working Group recommends NPWT for patients with closed surgical incisions who have high-risk factors or have undergone procedures that are associated with risk of complications (Figure 2). Future research may provide new evidence on the benefits of NPWT, potentially expanding its use to additional patients.[15]

Figure 2. Flowchart on closed surgical incision care



Note. BMI: Body mass index; NPWT: Negative pressure wound therapy. Adapted from "World Union of Wound Healing Societies (WUWHS) Consensus Document. Closed Surgical Incision Management: Understanding the Role of NPWT," by World Union of Wound Healing Societies, 2016, *Wounds Int, p*. 15.

3.4 Unlocking advanced wound care using sNPWT systems

Introduction to sNPWT

Recent advancements in NPWT include the development of single-use NPWT (sNPWT) systems, which are typically lightweight and powered either mechanically or by battery. These features enable the patients to remain mobile while undergoing treatment.[14]

- The single-use system is a canister-free NPWT device that includes a sterile pump and multi-layered adhesive dressings.
- Each dressing features 4 layers:
  - A silicone adhesive for minimal pain and reduced tension
  - An airlock layer for even pressure distribution

- An absorbent layer to manage exudate and bacteria
- A top film layer for moisture evaporation

- The sNPWT, powered by two AA batteries, maintains a constant negative pressure of 80 mmHg for up to 7 days, with LED indicators for the battery and pressure issues.
- The sNPWT dressings are available in standard sizes (10 × 20 cm to 25 × 25 cm) and multisite sizes (15 × 20 cm and 20 × 25 cm).
- The latest sNPWT (PICO◇ 7) system (Figure 3) includes an upgraded pump to reduce leakage and a built-in belt clip for easier transport. It also has a magnet and should be kept at least 10 cm away from other medical devices to avoid magnetic interference.[16]

Figure 3. PICO◇ 7 sNPWT device

3.5 Essential features of sNPWT systems for effective closed incision management

The sNPWT system has been shown to double wound healing speed and reduce scar tissue. It provides early wound management and stability during field settings and enhances healing in clinical settings.[17]

- **Simplified design:** The sNPWT system features a basic set-up, including a bellows hand pump, an occlusive drape, and a tube with connectors for easy assembly and use.
- **Airtight seal:** The system must be completely airtight to function effectively, which has been achieved through iterative design improvements.
- **Adaptability to field conditions:** The sNPWT system is designed to perform well in diverse and challenging environments, including low-resource settings, demonstrating its versatility and reliability under various conditions.
- **User-friendly assembly:** The design of the system ensures straightforward and secure assembly, including the use of liquid latex sealant and robust tube connections to maintain an effective seal and system integrity.

3.6 sNPWT: A powerful tool in minimizing surgical site complications

The sNPWT system has multiple mechanisms of action that can help improve the speed, strength, and quality of incisional wound healing. This can help minimize wound complications such as edema, seroma, hematoma formation as well as dehiscence. The key features of sNPWT in reducing SSIs are as under:[18–21]

- Keeps a closed incision together, reducing stress on the wound edges
- Enhances negative pressure on the wound, aiding tissue contraction and adjusting blood flow patterns
- Effective in preventing infections and fluid accumulation
- Helps lower the need for re-operations and is cost-effective, especially for high-risk patients
- Encourages the formation and growth of new microvessels early in the healing process

Key takeaways

- Surgeons aim for optimal results through their surgical skills as well as careful patient selection, planning, evaluation, and management.[2]
- Negative pressure wound therapy is a recommended post-operative dressing in the SSI care bundle.[11]
- Recent sNPWT systems are canister-free, portable, disposable, and feature a proprietary layer for even pressure distribution.[13]
- The sNPWT system enhances wound healing and reduces complications like edema and dehiscence.[16]

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Evidence on sNPWT in High-Risk Patients Undergoing C-Section Surgeries

Dr. Hrishikesh Pai and Dr. Girija Wagh

4.1 Background

Recent clinical evidence supports the use of single-use negative pressure wound therapy (sNPWT) in the management of closed surgical incisions, particularly in high-risk patients undergoing C-section surgeries, to reduce surgical site infections.[1]

4.2 Overview of recommendations on sNPWT

- The 2019 World Union of Wound Healing Societies (WUWHS) consensus document on wound exudate noted the benefits of sNPWT in the management of closed surgical incisions to provide a barrier to the external contamination, to remove the excess wound exudate, and to aid in wound healing.[2]
- As per the PICO◇ sNPWT provides better outcomes than standard care for preventing surgical site complications in patients with risk factors such as increased age, obesity, cigarette smoking, diabetes, and undergoing C-section.[3]

4.3 Objective

Based on the supporting literature, a compilation of the updated clinical evidence focused on the role of sNPWT in the healing of surgical wounds in high-risk patients undergoing C-section is presented in this section.

4.4. Methodology

Literature search

The literature search was performed using databases including PubMed, Google Scholar, and the Cochrane Database of Systematic Reviews, as well as a focused internet search. The search strategy included keywords such as "single use", "negative pressure wound therapy", and "cesarean section". The search was limited to articles published between January 1, 2013 and November 4, 2024. Except for restricting retrieval to the human population and English-language documents, no filters were applied based on the study type. Comments, newspaper articles, editorials, and letters to the editor were manually excluded.

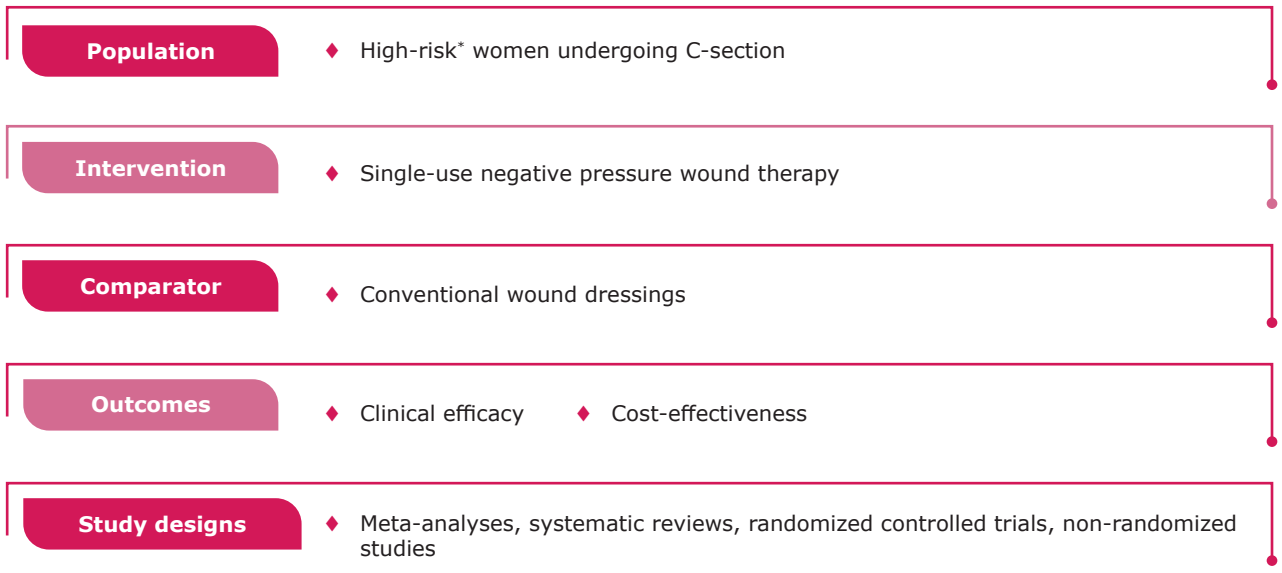
Inclusion and exclusion criteria

- After the literature search results were obtained, screening of the titles and abstracts was carried out. The relevant articles were retrieved and further evaluated for inclusion. The final selection of full-text articles was based on the 'PICOS' inclusion criteria[4] defined in Figure 1.
- Duplicate publications and articles not satisfying the selection criteria mentioned in Figure 1 were excluded.

Data analysis

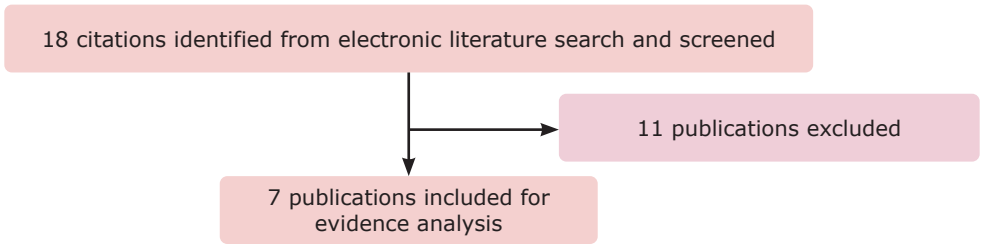
The literature search identified 18 citations. After screening titles and abstracts, 11 citations were excluded, and 7 potentially relevant publications on the beneficial role of sNPWT were retrieved. The flow chart for the study selection is presented in Figure 2.

Figure 1. PICOS inclusion criteria



Note. *Risk factors included obesity, diabetes, smoking, previous C-section, rupture of membranes, and history of wound dehiscence. Adapted from "Chapter 3: Defining the Criteria for Including Studies and How They Will be Grouped for the Synthesis," by J. E. McKenzie, *et al*., 2019. PICOS: Population, Intervention, Comparator, Outcomes, Study design

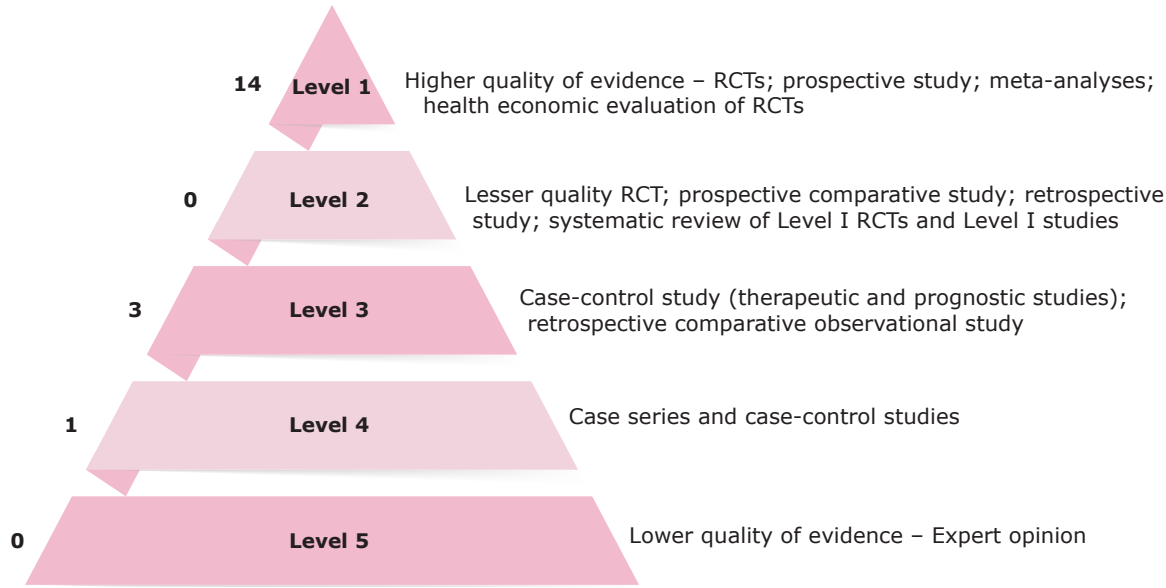
Figure 2. Flow chart of included studies



Quality of evidence

The quality of the included articles was categorized as per the level of evidence hierarchy. In the pyramidal scheme (Figure 3), there are five levels of evidence in the hierarchy of evidence, with Level 1 representing strong and high-quality evidence and Level 5 indicating evidence with effectiveness not established (Figure 3).[5]

Figure 3. Level of evidence hierarchy and the categorized number of articles



Note. RCT: Randomized controlled trial. Adapted from "Level of Evidence Hierarchy," by Elsevier Author Services, 2024.

4.5. Results

Clinical studies demonstrating efficacy

There were 6 clinical studies, out of which, 4 were Level 1 randomized controlled trials (RCT) on clinical efficacy and 2 were retrospective studies of Level 3 evidence (Table 1).

Table 1. Characteristics of included clinical studies related to the efficacy of sNPWT in high-risk patients undergoing C-section

Sr no.	Author and study year	LOE	Study details		Efficacy outcomes
1	Hyldig *et al.*, 2020[6]	1	Study design	Sub-study of cosmetic outcomes (N = 206)	sNPWT *vs.* standard postsurgical dressing: ♦ SSIs: 4.7 *vs.* 9.9% ♦ Patient satisfaction with scar appearance: ✦ 30 days: 72.4 *vs.* 53.1%; $p = 0.018$ ✦ 6 months: 75.3 *vs.* 58.2%; $p = 0.043$ ♦ Hatch mark appearance: ✦ 6 months: 20 *vs.* 43%; $p = 0.002$ ✦ 12 months: 19 *vs.* 36%; $p = 0.037$
			Risk factors	BMI ≥30 kg/m², diabetes, smoking during pregnancy, and prior C-section	
			Intervention	PICO◇ sNPWT (n = 105) *vs.* standard postsurgical dressing (n = 101)	
2	Hyldig *et al.*, 2019[7]	1	Study design	Multicentre, pragmatic, randomized study (N = 876)	sNPWT *vs.* standard dressing: ♦ SSIs: 4.6 *vs.* 9.2%; RR = 0.50 (95% CI: 0.30, 0.84); $p = 0.007$; ARR: −4.6% (95% CI: 1.2, 7.9%) ♦ Wound exudate as a complication: 22.4 *vs.* 32.9%; RR = 0.69 (95% CI: 0.55, 0.86); $p = 0.001$; ARR = −10.3% (95% CI: 4.2, 16.4%) ♦ Deep SSIs, dehiscence, and self-rated health status: Similar in both the groups
			Risk factors	BMI ≥30 kg/m², diabetes, smoking, and rupture of membranes	
			Intervention	PICO◇ sNPWT (n = 432) *vs.* standard dressing (n = 444)	

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Sr no.	Author and study year	LOE	Study details		Efficacy outcomes
3	Tuuli *et al.*, 2017[8]	1	Study design	Pilot randomized trial (N = 120)	sNPWT *vs.* standard dressing: ♦ Post-operative pain score: Was reduced; median [IQR]: 0 [0, 1] *vs.* 1 [0, 3], p = 0.02
			Risk factors	BMI ≥30 kg/m^2	
			Intervention	PICO◇ sNPWT *vs.* standard dressing (n = 60, each)	
4	Imcha *et al.*, 2023[9]	3	Study design	An observational, retrospective in-service evaluation (real-world) (N = 1,111)	♦ Proportion of patients who developed SSCs: 9.5% ♦ Of these patients who developed SSCs: ✦ Superficial SSIs: 73.6% ✦ Wound dehiscence: 23.6% ✦ Deep SSI: 7.5% ✦ Proportion of patients requiring readmissions for SSCs: 17.9%
			Risk factors	BMI ≥30 kg/m² and <30 kg/m² plus high-risk factors such as smoking, diabetes, previous C-section, history of wound dehiscence, and other significant risk factors according to clinical judgment	
			Intervention	PICO◇ sNPWT (n = 1,111)	
5	Searle *et al.*, 2017[10]	3	Study design	Audit study (4 sites in England and Ireland) (N = 399)	♦ SSIs: 9.0% (*vs.* 19.3% previously published data) ♦ Readmission incidence: 0.8%
			Risk factors	BMI ≥35kg/m²	
			Intervention	PICO◇ sNPWT (n = 399)	
6	Bullough L *et al.*, 2015[11]	3	Study design	Audit study reporting 2-year experience (N = 1,644)	♦ SSI rate: ✦ Baseline: 12.0% (before audit study) ✦ sNPWT: 0.4% ✦ OPSITE◇ Post-Op Visible dressing: 3.6% ♦ No readmission for infection or wound dehiscence ♦ sNPWT was cost-effective in high-risk patients
			Risk factors	BMI 35 kg/m²	
			Intervention	PICO◇ sNPWT (n = 239; BMI >35 kg/m²) *vs.* OPSITE◇ Post-Op Visible dressing (n = 1,405, BMI <35 kg/m²)	

Note. ARR: Absolute risk reduction; BMI: Body mass index; CI: Confidence interval; IQR: Interquartile range; LOE: Level of evidence; N: Total number of patients; n: Number of patients in subset; RR: Risk reduction; sNPWT: Single-use negative pressure wound therapy; SSC: Surgical site complication; SSI: Surgical site infection.

4.6. Future directions

Based on the efficacy data analysis presented in this section, the use of sNPWT may be justifiable to manage closed surgical incisions, including cesarean delivery, in patients at high-risk for developing surgical site complications. However, there is a need for availability of more evidence pertaining to the use of sNPWT in the Indian setting to be beneficial for the specific high-risk patient profiles.

Key takeaways

As per the overall clinical data on the efficacy of sNPWT in high-risk patients undergoing C-section, sNPWT has shown:

- Reduction in up to 50% of SSI risk with PICO◇ sNPWT compared with standard of care[7]
- Significant increase in patient satisfaction with scar and hatch mark appearance (p <0.05)[6]
- Reduction in post-operative pain score[8]
- Reduction in wound exudate up to 31% as a complication.
- Lower incidence of hospital readmissions[9,10]

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Assessing the Role of sNPWT in the Management of C-section Incision Wound: A Clinical Case Series

Dr. Gayathri Karthik, Dr. P. Vairamala, Dr. Niveditha Bharathy, Dr. Neha Pawar, Dr. Yashica Gudesar, Dr. Shachi Joshi

5.1 Introduction

Cesarean-section (C-section) surgeries have become more common, and the rate is rising in developed as well as developing countries.,[1,2] Although C-sections can effectively prevent maternal and perinatal morbidity and mortality, the high incidence rate of post-operative surgical site complications (SSCs) including surgical site infections (SSIs) can lead to substantial morbidity and mortality. The burden of SSIs includes delayed wound healing, prolonged hospitalization, and readmissions. It also increases healthcare costs and carries a significant emotional cost for patients and their relatives.[3] Previous C-section and one or more co-morbidity are reported to be associated with a 7.4-fold and 8-fold increased risk of SSI, respectively; there is a significant association between SSI and co-morbidity.[4] Despite the availability of best-practice surgical guidelines,[5] the number of SSCs that occur after C-sections remains high.[4]

Recent clinical evidence has demonstrated that advanced therapies, such as single-use negative pressure wound therapy (sNPWT), can effectively reduce the risk of SSIs when used on closed incisions, including those from C-sections. This approach is particularly beneficial for high-risk patients.[3,6] A randomized controlled trial reported that application of PICO◇ 7 sNPWT in high-risk, obese women with pre-pregnancy body mass index (BMI) >30kg/m^2 undergoing C-section significantly reduced the incidences of SSIs (50% reduction in relative risk) and wound exudate compared with the standard dressings.[7] Another study reported that the use of PICO◇ 7 sNPWT in high-risk patients, reduced the risk of SSIs by 63%, dehiscence risk by 30%, seroma risk by 77%, and mean length of hospital stay by 1.75 days compared to the standard care.[8]

Some of the key global recommendations by the World Union of Wound Healing Societies [WUWHS], 2016; World Health Organization [WHO], 2016; National Institute for Health and Care Excellence [NICE], 2018 also support the use of sNPWT in wound management to reduce the occurrence of SSIs.[6] sNPWT devices are particularly beneficial as they are small, light, easy to use, and highly portable. PICO, approved by the US FDA in 2010, is the most widely used sNPWT after C-section. It includes a single-use, battery-powered device and a foam-based or absorbent layer-based peel-and-place dressing designed for closed surgical incisions.[9] Currently, available sNPWT devices are designed to handle different volumes of exudate and come with shaped dressings in various sizes to suit different wound sizes and locations. These devices utilize a distinct mechanism to achieve therapeutic levels at the wound bed, differing from traditional mechanical NPWT.[10] However, in the Indian setting, no data exists on the use of the PICO◇ 7 sNPWT device. Hence, investigation and wider use of the PICO◇ 7 kit in post-operative C-section incisional sites in high-risk patients is warranted.

Our objective in developing the case series (n = 9) was to gather evidence specific to the Indian context by compiling and evaluating case reports on the effectiveness of the PICO◇ 7 device when used on closed surgical incisions following C-section surgeries in high-risk patients. In our investigation, we included elective or emergency C-section patients with comorbidities such as obesity, chorioamnionitis, pre-eclampsia, abdominal wall edema, pancreatitis, gestational diabetes mellitus, multiple fibroids, bronchial asthma, obstructive sleep apnea, cesarean myomectomy [higher blood loss], anemia, Jehovah's witness, hypoproteinemia, and deep vein thrombosis. The PICO◇ 7 dressing was applied immediately after the closing of the incision. In this case series, we aimed to evaluate the role of the PICO◇ 7 device in preventing SSCs. We also assessed outcomes related to wound parameters, including exudate volume, length of incision, wound healing rates, and patient satisfaction. The PICO◇ 7 device is designed to be worn for 7 days. The dressing used to manage exudate is inspected for saturation at 24 and 48 hours to determine if it needs to be changed. Detailed information on the patient's profile, treatment, and follow-up schedule are summarized in individual case reports.

5.2 Case Series

Case report 1

Patient

A 40-year-old woman received treatment for her wound following a C-section surgery. The total length of the incision was 15 cm, but the opening was less than 1 cm and was discharging a significant amount of exudate post-surgery. She had several comorbidities, including chorioamnionitis and obesity. Initially, she was treated with a standard dressing. Upon presentation, she had a dehisced and infected surgical incision.

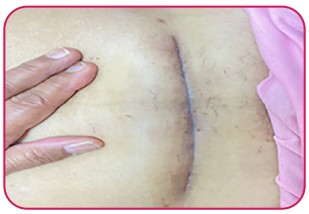
Treatment

A standard dressing was applied to the wound immediately in the operation theatre (Day 0). PICO◇ 7 dressing was applied on the incision after 4 days of surgery. In total, the dressing was changed twice per week.

Follow-up/results

The patient was monitored for 3 weeks following the surgery, during which, the 3 wound assessment visits: Day 4, Day 10, and Day 19 were conducted. As shown in Figure 1, on Day 0 and Day 4 the wound exhibited a significant amount of fluid discharge while using the standard dressing. However, after 3 weeks of post-operative treatment with PICO◇ 7 dressing, the wound had healed entirely, showing no fluid discharge. The scar appeared healthy and clean, with no signs of hematoma, seroma, or clinical indications of infection. The results with the PICO◇ 7 dressing were satisfactory.

Figure 1. Wound healing by application of PICO◇ 7 dressing

Day 0	Day 4	Day 10	Day 19
			
♦ Product used: Standard dressing ♦ Wound length: <1 cm opening ♦ Exudate volume: High	♦ Product used: PICO◇ 7 ♦ Wound length: <1 cm opening ♦ Exudate volume: High	♦ Product used: PICO◇ 7 ♦ Wound length: <1 cm opening ♦ Exudate volume: Moderate	♦ Product used: None ♦ Completely healed wound ♦ Exudate volume: None

Case report 2

Patient

A 36-year-old woman received treatment for her C-section incision wound, which had dehisced at presentation. The total length of the wound was 15 cm, with the dehiscence measuring 6 cm in length and 3 cm in depth. She had several comorbidities, including severe pre-eclampsia with imminent eclampsia, abdominal wall edema, and abnormal liver function tests due to pancreatitis, which was secondary to a common bile duct stone. Her prior treatments included regular dressings with hydrogen peroxide, debridement, and vacuum-assisted closure (VAC) dressing with a drain.

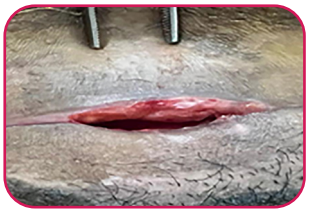
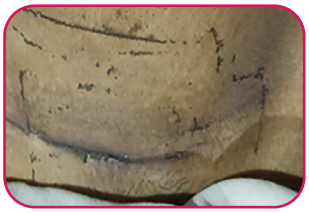
Treatment

On Day 0, a moderate volume of exudate was present. At the start of treatment, hydrogen peroxide, povidone-iodine, and VAC dressings were applied to the wound immediately after surgery in the operating theatre. A PICO◇ 7 dressing was applied after closing the incision on the 7th day of surgery. The dressing was changed once a week.

Follow-up/results

The patient was monitored for 3 weeks following surgery. During this period, there were a total of three wound assessment visits: Day 7, Day 14, and Day 21. By the end of 3 weeks of post-operative treatment with a PICO◇ 7 dressing (Figure 2), the dehisced wound had completely healed, showing no exudate. There were no signs of infection at the surgical site, nor was there any maceration observed.

Figure 2. Wound healing by application of PICO◇ 7 dressing

Day 0	Day 7	Day 14	Day 21
			
♦ Products used: Hydrogen peroxide, povidone-iodine, vacuum-assisted closure dressing ♦ Wound dimensions: ◇ Length: 6 cm ◇ Depth: 3 cm ♦ Exudate volume: Moderate	♦ Product used: PICO◇ 7 ♦ Wound dimensions: ◇ Length: 6 cm ◇ Depth: 2 cm ♦ Exudate volume: Low	♦ Product used: PICO◇ 7 ♦ Wound dimensions: ◇ Length: 4 cm ◇ Depth: 1 cm ♦ Exudate volume: None	♦ Product used: PICO◇ 7 ♦ Completely healed wound ♦ Exudate volume: None

Case report 3

Patient

A 40-year-old woman had a lower segment cesarean section (LSCS) surgery resulting in a closed wound measuring 20 cm in length. She has several comorbidities, including gestational diabetes mellitus, multiple fibroids, bronchial asthma, obstructive sleep apnea, and morbid obesity (BMI 40.6 kg/m^2). Additionally, she had a previous cesarean myomectomy, which involved higher blood loss. Prior to this surgery, she had been treated with antibiotics.

Treatment

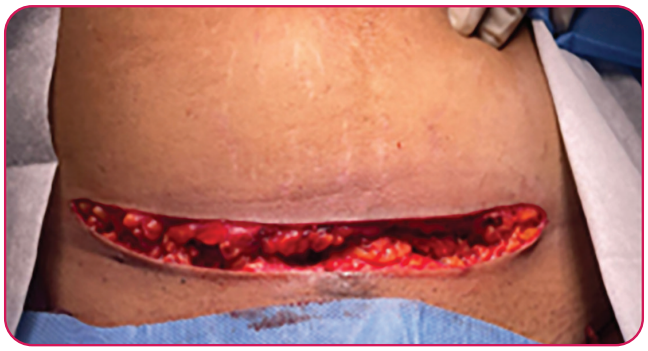
On Day 0, no exudate was present in the incision wound. PICO◇ 7 dressing was applied immediately in the operation theatre (Day 0) after closing the incision. The total treatment duration was 1 week, and the dressing was changed once a week.

Follow-up/results

The patient was instructed to visit the hospital or clinic 7 days after the intervention for a wound assessment and the removal of the device. She required only one wound assessment visit (Day 7). By the end of the treatment on Day 7, the wound had entirely healed, as shown in Figure 3. The wound was clean and healthy, with well-approximated edges.

Figure 3. Wound healing by application of PICO◇ 7 dressing

Day 0



- Product used: PICO◇ 7
- Wound dimensions:
  - Length: 20 cm
  - Depth: 3 cm
- Exudate volume: None

Day 7

- Product used: PICO◇ 7
- Wound dimensions:
  - Length: 20 cm
- Exudate volume: None

Case report 4

Patient

A 41-year-old woman received treatment for her C-section incision. The vertical surgical incision was 20 cm long and 3 cm deep, with no exudate present. She had comorbidities, such as moderate anemia, a history of three open myomectomies, and was a Jehovah's Witness (refused blood transfusion). Prior treatment included antibiotics.

Treatment

PICO◇ 7 dressing was applied in the operation theatre after closing the incision (Day 0). The patient was treated with antibiotics for over 2 weeks. The dressing was changed twice a week.

Follow-up/results

The patient was monitored for 2 weeks following surgery and was instructed to visit the hospital or clinic for wound assessment and device removal. The total number of visits for wound assessment was three: Day 7, Day 10, and Day 12. By the end of 2 weeks (Day 12), the wound had completely healed, with no exudate present (Figure 4).

Figure 4. Wound healing by application of PICO◇ 7 dressing

Day 0	Day 7	Day 10	Day 12
			
♦ Product used: PICO◇ 7 ♦ Wound length: 20 cm ♦ Exudate volume: None	♦ Product used: PICO◇ 7 ♦ Wound length: 20 cm ♦ Exudate volume: Negligible	♦ Product used: PICO◇ 7 ♦ Wound length: 20 cm ♦ Exudate volume: None	♦ Product used: PICO◇ 7 ♦ Wound length: 20 cm ♦ Exudate volume: None

Case report 5

Patient

A 40-year-old woman underwent a LSCS surgery, resulting in a closed wound measuring 14 cm in length and 1.5 cm in depth. She had a history of wound-related comorbidities, i.e., obesity, hypoproteinemia, and deep vein thrombosis. Additionally, she had been treated for systemic lupus erythematosus, albuminuria, lupus nephritis, diffuse membranoproliferative glomerulonephritis, and immune thrombocytopenic purpura.

Treatment

PICO◇ 7 dressing was applied in the operation theatre after closing the incision. The total treatment duration was 1 week. The dressing was changed twice a week. Appropriate nutritional advice was provided.

Follow-up/results

The patient was instructed to visit the hospital or clinic 7 days after the intervention for a wound assessment and the removal of the device. The patient was monitored for 1 week following the surgery, during which, the 2 wound assessment visits: Day 4 and Day 7 were conducted. By the end of 1 week (Day 7), the wound had completely healed, with no exudate present (Figure 5).

Figure 5. Wound healing by application of PICO◇ 7 dressing

Day 0	Day 4	Day 7
		
♦ Product used: PICO◇ 7 ♦ Wound dimensions: ◇ Length: 14 cm ◇ Depth: 1.5 cm	♦ Product used: PICO◇ 7 ♦ Exudate volume: Negligible	♦ Completely healed wound ♦ Exudate volume: None

Case report 6

Patient

A 29-year-old woman had an emergency LSCS surgery, resulting in a closed wound measuring 12 cm in length, while its depth was 2 cm. She had comorbidities, i.e., a high BMI and anterior abdominal wall edema.

Treatment

PICO◇ 7 dressing was applied in the operation theatre after closing the incision. The total treatment duration was 1 week. The dressing was changed once a week.

Follow-up/results

The patient was instructed to visit the hospital or clinic 7 days after the intervention for a wound assessment and the removal of the device. The patient was monitored for 1 week following the surgery, during which, the 2 wound assessment visits: Day 4 and Day 7 were conducted. By the end of 1 week (Day 7), the wound had completely healed, with no exudate present (Figure 6).

Figure 6. Wound healing by application of PICO◇ 7 dressing

Day 0

- Product used: PICO◇ 7
- Wound dimensions:
  - Length: 12 cm
  - Depth: 2 cm
- Exudate volume: None

Day 4

- Product used: PICO◇ 7
- Exudate volume: None

Day 7

- Completely healed wound
- Exudate volume: None

Case report 7

Patient

A 32-year-old woman received treatment for her closed surgical incision from a LSCS surgery. The incision measured 11 cm in length and 3 cm in depth. She had a history of non-healing tuberculosis at a previous scar. She had previously undergone a repair for an infected hernia sac located 3 cm above the site of her current incision. Additionally, she had a LSCS surgery a few years ago.

Treatment

PICO◇ 7 dressing was applied in the operation theatre after closing the incision. The total treatment duration was 1 week. The dressing was changed once a week.

Follow-up/results

The patient was instructed to visit the hospital or clinic 7 days after the intervention for a wound assessment and the removal of the device. The patient was monitored for 1 week following the surgery, during which, the 2 wound assessment visits: Day 4 and Day 7 were conducted. By the end of 1 week (Day 7), the wound had healed completely, with no exudate present (Figure 7). The post-operative wound recovery was fast.

Figure 7. Wound healing by application of PICO◇ 7 dressing

Day 0

- Product used: PICO◇ 7
- Wound dimensions:
  - Length: 11 cm
  - Depth: 3 cm
- Exudate volume: None

Day 4

- Product used: PICO◇ 7
- Exudate volume: None

Day 7

- Completely healed wound
- Exudate volume: None

Case report 8

Patient

A 33-year-old woman received treatment for her closed surgical incision wound with moderate exudate following an elective LSCS surgery. The incision measured 16 cm in length. She a had history of gestational hypertension and gestational diabetes in her previous pregnancy. She also had comorbid obesity and did not receive any additional treatment or undergo further surgical procedures.

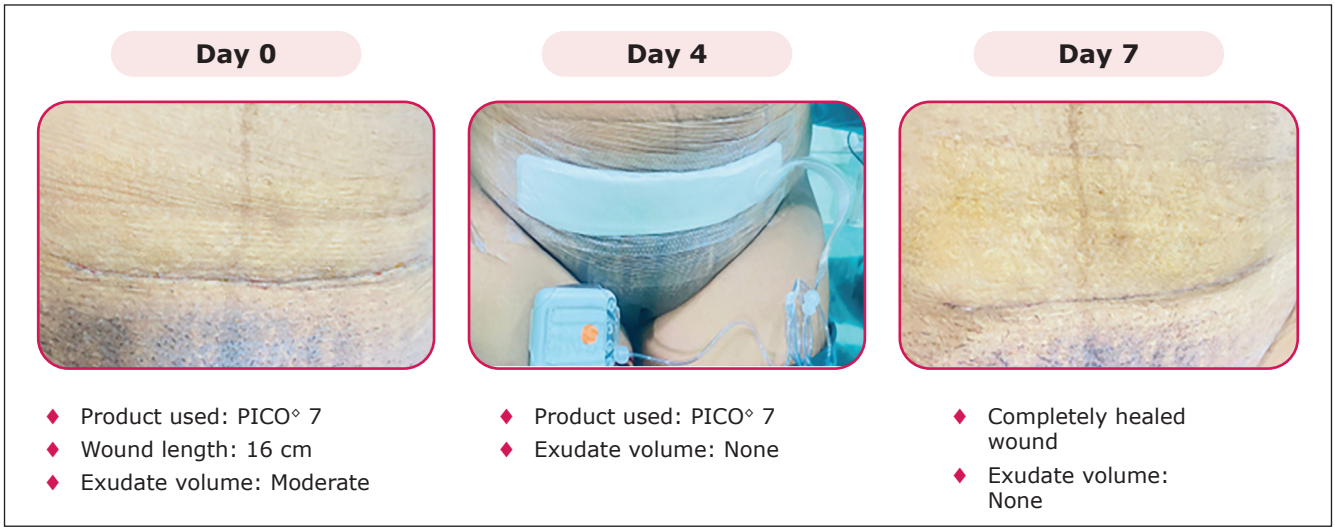
Treatment

PICO◇ 7 dressing was applied in the operation theatre after closing the incision. The total treatment duration was 1 week. The dressing was applied twice a week.

Follow-up/results

The patient was instructed to visit the hospital or clinic 7 days after the intervention for a wound assessment and the removal of the device. A total of two wound assessment visits (Day 4 and Day 7) were conducted. By the end of the treatment on Day 7, the wound had entirely healed without complications. The wound was clean and healthy, with well-approximated edges and no exudate volume present (Figure 8).

Figure 8. Wound healing by application of PICO◇ 7 dressing



Case report 9

Patient

A 35-year-old woman presented with a breech pregnancy at term and was scheduled for elective LSCS surgery. She had a BMI of 40 kg/m^2 and a significant medical history of keloid formation following a knee injury 5 years ago. Preoperatively, her hemoglobin level was 10 g/dL, and she had been diagnosed with gestational diabetes, which was managed with insulin. The surgical procedure involved a low transverse (modified Pfannenstiel) incision. The incision was a clean, intentional surgical wound measuring 10 cm in length and 4 cm in depth (extending into the subcutaneous fat), with moderate volume of exudate.

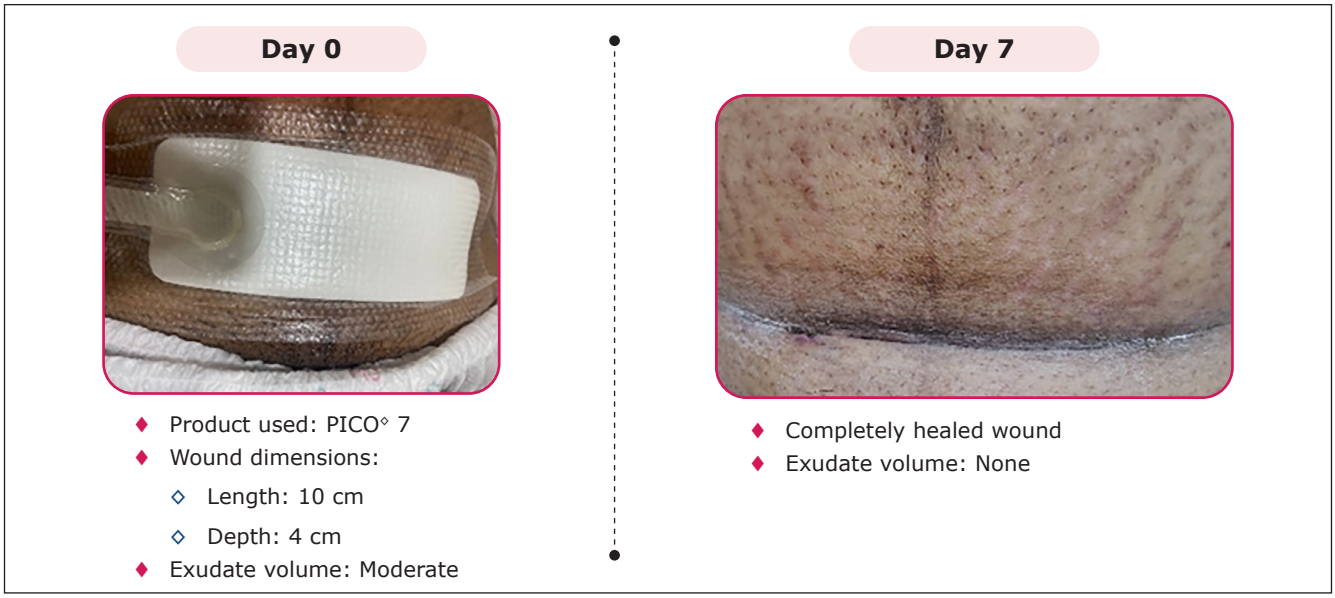
Treatment

Given the patient's history of keloid formation, careful planning was done to ensure optimal wound healing. She was counseled and consented to the use of a PICO◇ 7 dressing to minimize the risk of wound gaping and to improve cosmetic outcomes. The C-section was performed without complications, and subcuticular stitches were used for skin closure. PICO◇ 7 dressing was applied in the operation theatre after closing the incision.

Follow-up/results

The post-operative course was unremarkable. The PICO◇ 7 dressing significantly aided in promoting healing, with no exudate volume. The scar healed beautifully, with no signs of keloid formation, ensuring a favorable cosmetic outcome (Figure 9).

Figure 9. Wound healing by application of PICO◇ 7 dressing



5.3 Discussion and conclusion

The case reports discussed in the present series explored the outcomes of real-world use of PICO◇ 7 dressing in high-risk patients undergoing C-sections. Management of the post-operative incision with sNPWT has been shown to reduce the risk of SSC in high-risk individuals.[7,8,9] The patient population included individuals with pre-existing conditions such as obesity, chorioamnionitis, pre-eclampsia, abdominal wall edema, pancreatitis, gestational diabetes mellitus, multiple fibroids, bronchial asthma, obstructive sleep apnea, cesarean myomectomy (which is associated with higher blood loss), anemia, being a Jehovah's Witness, hypoproteinemia, and deep vein thrombosis. These conditions were categorized as potential high-risk factors for developing SSCs, including SSIs. Obesity was the most common comorbidity observed across all the cases. Although the criteria for defining a patient as high-risk varied, the patient profiles in the case series reflect considerable heterogeneity. This variability should be considered when extrapolating the results to local practice.

PICO◇ 7 dressing was applied prophylactically after closing the incision in high-risk patients undergoing C-section surgery and was also considered during the initial treatment options for these patients. In all the 9 cases, the observed wound outcomes were satisfactory with the use of the PICO◇ 7 device. As illustrated in these cases, the post-operative incision wound healed completely. The patient satisfaction was high, with the excellent appearance of the scar, with no exudate present, no clinical signs of infection, and no visible hematoma or seroma within 1 to 2 weeks of surgery, compared to what has been noted with the standard dressing. All the patients were discharged early and managed under home care. The patients expressed no major concerns about using the device and were happy at not having to come for daily dressings! The post-operative wound recovery was fast. Routine consideration of this specific technology may be included in SSI care bundles to prevent SSIs and dehiscence in at-risk incisional wounds. The clinical use of PICO◇ 7 dressing may enable early mother and baby bonding, prompt discharge, and positively impact the patient's emotional wellbeing.

Key takeaways

- The evidence and clinical experience on the use of PICO◇ 7 sNPWT confirms that clinicians can reduce the risk of SSIs and associated complications in high-risk patients undergoing C-sections compared to the standard dressings.
- The surgical wound in high-risk patients undergoing C-section surgeries was healed completely with PICO◇ 7 sNPWT, which resulted in faster recovery.
- The patients easily understood the portable system, had no issues with the PICO◇ 7 device, and were able to live a normal life.
- The PICO◇ 7 sNPWT system can set a new standard of C-section incision care, potentially transforming postoperative recovery practices.

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Section 5 disclaimer: The case series is intended for informational and educational purposes only. Each patient undergoing treatment is a unique case; therefore, outcomes may vary. These cases may represent different results.

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Reduce risk and uncertainty

50% reduction in relative risk of SSIs
In an RCT of 876 women undergoing C-section with pre-pregnancy BMI ≥ 30, PICO sNPWT significantly reduced the relative risk of SSIs by 50% compared with standard dressings (p=0.007)[1]

Smith+Nephew

PICO◊
Single Use Negative Pressure
Wound Therapy System

IND-A-39-2024

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