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SIMPIOS

Società Italiana Multidisciplinare per la Prevenzione delle Infezioni nelle Organizzazioni Sanitarie

English version

Bundle for the prevention of surgical site infections

December 2024 version

STOP AMR AME SAVE

Approved and endorsed by:

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Associazione Chirurghi Ospedalieri Italiani

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SIAARTI
Società Italiana Anestesia, Analgesia, Rianimazione e Terapia Intensiva

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Società italiana chirurgia plastica ricostruttiva rigenerativa ed estetica

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Società Italiana di Microbiologia

SIMIT
Società Italiana di Malattie Infettive e Tropicali

SItI
Società Italiana di Igiene, Medicina Preventiva e Sanità Pubblica

Bundle for the prevention of surgical site infections

December 2024 version

Istituto Superiore di Sanità
Bundle for the prevention of surgical site infections.
Maria Luisa Moro, Massimo Sartelli, Silvana Gastaldi, Angelo Pan, Francesco Cortese, Stefano Bartoli, Francesco Battistelli, Stefano Berti, Nicola Cillara, Elisa Fabbri, Adriano Grossi, Martin Iurilli, Daniela Pasero, Roberto Parrella Francesco Silvestri, Fortunato "Paolo" D'Ancona
2025, v, 68 p.

The document proposes a set of evidence-based interventions aimed at preventing surgical site infections. Developed in collaboration with Italian scientific societies, the bundle includes five core measures: avoiding hair removal or, if necessary, using an electric razor; administering prophylactic antibiotics before surgical incision and re-administering them during prolonged surgeries; using alcohol-based antiseptics for surgical site preparation; and discontinuing antibiotic prophylaxis after surgery. Additionally, the document discusses supplementary measures to be implemented once the core measures are established, such as screening for *Staphylococcus aureus* and maintaining perioperative normothermia and glycaemic control. The bundle is designed to be adaptable to different surgical settings and includes an implementation strategy that involves staff training and monitoring adherence to the recommended practices.

Istituto Superiore di Sanità
Bundle per la prevenzione delle infezioni del sito chirurgico.
Maria Luisa Moro, Massimo Sartelli, Silvana Gastaldi, Angelo Pan, Francesco Cortese, Stefano Bartoli, Francesco Battistelli, Stefano Berti, Nicola Cillara, Elisa Fabbri, Adriano Grossi, Martin Iurilli, Daniela Pasero, Roberto Parrella, Francesco Silvestri, Fortunato "Paolo" D'Ancona
2025, v, 68 p.

Il documento propone un pacchetto di interventi basati sull'evidenza per prevenire le infezioni del sito chirurgico. Sviluppato in collaborazione con società scientifiche italiane, il bundle include cinque misure principali: evitare la tricotomia o, se necessario, usare un rasoio elettrico; somministrare antibiotici profilattici prima dell'incisione chirurgica e risomministrarli durante interventi prolungati; utilizzare antisettici a base alcolica per la preparazione del sito chirurgico; interrompere la profilassi antibiotica dopo l'intervento. Inoltre, il documento discute misure aggiuntive da implementare una volta consolidate le misure di base, tra cui lo screening per *Staphylococcus aureus* e il mantenimento della normotermia e del controllo glicemico perioperatorio. Il bundle è progettato per essere adattabile a diversi contesti chirurgici e include una strategia di implementazione che comprende la formazione del personale e il monitoraggio dell'adesione alle pratiche raccomandate.

Declaration of conflict of interest
The individuals who prepared this document declare that they have no conflicts of interest regarding its content and objectives.

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Graphic design (cover, layout, infographics) and editing:
Sandra Salinetti (Scientific Communication Unit)

viale Regina Elena, 299 – 00161 Roma

Experts multidisciplinary group composition

Maria Luisa MORO	*Società Italiana Multidisciplinare per la Prevenzione delle Infezioni nelle Organizzazioni Sanitarie*
Massimo SARTELLI	*UO Chirurgia Generale, Ospedale di Macerata, Macerata*
Silvana GASTALDI	*Dipartimento Malattie Infettive, Istituto Superiore di Sanità, Roma*
Angelo PAN	*UOC Malattie Infettive, Ospedale di Cremona, ASST Cremona*
Francesco CORTESE	*UOC Chirurgia d'Urgenza, PO San Filippo Neri, Roma*
Stefano BARTOLI	*UOC Chirurgia Vascolare, Ospedale Sant'Eugenio, ASL Roma 2*
Francesco BATTISTELLI	*Dipartimento di Medicina Clinica, Sanità Pubblica, Scienze della Vita e dell'Ambiente, Università degli Studi dell'Aquila, L'Aquila*
Stefano BERTI	*SC Chirurgia Generale e Oncologica Ospedale Pietro e Michele Ferrero, ASL CN2, Verduno (CN)*
Nicola CILLARA	*UOC Chirurgia Generale Santissima Trinità Hospital, ASL Cagliari*
Elisa FABBRI	*Settore Innovazione nei Servizi Sanitari e Sociali, Regione Emilia-Romagna, Bologna*
Adriano GROSSI	*Dipartimento di Prevenzione, ASL Roma 1, Roma*
Martin IURILLI	*SC Chirurgia Plastica, Azienda Sanitaria Universitaria Giuliano Isontina, Trieste; Dipartimento Universitario Clinico di Scienze Mediche, Chirurgiche e della Salute, Università degli Studi di Trieste*
Daniela PASERO	*Dipartimento di Medicina, Chirurgia e Farmacia, Università degli Studi di Sassari, Sassari; SCDU Anestesia, Terapia Intensiva Multidisciplinare, Rianimazione e Terapia Antalgica, Ospedale Civile Alghero, ASL1, Sassari*
Roberto PARRELLA	*UOC Malattie Infettive ad Indirizzo Respiratorio, AORN Ospedale dei Colli, Napoli*
Francesco SILVESTRI	*USL-IRCCS Arcispedale S. Maria Nuova, Reggio nell'Emilia*
Fortunato "Paolo" D'ANCONA	*Dipartimento Malattie Infettive, Istituto Superiore di Sanità, Roma*

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ACRONYMS

AGREE	Advancing Guideline development, Reporting and Evaluation in health care
CDC	Centers for Disease Control and Prevention (USA)
CHG	Chlorhexidine gluconate
IDSA	Infectious Diseases Society of America (USA)
IHI	Institute for Healthcare Improvement
SSI	Surgical Site infection
ISS	Istituto Superiore di Sanità
MRSA	Methicillin-Resistant *Staphylococcus aureus*
NICE	National Institute for Health and Care Excellence (UK)
PAP	Perioperative Antibiotic Prophylaxis
SHEA	Society for Healthcare Epidemiology of America (USA)
ABHR	Alcohol-based handrub
SIC	Società Italiana di Chirurgia
SIMPIOS	Società Italiana Multidisciplinare per la Prevenzione delle Infezioni nelle Organizzazioni Sanitarie
SNLG	Sistema Nazionale Linee Guida National (National Guidelines System in Italy)
SIOT	Società Italiana di Ortopedia e Traumatologia
WHO	World Health Organization

INTRODUCTION

Surgical site infections represent one of the most common adverse events affecting patients undergoing surgical procedures and, when they occur, they constitute a serious clinical issue [1, 2].

A significant proportion of these infections can be prevented by implementing a set of evidence-based measures aimed at reducing infection risk before, during, and after surgery. A systematic review has shown that up to 55% of SSIs could be prevented through the application of good practices supported by scientific evidence [3].

However, these measures are not adopted uniformly across all healthcare facilities and, even where they are implemented, adherence is often inconsistent and unsystematic [4, 5].

The challenge of translating evidence-based clinical recommendations into practice is well known and is linked to a wide array of barriers that stem from individual professionals, social dynamics, and organizational or economic constraints. Multimodal strategies aimed at promoting the adoption of evidence-based practices – including the use of care bundles – have proven effective in enhancing compliance with good practices and in reducing the rates of surgical site infections [6].

Adapting evidence-based guidelines to the local context can enhance adherence and the practical applicability of best practices, as guidelines alone do not ensure acceptance, utilization, or effective implementation.

As part of a multimodal strategy to prevent healthcare-associated infections, care bundles are among the most commonly employed methods [7].

A care bundle is a small set of evidence-based interventions, behaviors, and/or practices targeted at a specific patient group and care setting. When implemented together and correctly, these interventions exert a synergistic effect, improving the quality and outcomes of care beyond what each measure could achieve individually.

The concept of care bundles was first developed by the Institute for Healthcare Improvement (IHI) in 2001 to support healthcare workers in enhancing the care of patients undergoing high-risk procedures.

In general, a care bundle should adhere to the following core principles:

- Comprise a limited number of evidence-based interventions, ideally of high-level evidence.
- Be easy to apply, simple (typically three to five elements), clear, and concise.
- Promote interdisciplinary collaboration.
- Be implemented collectively, following an "all-or-none" approach to achieve the best outcomes. However, since the individual components are relatively independent, clinical contraindications to one element should not preclude the application of the others.

- Include context-appropriate measures that are routinely monitored to assess compliance by all healthcare personnel involved in the care process.

OBJECTIVE

The objective of this bundle is to provide **guidance for the effective prevention of surgical site infections**, by identifying measures supported by strong scientific evidence which, when adopted jointly, can significantly reduce the risk of infection.

SCOPE OF APPLICATION

This bundle is intended for **all healthcare personnel** directly involved in the prevention of surgical site infections, particularly those working in surgery, anesthesia, and intraoperative care.

It is also addressed to individuals involved in **hospital-based infection prevention and control teams**, as well as to the general population and patients undergoing surgical procedures.

PROPOSED BUNDLE FOR THE PREVENTION OF SURGICAL SITE INFECTIONS

The Istituto Superiore di Sanità (ISS, the National Institute of Health in Italy) – invited by the Observatory for Good Practices in Patient Safety in collaboration with SIMPIOS (Società Italiana Multidisciplinare per la Prevenzione delle Infezioni nelle Organizzazioni Sanitarie - Italian Multidisciplinary Society for the Prevention of Infections in Healthcare Organizations) and with the involvement of several surgical societies, including SIC (Società Italiana di Chirurgia - Italian Society of Surgery), ACOI (Associazione dei Chirurghi Ospedalieri Italiani - Association of Hospital Surgeons of Italy), and AICO (Associazione Infermieri di Camera Operatoria - Association of Operating Room Nurses) – proposes a bundle for the prevention of Surgical Site Infections (SSIs).

The bundle includes **five core measures strongly recommended** across all the guidelines reviewed. These measures constitute the core set – practices that must be systematically adopted in all surgical care settings and that, according to the expert panel, are not yet routinely implemented across all surgical contexts.

A later chapter presents **additional measures** for which the strength of recommendations varies across guidelines, but which may still offer added value in reducing patient risk, as they are supported by evidence and recommended by one or more sources.

In settings where the initial five measures have already become standard clinical practice, the implementation of these additional measures should be encouraged, supported by multidisciplinary strategies that include monitoring adherence by surgical and perioperative care teams.

Hand hygiene – both in the operating theatre and on the ward – is also included in this chapter, despite being a core measure, as adherence appears more widespread. If that is not the case locally, hand hygiene should be included in the local bundle configuration.

Methodology for identifying evidence-based measures

To identify measures supported by strong scientific evidence, a systematic review was conducted of national and international guidelines on the prevention of SSIs published between 2009 and 2023. These guidelines were evaluated using the AGREE protocol (Advancing Guideline development, Reporting and Evaluation in health care) [8] and were considered to be of good methodological quality.

The search for relevant guidelines was carried out in Medline/PubMed and in the National Guidelines System (Sistema Nazionale Linee Guida – SNLG) database managed by the ISS.

The following national and international guidelines were included (for national guidelines, only those listed within SNLG were selected):

- WHO – World Health Organization, 2018
  Global guidelines for the prevention of surgical site infection, 2nd ed. [9];

- CDC – Centers for Disease Control and prevention, 2017
  CDC guideline for the prevention of surgical site infection [10];

- NICE – National Institute for Health and Care Excellence, 2008 and 2019
  Surgical site infections: prevention and treatment. NICE guideline [NG125] [11];

- SHEA – Society for Healthcare Epidemiology of America, 2023
  Strategies to prevent surgical site infections in acute-care hospitals: 2022 Update, guidance document sponsored by SHEA [12];

- SNLG – Sistema Nazionale Linee Guida, 2011
  Antibioticoprofilassi peri-operatoria nell'adulto [13];

- SIOT – Società Italiana di Ortopedia e Traumatologia, 2021
  Prevenzione delle infezioni in chirurgia ortopedica, SIOT guideline, included in the SNLG [14];

Each guideline was reviewed to extract those practices that were strongly recommended.

Appendix A presents a comparative table showing only those care practices that are strongly recommended in at least one of the included guidelines, along with the corresponding strength of recommendation. Some practices are consistently recommended across all sources, while others are supported by only some of them.

For each measure, indicators were also identified to monitor adherence to bundle practices and patient outcomes.

The text also outlines commonly reported barriers and facilitators drawn from the scientific literature.

Methodology for the bundle development

Professional profiles and specializations of the panel

Member	Professional profile	Specialization
Maria Luisa Moro (MLM)	Medical doctor	Public health and hygiene
Massimo Sartelli (MS)	Medical doctor	General surgery
Silvana Gastaldi (SG)	Nurse, Biologist	Infection risk management
Angelo Pan	Medical doctor	Infectious diseases
Francesco Cortese	Medical doctor	Infectious diseases, general surgery
Stefano Bartoli	Medical doctor	Vascular surgery
Francesco Battistelli	Medical doctor	Public health and hygiene
Stefano Berti	Medical doctor	General surgery
Nicola Cillara	Medical doctor	General surgery
Elisa Fabbri (EF)	Nurse	Infection risk management
Adriano Grossi	Medical doctor	Public health and hygiene
Martin Iurilli (MI)	Medical doctor	Plastic and reconstructive surgery
Daniela Pasero	Medical doctor	Anesthesiology and intensive care
Roberto Parrella	Medical doctor	Respiratory infectious diseases
Francesco Silvestri	Nurse	Operating room nurse
Fortunato "Paolo" D'Ancona (FDA)	Medical doctor	Infectious diseases

After MLM and MS identified the SSI prevention measures to be included in the bundle – via a systematic review of guidelines published between 2009 and 2023 – the multidisciplinary panel met initially to approve the strongly recommended measures to include in the bundle. The panel subsequently convened multiple times online to monitor the progress of the work. MS and MLM led the operational aspects of the bundle measures. MLM, SG, and EF were responsible for documenting barriers, facilitators, and indicators. MI and FDA coordinated the methodology for bundle implementation. SG handled editing of the final document. All authors reviewed and formally approved the final version of the text.

Measures included in the bundle

The bundle includes core preventive measures that all Italian hospitals should implement in their clinical practice to ensure the safety of patients undergoing surgery (Figure 1). As previously noted, the bundle includes those measures that are strongly recommended across all reviewed guidelines because they are considered capable of significantly improving patient outcomes. The selection of which measures to include at the local level should take into account the existing degree of adherence to these measures in that specific setting.

The elements of the bundle are descriptive, not prescriptive, to allow for adaptation to the local context.

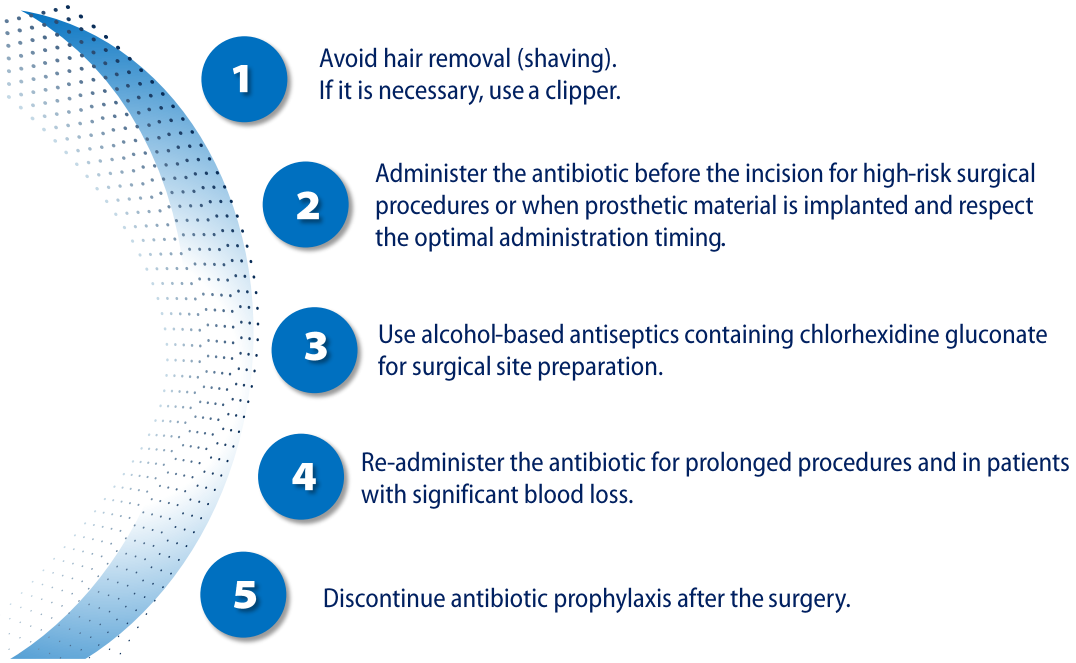

Figure 1: Bundle for the prevention of SSIs

It is important to support the adoption of these measures through multidisciplinary interventions that include monitoring of compliance by healthcare personnel.

The proposed bundle measures and corresponding indicators are detailed in Appendix B. An infographic summarizing the bundle measures suitable for display as a staff reminder – is included in Appendix E1.

1 Avoid hair removal (shaving). If it is necessary, use a clipper

Rationale

Hair removal at the incision site increases the risk of infection due to skin microtrauma caused by traditional razors. The World Health Organization (WHO) [9] reported that avoiding hair removal or using a clipper is associated with a significantly lower risk of SSIs compared to using a traditional razor – a 49% lower infection rate was observed.

All published guidelines unanimously oppose routine preoperative hair removal. When hair removal is deemed necessary – e.g., if the surgeon considers that hair may interfere with the surgical field – guidelines recommend the use of clippers over traditional razors, and that hair removal be performed on the day of the surgery.

Measures to include in the bundle

- Avoid hair removal for all types of surgical procedures.
- If absolutely necessary, use only clippers for hair removal. The use of traditional razors is strongly discouraged in both the preoperative and intraoperative phases.
- When required, perform hair removal immediately before entering the operating theatre.

Barriers to adherence and facilitating factors

To promote adherence to the hair removal recommendations, local implementation should identify specific barriers that hinder adoption. The most frequently reported barriers from the WHO Implementation Manual [15] and actions to address them are as follows:

Barrier	Action
No instructions for patients and families on avoiding hair removal before hospital admission.	Educate patients not to shave the surgical site before admission. Include this information in preoperative leaflets.
Absence of a protocol on hair removal available to the surgical team.	Share a protocol with the surgical team that outlines when shaving is avoidable, mandates electric clippers when necessary, and defines timing.
Reluctance of surgical staff to avoid shaving due to habit or cultural resistance. Extended shaving increases the risk of skin abrasions, colonization, and SSIs.	Weigh the risk of non-glabrous skin in surgery against the increased risk of colonization and infection.
Hair removal performed too early (e.g., the day before instead of just before surgery).	Emphasize the correct timing in standard operating procedures.
Financial or supply constraints that prevent continuous availability of disposable electric clippers.	Replace traditional razors with electric ones across all facilities.
Lack of or inadequate decontamination processes for reusable clippers.	Use single-use clippers or ensure reusable models can be disinfected between patients via replaceable or sterilizable heads.

Surveillance of infections, monitoring of adherence, and feedback of data

- Activate a surveillance/monitoring and feedback system on: the actual availability of single-use clippers; staff knowledge and perceptions regarding the avoidance of hair removal; adherence to the recommended measures for hair removal; the assessment by patients scheduled for surgery of the information tools provided to them; and the incidence of SSIs [9].
- With regard to adherence to the recommended measures for hair removal, use as an indicator the percentage of patients undergoing surgery (out of all surgical procedures performed) who either had hair removal with a clipper or for whom no hair removal was performed: the higher this percentage, the greater the adherence to the recommendation.
- To calculate this indicator, carry out a local survey on a sample of operated patients (≥ 100 surgical procedures per year per specialty) or, where possible, include this information in continuous monitoring systems – for example, integrate it into the operating room checklist or into the preoperative preparation form (if digitalized), in order to enable ongoing data collection.

2 Administer the antibiotic before incision for high-risk surgical procedures or when prosthetic material is implanted and respect optimal administration timing

Rationale

Although numerous clinical practice guidelines on antibiotic prophylaxis have been published, management practices that do not comply with these guidelines are still very common. These may lead to suboptimal outcomes for surgical patients, cause adverse effects, and promote the spread of antimicrobial resistance.

Antibiotic prophylaxis should be administered prior to high-risk surgical procedures for SSIs or when prosthetic material is implanted. The antibiotics prescribed should be non-toxic, inexpensive, and active *in vitro* against the common bacteria responsible for SSIs.

The antibiotic concentration at the surgical site must be adequate from the initial incision to the end of the operation. Administration of Perioperative Antibiotic Prophylaxis (PAP) more than 120 minutes before the incision or after surgery significantly increases the risk of infection. WHO guidelines [9] recommend the administration of PAP before surgical incision when indicated (depending on the type of operation) (strong recommendation supported by low-quality evidence). These guidelines also recommend administering PAP within 120 minutes before the incision, taking into account the antibiotic's half-life (strong recommendation supported by moderate-quality evidence).

The 120-minute window applies especially to longer half-life drugs such as glycopeptides, which should in any case be reserved for selected clinical situations. In particular, the use of glycopeptides should be considered in case of allergy, or where there is a high incidence or high risk of *Staphylococcus aureus* methicillin-resistant (MRSA) infections [14].

NICE guidelines [11] recommend, before performing antibiotic prophylaxis, to consider timing, pharmacokinetics, and the infusion time required for the antibiotic. NICE [11] also recommends administering an additional dose of antibiotic when the operation exceeds the half-life of the administered antibiotic.

Measures to include in the bundle

- Administer PAP, when indicated (depending on the type of surgery), before surgical incision (within the 120 minutes preceding the incision). The appropriate timing within this time window depends on the half-life of the antibiotic used. In particular, the use of glycopeptides should be considered in case of allergy, or where there is a high incidence or high risk of MRSA infection [14].
- For caesarean section, administer PAP before skin incision rather than after cord clamping.

Barriers and facilitating factors

To promote adherence to the recommendations, it is necessary to assess, in the local context, which barriers may hinder the adoption of this measure. Below are the most frequently reported barriers in the literature [15] and some actions that may help to overcome them.

Barrier	Action
Absence of adequate PAP protocols, including proper administration timing.	Develop, with the contribution of management, pharmacy, infection control and antimicrobial stewardship personnel, and surgical staff, an updated and detailed local protocol that is easily accessible to all staff.
Unclear roles and responsibilities for the correct application of the PAP protocol.	Develop the local protocol with shared input, clearly defining responsibilities and roles.
Lack of knowledge about the evidence supporting the need for intravenous PAP administration within 120 minutes before incision.	Activate a mechanism to produce and update information and training for staff on the protocol, including supporting scientific evidence and promoting focus groups to enable staff discussions.
Improper storage of antibiotic supplies, hindering timely PAP administration.	Ensure an appropriate mechanism to guarantee the availability of the required antibiotics.
Lack of resources to guarantee proper prophylaxis.	Ensure, through hospital management, the necessary resources to implement the new protocol.

Surveillance of infections, monitoring of adherence, and feedback of data

- Activate a system of surveillance/monitoring and feedback on: knowledge and perceptions of staff on PAP; availability of the necessary antibiotics; adherence to recommended measures for PAP; antibiotic consumption for PAP; incidence of SSIs [9].
- Consider using the following indicators for surveillance/monitoring:
    - existence of an updated protocol on specific indicators;
    - percentage of procedures with appropriately administered antimicrobial prophylaxis = (number of patients undergoing surgery who received appropriate PAP / total number of selected surgical procedures) × 100.

      Appropriateness is defined by the presence of at least one of the following criteria:
        - indication for prophylaxis consistent with the protocol,
        - appropriate antibiotic selection for the type of procedure,
        - correct antibiotic dose administered;
    - antibiotic initiated within 1 hour before incision (with some exceptions: e.g. 2 hours allowed for vancomycin, in accordance with peak plasma concentration and permitted infusion rate for the drug).
- To calculate these indicators, base the analysis on data recorded in the operating register or clinical record. If these tools are digitalized, systematic monitoring is possible. Alternatively, conduct a local survey on a sample (≥100 surgeries/year per specialty).

3 Use alcohol-based antiseptics containing chlorhexidine gluconate for surgical site preparation

Rationale

Another key component in the prevention of SSIs is meticulous preoperative skin antisepsis. The goal is to minimize the bacterial load on the skin of the person undergoing surgery – both commensal and pathogenic bacteria such as *Staphylococcus aureus*. This significant reduction, achieved through adequate skin antisepsis, limits the risk of SSIs.

Current evidence demonstrates that alcohol-based preparations containing chlorhexidine Gluconate (CG) are more effective than aqueous solutions and should be used unless contraindicated. However, the choice of the most appropriate alcohol-based solution remains debated. With the exception of the CDC [10] and SIOT [14] guidelines, all others, including WHO, recommend the use of chlorhexidine in an alcohol-based solution.

The meta-analysis conducted by WHO experts [9] included 17 randomized controlled trials. Six of these compared alcohol-based chlorhexidine solutions with alcohol-based povidone-iodine solutions and found a significantly lower risk of SSIs with chlorhexidine-based formulations. However, in most of these studies, SSIs were not the primary endpoint.

The NICE guidelines [11] suggest alcohol-based chlorhexidine solutions as the first choice, unless contraindicated or if the surgical site is near a mucous membrane. The 2017 CDC guidelines [10] and the SIOT guideline recommend the use of alcohol-based antiseptic solutions without distinguishing between chlorhexidine- or povidone-iodine–based formulations.

At the same time, alcohol-based antiseptics are flammable and should be allowed to dry completely (about three minutes, longer in areas with excessive hair) to reduce the risk of fires.

Measures to include in the bundle

- Use alcohol-based antiseptics containing CG for skin preparation in persons undergoing surgical procedures, or in any case, antiseptics in alcohol-based solution.

Barriers and facilitating factors

To promote adherence to the recommendations, it is necessary to evaluate what the local barriers are that hinder the adoption of this measure. Identifying the most relevant barriers will allow for effective interventions to overcome them. Below are the most frequently reported barriers in the literature [15] and some actions that may help to address them.

Barrier	Action
Lack of resources to prioritize the procurement of alcohol-based antiseptic solutions containing chlorhexidine or difficulty in acquiring them.	Organize a reliable system to ensure the availability of required antiseptic solutions, providing the resources necessary to achieve this goal.
Absence of a standard operating protocol for adequate surgical site skin preparation.	Define, in collaboration with surgical staff, a local protocol based on scientific evidence, updated, and readily available to all staff.
Lack of awareness regarding the superior effectiveness of alcohol-based solutions over aqueous formulations for surgical site preparation.	Establish a reliable mechanism to inform and train all staff on proper skin preparation techniques, including evidence-based practices. Provide scientific literature supporting the use of alcohol-based chlorhexidine solutions.
Reluctance by surgeons to use colorless solutions that do not delineate the surgical site.	Facilitate discussions to find solutions and overcome this obstacle.
Concerns about potential adverse effects from using alcohol and/or CG-containing solutions (e.g., skin tolerance, allergies, religious beliefs, fire risk).	Provide evidence on actual documented risks and how to mitigate them.

Surveillance of infections, monitoring of adherence, and feedback of data

- To monitor adherence to this measure, use the following indicator: proportion of surgical procedures in which alcohol-based antiseptics containing CG were used.
- To calculate this indicator, base the analysis on data recorded in the operating room register or clinical record. If these tools are digitalized, systematic monitoring is possible. Alternatively, a local survey can be conducted on a sample (≥ 100 surgeries/year per specialty).

4 Re-administer the antibiotic for prolonged procedures and in patients with significant blood loss

Rationale

All guidelines recommend re-administering the antibiotic for prolonged procedures and in patients with significant blood loss.

Most antibiotics used for PAP have short half-lives (1-2 hours). For this reason, from a pharmacokinetic perspective, additional intraoperative doses should be administered for procedures lasting more than twice the antibiotic's half-life or when there is significant associated blood loss (more than 1,500 mL), to maintain effective antibiotic concentrations at the surgical site throughout the operation [9, 16, 17, 18].

Measures to include in the bundle

- In the case of long-duration procedures, re-administer an intraoperative dose if the operation is still in progress at a time equivalent to twice the half-life of the drug used.
- Administer an additional intraoperative antibiotic dose (after fluid resuscitation) in adult patients if, during the intervention, blood loss exceeds 1,500 mL or there is haemodilution exceeding 15 mL/kg.

Barriers and facilitating factors

To promote adherence to the recommendations, it is necessary to assess, in the local context, which barriers hinder adoption of this measure. Investigate whether the failure to re-administer the antibiotic during surgery is due to cultural, knowledge-based, or organizational factors and identify appropriate solutions to address them [15].

Surveillance of infections, monitoring of adherence, and feedback of data

- To monitor adherence, consider using the following indicator: percentage of patients undergoing surgery who receive appropriate re-administration of prophylactic antibiotics in cases of prolonged procedures or massive blood loss.
- To calculate this indicator, base the analysis on data recorded in the operating register or clinical record. If these tools are digitalized, systematic monitoring is possible. Alternatively, conduct a local survey on a sample (≥100 surgeries/year per specialty).

5 Discontinue antibiotic prophylaxis after surgery

Rationale

The WHO global guidelines [9] recommend not prolonging the administration of antibiotic prophylaxis after the surgical procedure is completed for the purpose of preventing SSIs. In developing its meta-analysis [9], the WHO panel identified a total of 69 randomized controlled trials investigating the optimal duration of antibiotic prophylaxis. The meta-analysis identified some evidence – rated as low to very low quality – that prolonged postoperative antibiotic administration (e.g., for 24 hours after surgery) might reduce the risk of SSIs in cardiac and vascular surgery compared to single-dose prophylaxis. Given the limited and low-to-very-low-quality evidence in support of prolonged prophylaxis in these procedures and considering the potential harms associated with extended antibiotic use, the panel decided to recommend discontinuing antibiotics after completion of the operation.

CDC guidelines [10] also recommend, in clean and clean-contaminated procedures, not to administer additional doses of prophylactic antibiotics once the surgical incision has been closed, even in the presence of a drain (strong recommendation supported by high-to-moderate-quality evidence).

The SIOT guideline [14] reiterates the efficacy of PAP. Prolongation of PAP beyond 24 hours is ineffective in reducing infection incidence and is associated with increased costs, risk of systemic toxicity, risk of *Clostridioides difficile* colitis, and negative effects on the microbiome (at individual and community level), increasing antimicrobial resistance [14]. According to this guideline [14], the possibility of issuing a more definitive recommendation supporting single-dose prophylaxis remains open. This issue is more clearly defined by a meta-analysis published in 2020 on the effect of prolonged prophylaxis on SSI incidence, published in *The Lancet Infectious Diseases* by de Jonge et al. [19]. The study evaluated 83 relevant randomized trials, of which 52 (19,273 participants) were included in the primary meta-analysis. Overall, no conclusive evidence supported continued postoperative antibiotic prophylaxis over discontinuation. When good clinical practice standards were followed, continued postoperative prophylaxis provided no additional benefit in reducing SSIs. These findings support the recommendation not to continue antibiotic prophylaxis after surgery.

A multicenter national retrospective cohort study published in 2019 [20] found that prolonged antibiotic prophylaxis was associated with increased risk of acute kidney injury and *Clostridioides difficile* infection, without reducing SSIs.

Measures to include in the bundle

- Discontinue antibiotic administration after closure of the incision in the operating theatre.
- Do not administer additional doses after closure of the incision, even in the presence of a drain.

Barriers and facilitating factors

To promote adherence to the recommendations, it is necessary to assess, in the local context, which barriers hinder adoption of this measure. Identifying the most relevant barriers will allow for effective interventions to overcome them. Below are the most frequently reported barriers in the literature [15] and some actions that may help to address them

Barrier	Action
Inappropriate beliefs about the benefits of extending PAP beyond the recommended duration, leading to a flawed risk-benefit assessment of the intervention.	Investigate the reasons for not discontinuing PAP after the end of surgery
Misplaced perception of wanting to be "on the safe side" for the patient	

Surveillance of infections, monitoring of adherence, and feedback of data

- To monitor adherence to this measure, use the following indicator: proportion of surgical procedures in which PAP was discontinued at the end of the operation [21].
- To calculate this indicator, base the analysis on data recorded in the operating register or clinical record. If these tools are digitalized, systematic monitoring is possible. Alternatively, conduct a local survey on a sample (≥100 surgeries/year per specialty).

ADDITIONAL MEASURES
to be considered only after implementation of the core bundle measures

In care settings where the initial five measures have already become clinical routine, the adoption of these additional measures should be promoted, supported by multidisciplinary interventions that also include monitoring of adherence by healthcare personnel. The proposed additional measures, together with related actions and indicators, are presented in Appendix C, and an infographic is available in Appendix E2.

The proposed additional measures are listed in Table 1.

Table 1. Additional measures to be considered only after implementation of the core bundle measures

Phases	Additional measures
PREOPERATIVE	Inform the patient scheduled for surgery
	Perform screening and decolonization of patients colonized with *Staphylococcus aureus*
INTRAOPERATIVE	Properly perform surgical hand/arm antisepsis by the surgical team
	Maintain perioperative normothermia with a target temperature >36°C
	Maintain intraoperative glycemic control with blood glucose target levels <150 mg/dL during the 24-48 hours after surgery

Pre-operative measures

Inform the patient scheduled for surgery

Rationale

Both the 2008 NICE guidelines (updated in 2019) [11] and the 2022 SHEA guidelines [12] emphasize the importance of informing and educating surgical patients and their families about the risks of contracting an SSI, the measures the facility adopts to reduce such risks, and how the infection will be treated should it occur. It is also important to educate patients on the behaviors to adopt before surgery (e.g., avoid shaving the surgical site) and after surgery (e.g. correct wound care after discharge and early recognition of signs and symptoms of a potential infection).

Additional measures

- Provide clear and consistent information to patients and their families about SSI prevention.
- Inform and educate patients and their families about the following:
    - risk of contracting an SSI;
    - measures adopted by the facility to minimize such risks;
    - management plan in case the patient develops an infection;
    - correct wound care procedure after discharge;
    - early recognition of signs and symptoms of a potential infection;
    - possible antibiotic administration after the surgical procedure.

Barriers and facilitating factors

To promote adherence to the recommendations, it is necessary to assess, in the local context, which barriers hinder the adoption of this measure. Identifying the most relevant barriers will allow for effective interventions to overcome them. Below are the most frequently reported barriers in the literature [15] and some actions that may help to address them.

Barrier	Action
Use of technical and complex language that may be difficult for patients to understand. This language barrier can cause confusion and anxiety, undermining patients' ability to make informed decisions.	Train staff to use clear, accessible language for patients, avoiding excessive medical jargon. Develop written or multimedia informational materials using plain language to help patients better understand the surgical information.
Absence of clear, comprehensive brochures for patients and families on infection risk and appropriate behaviors before and after surgery.	Develop information brochures and assess their clarity by testing them on a limited number of surgical patients.
Lack of time for in-depth communication with patients regarding upcoming surgical procedures. Rushed interactions may reduce the quality of the information provided and leave little room to answer patient questions.	Create opportunities for dedicated consultation sessions where surgical patients can meet with the surgical or medical team to discuss their procedure in detail. Schedule these sessions in advance to ensure enough time to address patient questions and concerns. Assigning dedicated staff to support the patient throughout the process may also be helpful, providing further information and support when needed.

Surveillance of infections, monitoring of adherence, and feedback of data

To ensure that this information is effectively delivered and understood by surgical patients, it is necessary to activate monitoring on the information actually provided, using the following specific indicators:

- percentage of patients undergoing surgery, out of all surgeries performed, who were informed not to shave the surgical site before hospital admission;
- percentage of patients, out of all those undergoing surgery, who were given the specific preoperative informational brochure.

These data should be collected through local surveys on a sample of at least 100 surgical procedures per year per specialty. These measurements allow monitoring of the effectiveness of communication and education provided to patients during the surgical care process and support data-driven improvements.

Perform screening and decolonization of patients colonized with *Staphylococcus aureus*

Rationale

Screening and decolonization of *Staphylococcus aureus* carriers, whether for selected procedures (e.g., cardiac and orthopedic surgeries) or for all surgical procedures (particularly those involving prosthetic implants) are strongly recommended by the 2018 WHO guidelines [9] and the recent SHEA/IDSA guidelines [12]. The 2017 CDC guidelines [10] do not address this topic, while the 2021 SIOT guidelines [14] conclude that recommendations are inconsistent on this matter.

The WHO [9] and SHEA/IDSA [12] guidelines strongly recommend this practice because *S. aureus* is the most frequently isolated pathogen in SSIs, and a systematic review on the effectiveness of 2% mupirocin decolonization showed significant benefits in colonized patients. Evidence is stronger for cardiac and orthopedic surgeries, but other surgical patients may also benefit from this practice. Screening and decolonization are therefore strongly recommended for those undergoing cardiac or orthopedic surgery and conditionally recommended (based on local assessment) for other types of procedures.

The SHEA/IDSA guidelines [12] also strongly recommend screening and decolonization for patients undergoing cardiac or orthopedic surgeries, or other interventions involving the implantation of prosthetic material.

Use of nasal mupirocin in combination with whole-body washing with chlorhexidine should be considered prior to procedures where *S. aureus* is a likely causative agent of SSIs. This decision should be made at the local level, considering the type of procedure, individual patient risk factors, the potential for adverse events in neonates or preterm infants, and the infection's potential impact [9].

Additional measures

- Perform preoperative screening for individuals undergoing cardiothoracic and orthopaedic surgery and, if they are identified as nasal carriers of *S. aureus*, initiate preoperative treatment with 2% mupirocin nasal ointment. The treatment should be repeated twice daily for 5–7 days before the procedure, plus one additional application in the immediate preoperative period

on the day of surgery. Body washing with 2-4% CG soap may be used in combination with nasal mupirocin application [9]. There is no need to perform follow-up swabs to assess the effectiveness of decolonization [9].

- Screen and decolonize also those undergoing other surgical procedures involving the implantation of prosthetic material, subject to local evaluation.
- Maintain surveillance on antibiotic resistance associated with mupirocin use.

Barriers and facilitating factors

To promote adherence to the recommendations, it is necessary to assess, in the local context, which barriers hinder adoption of this measure. Below are the most frequently reported barriers in the literature [15] and some actions that may help to address them.

Barrier	Action
Lack of high-quality laboratory support to perform screening and identify colonized individuals.	Ensure laboratory support for screening by providing specific resources and full laboratory involvement.
Lack of resources to prioritize screening and/or ensure the availability of 2% mupirocin ointment.	Develop a system to guarantee the necessary resources and organizational changes to enable screening and decolonization.
Difficulty in acquiring 2% mupirocin ointment.	Identify solutions to ensure mupirocin availability.
Absence of protocols for conducting timely screening and treatment in the preoperative period, including in outpatient settings.	Develop an operational protocol with instructions for collecting the necessary samples to identify nasal colonization with S. aureus and for administering the decolonization treatment, including roles and responsibilities.
Patient fears of being stigmatized or identified as a potential infection source.	Provide patients with adequate information on the purpose of screening and the benefits of decolonization.
Concerns about antimicrobial resistance as a significant potential side effect associated with mupirocin use.	Monitor resistance trends and provide feedback to the surgical team.
Concerns about possible adverse effects associated with chlorhexidine-containing solutions (e.g., skin irritation, delayed reactions such as contact dermatitis and photosensitivity, and rare hypersensitivity reactions like anaphylactic shock).	Develop a training program providing scientific evidence on these issues.

Surveillance of infections, monitoring of adherence, and feedback of data

To monitor adherence to this measure, activate a system of monitoring and feedback on the following:

- knowledge of healthcare workers involved regarding the rationale for this intervention and protocol contents;
- actual availability and consumption of mupirocin ointment;
- adherence to the protocol;
- local epidemiology of mupirocin resistance in *Staphylococcus aureus*;
- incidence of SSIs.

To monitor these aspects, conduct a *survey* among the involved healthcare personnel, also investigating the actual availability of mupirocin. To evaluate adherence to the protocol, conduct a local survey on a sample of patients undergoing surgery (≥100 surgeries/year per specialty) or, where feasible, include this information in continuous data collection systems, e.g., by integrating it into the operating theatre checklist or the digital preoperative patient assessment form, so that data can be collected continuously for all surgical patients.

Intra-operative measures

Properly perform surgical hand/arm antisepsis by the surgical team

Rationale

Surgical hand washing is performed with an antiseptic soap and is required before any invasive surgical procedure. Its purpose is to eliminate transient microbial flora, reduce resident flora, and inhibit bacterial regrowth under gloves. The use of sterile gloves does not replace surgical handwashing. Surgical hand preparation is crucial to minimize contamination of the surgical field, especially in the event of glove perforation during procedures. WHO hand hygiene guidelines published in 2009 [22], along with all other national and international guidelines on SSI prevention, recommend adequate surgical hand preparation.

The recent SHEA/IDSA guidelines [12] also recommend using an appropriate antiseptic agent for preoperative surgical hand antisepsis. For most products, hands and forearms should be scrubbed for 2–5 minutes.

WHO guidelines [9] recommend that surgical hand preparation be performed either with antiseptic soap and water or by rubbing with an appropriate alcohol-based handrub prior to donning sterile gloves.

Additional measures

- Ensure that anyone entering the operating block performs hand hygiene before entry, following the WHO's 5 Moments. If hands are visibly soiled with organic material, they should be washed with soap and water [22].
- Perform surgical hand antisepsis using either a suitable antimicrobial soap or an Alcohol-Based HandRub (ABHR), preferably one with prolonged activity, prior to donning sterile gloves [9].
- When performing surgical hand antisepsis with antimicrobial soap, wash hands and forearms for the duration recommended by the manufacturer – generally 2-5 minutes. Prolonged scrubbing is not necessary [9].
- When using an alcohol-based product with prolonged activity, follow the application time recommended by the manufacturer. Apply the product only to dry hands. Do not combine scrubbing with soap and subsequent application of ABHR in a single preoperative procedure [9].
- When using an ABHR, apply a sufficient amount to keep hands and forearms wet during the entire hand preparation procedure [9].
- After ABHR application, allow hands and forearms to dry completely before putting on sterile gloves [9].
- Wash hands before the first scheduled surgery using an ABHR, and ensure that hands and nails are visibly clean [9].
- Before subsequent procedures, use an alcohol-based handrub or an antiseptic surgical solution [9].
- If hands are visibly dirty, rewash them using an antiseptic surgical solution [9].

Barriers and facilitating factors

To promote adherence to the recommendations, it is necessary to assess, in the local context, which barriers hinder adoption of this measure. Identifying the most relevant barriers will allow for effective interventions to overcome them.

Below are the most frequently reported barriers in the literature [15] and some actions that may help to address them.

Barrier	Action
Lack of resources to prioritize procurement of ABHR and/or antimicrobial soap.	Implement a sustainable procurement system by assigning responsibilities and including a dedicated budget.
Difficulty in sourcing ABHR.	
Absence of standard procedures for correct surgical hand preparation.	Develop standard operating procedures that specify products and techniques in accordance with WHO hand hygiene guidelines, and create dedicated training programs.
Lack of knowledge about the efficacy of ABHR for surgical hand preparation, leading to reluctance to use it among surgical teams.	Implement training strategies on proper surgical hand preparation techniques, including evidence supporting alcohol-based hand hygiene and all related topics covered by WHO guidelines (e.g. avoiding nail brushes).
Concerns about adverse effects associated with ABHR (e.g. skin tolerance, occupational health risks, religious concerns, fire hazards).	Conduct tolerance testing and communicate results to staff.

Surveillance of infections, monitoring of adherence, and feedback of data

To monitor adherence to this measure, implement:

- a system for monitoring and feedback (including roles and responsibilities) regarding:
    - knowledge of staff on surgical hand preparation;
    - continuous procurement of ABHR and antimicrobial soap;
    - consumption of ABHR and antimicrobial soap;
    - tolerance and acceptability of hand preparation solutions;
    - correct surgical hand preparation;
    - SSI incidence;
- systems for assessing proper execution of surgical hand/arm antisepsis by the surgical team;
- monitoring and feedback on ABHR consumption in the previous year per 1,000 patient-days. Data can be obtained from hospital pharmacy or ward records.

Maintain perioperative normothermia with a target temperature >36°C

Rationale

Even mild degrees of hypothermia can increase the risk of SSIs. Hypothermia can directly impair neutrophil function or indirectly compromise it by triggering subcutaneous vasoconstriction and resulting tissue hypoxia. In addition, hypothermia can increase blood loss, leading to wound hematomas or the need for transfusions – both of which are factors that can increase SSI incidence [23].

The WHO guidelines [9] suggest the use of warming devices in the operating room and during the surgical procedure to warm the patient's body to reduce SSIs (conditional recommendation supported by moderate-quality evidence). The CDC [10] also recommends maintaining perioperative normothermia (strong recommendation supported by high-to-moderate-quality evidence).

The WHO working group's meta-analysis [9] identified two prospective randomized trials comparing systemic warming to maintain normothermia vs. no warming, for the purpose of SSI prevention.

The evidence, rated as moderate quality, showed that systemic warming was beneficial in reducing the risk of SSI compared to no warming. It should be noted, however, that this analysis has limitations, as it is based on only two studies with relatively small sample sizes and populations undergoing only clean or contaminated surgical procedures.

The CDC guidelines [10] did not find sufficient evidence to evaluate strategies for achieving and maintaining normothermia, the lower limit of normothermia, or the optimal timing and duration of normothermia for preventing SSIs.

Given that "hypothermia" refers to an internal body temperature <36°C, an accepted target is to maintain a core temperature >36°C throughout the perioperative period, although the SHEA/IDSA guidelines [12] lower this threshold to 35.5°C.

Additional measures

In the operating room

- Maintain ambient temperature between 20-24°C.
- Use forced-air warming blankets or a warm blanket covered by a warm sheet.
- Check and record temperature every 30 minutes.
- Ensure the patient is adequately covered throughout the entire procedure.
- Warm infusion fluids and blood products to 37°C for procedures >1 hour.
- Irrigation fluids, including those used for colorectal irrigation, should be between 38-40°C.

- For all high-risk patients undergoing surgery, use forced-air warming.
- Set the forced-air warming temperature to maximum, then reduce it to maintain a body temperature ≥36.5°C.

After transfer to the post-anesthesia care unit

- Check temperature every 15 minutes.
- If temperature drops below 36°C, adequately warm the patient until reaching ≥36°C or until the patient feels warm.

In the ward

- Measure temperature on arrival and then every 4 hours.
- If temperature drops below 36°C, use forced-air warming until the patient feels warm; measure temperature every 30 minutes.

Barriers and facilitating factors

To promote adherence to the recommendations, it is necessary to assess, in the local context, which barriers hinder adoption of this measure. Identifying the most relevant barriers will allow for effective interventions to overcome them. Below are the most frequently reported barriers in the literature [15] and some actions that may help to address them.

Barrier	Action
Failure to recognize hypothermia as a risk factor for SSIs and other complications.	The facility should initiate a decision-making and resource-assessment process to evaluate the use of body-warming devices in the operating room and during surgery, in order to prevent intraoperative hypothermia and reduce the risk of SSIs.
Lack of resources to monitor temperature in the ward and to acquire devices for adequately warming surgical patients.	
Lack of protocols for intra- and postoperative temperature monitoring.	Develop an operational procedure and training pathways that include: - actions to prevent hypothermia; - patient temperature monitoring during surgery; - characteristics and use of available devices (hands-on sessions with identified devices and their positioning).

Surveillance of infections, monitoring of adherence, and feedback of data

To monitor adherence to this measure:

- Implement/improve a monitoring, reporting, and feedback mechanism (including roles and responsibilities) regarding:
    - identification of patients at risk of postoperative hypothermia;
    - standard monitoring of postoperative patient temperature;
    - frequency of unavailable warming devices when needed;
    - SSI incidence.
- Integrate active and passive warming strategies into preoperative briefings or checklists:
    - where possible, aim to establish a data collection system to examine patients with postoperative complications associated with hypothermia (especially if warming practices do not improve).
    - to ensure monitoring of this measure, record the percentage of patients undergoing surgery with general anesthesia (excluding procedures where hypothermia is intentionally induced, such as coronary artery bypass grafting) lasting at least 60 minutes, among all surgeries performed, in whom the intraoperative temperature was 36–38°C (rectal) or 35.5–37.5°C (non-rectal) within 1 hour of surgery completion. This data may derive from local surveys on a sample of at least 100 surgeries/year per specialty.

Maintain intraoperative glycemic control with blood glucose target levels <150 mg/dL during the 24-48 hours after surgery

Rationale

Blood glucose levels increase during and after surgery due to surgical stress. Surgery induces stress that triggers the catabolic release of hormones and inhibits insulin. Additionally, surgical stress affects pancreatic beta-cell function, resulting in lower plasma insulin levels.

WHO global guidelines [9] recommend the use of perioperative blood glucose control protocols for both diabetic and non-diabetic adult patients undergoing surgery to reduce the risk of SSIs (conditional recommendation supported by low-quality evidence).

In these guidelines, low-quality evidence shows that protocols with blood glucose targets significantly reduce SSI risk compared to conventional protocols. However, the WHO working group concluded that the available evidence does not allow for identification of an optimal blood glucose target.

The CDC guidelines [10] recommend implementing perioperative glycemic control and using blood glucose target levels below 200 mg/dL in patients with and without diabetes (strong recommendation, category IA; high-to-moderate-quality evidence). The guidelines did not

identify high-quality studies assessing targets lower than <200 mg/dL or narrower target ranges than those recommended, nor did they define optimal timing, duration, or delivery method for perioperative glycemic control to prevent SSIs.

The recent SHEA guidelines [12] considerably narrow the recommended range, setting it between 110 and 150 mg/dL, and specify that there is no evidence supporting a time window longer than 24–48 hours after surgery.

Published guidelines recommend blood glucose target levels below 150 mg/dL to reduce SSI incidence in both diabetic and non-diabetic patients. However, the available evidence is of low quality, and hypoglycemic events must be avoided through tight glycemic control.

Additional measures

- Use protocols for perioperative blood glucose monitoring in adult patients – both diabetic and non-diabetic – undergoing surgical procedures to reduce the risk of SSIs.
- Check blood glucose levels in all surgical patients during the immediate postoperative period.

Barriers and facilitating factors

To promote adherence to the recommendations, it is necessary to assess, in the local context, which barriers hinder the adoption of this measure. Identifying the most relevant barriers will allow for effective interventions to overcome them. Below are the most frequently reported barriers in the literature [15] and some actions that may help to address them.

Barrier	Action
Lack of understanding of the importance of hyperglycemia and its effect on SSIs.	Initiate a decision-making process within the facility to assess the use of protocols for intensive perioperative glycemic control in both diabetic and non-diabetic adult patients undergoing surgical procedures. This process should also define responsibilities and required budget.
Lack of materials and resources to regularly and appropriately monitor intra- and postoperative blood glucose levels.	
Discomfort or limited familiarity with glucose monitoring protocols.	Develop/adapt an evidence-based protocol to implement and/or standardize this practice and ensure it is performed safely. Training should include: • blood glucose monitoring; • use of intensive perioperative glycemic control; • prevention and management of hypoglycemia.
Lack of skills for managing intensive perioperative glycemic control.	

Surveillance of infections, monitoring of adherence, and feedback of data

Implement/improve a monitoring, reporting, and feedback mechanism (including roles and responsibilities) concerning:

- staff compliance with perioperative glycaemic management protocol;
- availability of resources to monitor blood glucose levels;
- any adverse events related to protocol use.

To ensure monitoring of this measure, it should be recorded the percentage of patients undergoing surgery (out of all surgeries performed) in which an intensive glycemic control protocol was adopted and blood glucose levels were monitored. This data may derive from a local survey on a sample of at least 100 surgeries/year per specialty.

SUGGESTED INDICATORS

Table 2 schematically summarizes the suggested indicators for the monitoring and annual evaluation of the SSI prevention measures, presented in logical-temporal order according to the phases of the surgical procedure.

The indicators are divided into process and outcome indicators, and, where possible, include:

- numerator,
- denominator,
- population to include.

The ideal target for the process indicators included in the bundle is 95%.

However, this value may vary depending on context, baseline conditions of implementation, type of surgical procedure, feasibility, etc.

This target does not take into account any specific standards set by regulations or local directives that may have been issued for similar or other purposes.

As for the outcome indicator on SSI incidence, it is not possible to define a single target, as the expected rate varies depending on the type of procedure and patient characteristics. In any case, SSI incidence does not depend solely on bundle implementation.

Table 2. SSI: suggested indicators for monitoring and evaluating prevention measures on an annual basis

Indicator	Type	Numerator	Denominator	Population to be included
% of people without hair removal or with clipper hair removal	Process	No. of people undergoing surgery without hair removal or with clipper	Total number of people undergoing surgery	Entire population or a sample
% of people with hair removal, if necessary, performed on the day of surgery	Process	No. of people who underwent hair removal on the day of surgery	Total number of people with hair removal during surgery	Entire population or a sample
% of people who received antibiotics within 120 minutes before incision	Process	No. of people who received antibiotics within 120 minutes before surgical incision	Total number of people indicated for antibiotic prophylaxis	Entire population or a sample
% of surgeries with skin preparation using alcohol-based antiseptics containing CG	Process	No. of surgeries using alcohol-based antiseptics containing CG	Total number of surgeries performed	Entire population or a sample
% of surgeries with antibiotic prophylaxis stopped at the end of the operation	Process	No. of surgeries with antibiotic prophylaxis stopped at the end	Total number of surgeries with PAP	Entire population or a sample
% of people who received antibiotic re-dosing during prolonged surgery	Process	No. of people receiving antibiotic re-dosing during prolonged surgery	Total number of people with prolonged surgeries	Entire population or a sample
Incidence of SSI	Outcome	Number of people with a confirmed SSI within 30 days after surgery (or 90 days in the case of procedures involving implantation of prosthetic material	Total number of surgical procedures performed belonging to the category of surgeries under surveillance.	Entire target population
% of people adequately informed about SSI prevention	Process	No. of people informed with brochures or pre-operative briefings	Total number of people undergoing surgery	Entire population or a sample
% of high-risk people screened for *S. aureus* colonization	Process	No. of high-risk people screened	Total number of high-risk people	Entire population or a sample
% of surgical staff performing hand antisepsis according to protocol	Process	No. of surgical staff compliant with hand antisepsis guidelines	Total surgical staff in operating room	Entire population or a sample
% of people maintained at target temperature (>36°C) during surgery	Process	No. of people maintained at >36°C during surgery	Total number of people undergoing surgery	Entire population or a sample
% of people with blood glucose control during the immediate postoperative period	Process	No. of people with blood glucose control in the immediate post-op period	Total number of people undergoing surgery	Entire population or a sample

IMPLEMENTATION STRATEGY FOR THE BUNDLE

To achieve lasting changes in healthcare workers' behavior and care practices, it is essential that the selected improvement strategies are based on strong scientific evidence and apply recommended methodologies for the effective implementation of care innovations.

The most effective improvement interventions rely on a multimodal approach, which assesses all factors that may act as barriers to the implementation of necessary changes and considers multiple interventions to overcome these barriers.

The factors taken into consideration include:

- which resources, infrastructures, or equipment are needed to effectively implement the new care measures;
- who needs to be informed, trained, and educated to address identified problems of non-adherence;
- how to ensure that the intervention is a priority for facility leadership;
- how to identify the practices that need to be modified and the barriers to their implementation;
- how to communicate and disseminate the innovations to be introduced.

To carry out multimodal interventions effectively, a strong understanding of the local context is essential to translate the selected interventions into practice. Understanding the local context is also crucial in deciding which SSI prevention bundle is most appropriate for the setting.

This document proposes a bundle of five measures supported by strong evidence, which the panel believes are not yet systematically adopted across all healthcare facilities and for all surgical patients.

Before adopting this proposal, it is fundamental to assess its applicability to the specific local setting. It may be the case that none of the proposed measures are routinely implemented, or that only some are already in place.

In the latter case, it will be appropriate to adapt the bundle to local conditions, prioritizing the inclusion of those measures not yet systematically adopted. It may also be appropriate to integrate some of the additional measures proposed, if they are not yet consolidated as standard practice in the facility.

The multimodal approach for implementing the selected bundle measures at the local level has been described in detail in the 2018 WHO Implementation Manual [15], which provides a structured approach for successfully implementing SSI prevention recommendations, including the following steps (Figure 2):

- prepare for action;
- perform a baseline situation analysis to design context-appropriate actions;
- develop and implement the intervention plan;
- evaluate results;
- sustain the program in the long term

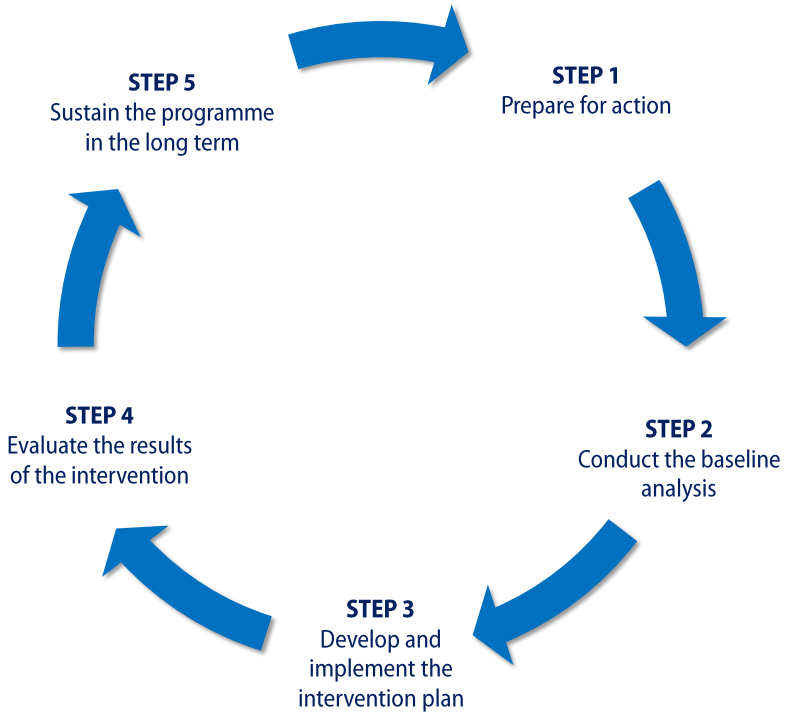

Figure 2. Implementation process of SSI prevention measures according to the WHO 5-step cycle [15]

By following these steps, healthcare facilities can successfully implement an SSI prevention bundle, significantly reducing the risk of SSIs and improving overall surgical outcomes. Regular re-evaluation of effectiveness and adjustments to enhance prevention efforts are critically important.

1. Prepare for action

To implement the intervention effectively, it is necessary to mobilize the resources required to enable change. This includes identifying the resources and actions needed to put the bundle measures into practice, engaging facility leadership and healthcare personnel, especially those in managerial roles.

It is also necessary to identify the team responsible for coordinating the intervention, ensuring the involvement of all professional roles directly engaged in SSI prevention. This group should include medical, nursing, and technical staff involved in surgery, anesthesia, and intra- and post-operative care, as well as personnel dedicated to infection control, patient safety, and clinical risk management.

At this stage, it is important to inform all individuals who will be involved in the bundle implementation about what is being prepared.

2. Conduct the baseline analysis

To plan the intervention effectively, it is necessary to understand the local context. In particular, it is important to:

- collect data on the knowledge, perceptions, and attitudes of the personnel whose behaviors are to be modified;
- review available SSI surveillance data. If no surveillance system exists, it must be established in order to monitor outcomes over time and identify potential emerging issues;
- obtain information on adherence to care practices which, as they are evidence-based, should be an integral part of standard care;
- assess the existence of organizational barriers, including lack of resources, medicines/devices, or required laboratory or other support.

To gather information on adherence to care practices and to identify barriers perceived by healthcare workers, the following actions are recommended:

- observe personnel during procedures, potentially using ad hoc checklists, which are useful for identifying areas for improvement;
- evaluate the entire care process to detect any deficiencies. Review the entire surgical pathway, assessing every phase from preoperative to postoperative, to identify possible errors or gaps in the application of infection prevention measures. It is essential to document all findings for further analysis. It is advisable to conduct this baseline assessment using an audit tool;
- invite all individuals involved in the surgical pathway, including surgeons, nurses, anesthesiologists, and support staff, to share doubts and concerns by establishing open

communication channels to gather insights and suggestions on current infection prevention practices. This collaborative approach can help reveal valuable perspectives and identify potential implementation barriers.

The Agency for Healthcare Research and Quality (AHRQ) has developed a tool to identify local barriers, prioritize them, and develop an action plan to overcome them (Barrier Identification and Mitigation Tool) [24].

3. Develop and implement the intervention plan

In developing the intervention plan, it is essential to consider the results of the baseline assessment and to adopt a realistic, priority-driven approach tailored to the local context, using a multimodal improvement strategy. To ensure effective implementation, it is useful to:

- initially focus on short-term objectives that allow for tangible, measurable outcomes;
- pilot the plan during a preliminary phase to assess its feasibility and identify potential issues;
- clearly define responsibilities, timelines, budget, and required resources, including specific competencies, and establish evaluation and reporting checkpoints;
- share the action plan with facility leadership and staff to ensure commitment and allocation of necessary resources.

Implementing an SSI prevention bundle requires a standardized approach to ensure that every patient receives the recommended infection prevention measures. This involves the adoption of:

- checklists and protocols to support the application of bundle measures during every surgical procedure by all healthcare personnel. Completing checklists is like to mapping the route to success: each item checked off marks a step toward accuracy, efficiency, and desired outcomes. For this reason, the working group proposes a dedicated checklist to monitor bundle implementation, to be completed for each surgical case (see Appendix D – Checklist: Bundle and Additional Measures for SSI Prevention);
- training and education to ensure appropriate behaviors by all staff involved throughout the surgical pathway, highlighting the importance of following the bundle;
- supervision and audit to ensure full compliance with the bundle and to provide constructive feedback for improvement.

4. Evaluate the results of the intervention

Evaluate the results of the intervention using, where possible, the same tools adopted during the initial context analysis, to allow assessment of changes.

Elements to be considered include:

- adherence to each component of the bundle;
- incidence of SSIs over time;
- appropriate use of antibiotics for PAP.

It is essential to periodically collect and analyze data in order to assess progress, identify areas for improvement, and determine the effectiveness of the plan.

Appendices B and C contain the internationally recommended indicators for each of the measures included in the SSI prevention strategy.

5. Sustain the program in the long term

It is important to ensure that the improvement actions are integrated into routine care over the long term. This entails guaranteeing the availability of the necessary resources and implementing measures to counter the natural tendency to abandon newly introduced good practices over time.

To this end, it is necessary to continue monitoring infections and care practices and to work toward making SSI prevention a recognized institutional priority to ensure the safety of care delivery.

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APPENDIX A

Comparison table between different guidelines

Guide to consultation

The table below summarizes the topics of interest covered by the considered guidelines and the corresponding grading scheme for the strength of recommendations adopted in each of them.

NICE 2008 (rev. 2019)	SNLG 2011	WHO 2018	CDC 2017	SNLG SIOT 2021	SHEA/IDSA 2022
Topics of interest					
SSI	Only PAP	SSI	Only selected practices*	SSI in orthopedic surgery	SSI
Definition of strong recommendation					
Prioritized	**A – strongly recommended**	**Strong**	**Strongly recommended**	**Strong**	**Essential practices**
Recommendations identified as priorities in 2008, including updates in 2019, which did not provide a prioritization scale for interventions.	Procedure (or diagnostic test) supported by good-quality scientific evidence, even if not necessarily type I or II.	Intervention whose benefits clearly outweigh the risks.	**IA:** supported by well-designed experimental, clinical, or epidemiological studies; **IB**: supported by some experimental, clinical, or epidemiological evidence and a strong theoretical rationale; **IC**: required by regulation, law, or standard.	The desirable effects of the recommendation outweigh the undesirable effects.	Practices to be implemented in all hospitals.

SSI: Surgical Site Infections; **PAP**: Perioperative Antibiotic Prophylaxis
* For other practices, refer to CDC 1999 (see below).

Below are the comparison tables of the reviewed guidelines, organized according to the phases of a surgical procedure: pre-operative, intra-operative, and post-operative.

Recommendations that are not strongly supported (defined as *conditional* or *non-priority* depending on the guideline) are highlighted in **red**.

The last column indicates how many guidelines strongly recommend the specific measure considered.

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Measures	NICE 2008 (rev. 2019)	SNLG 2011	WHO 2018	CDC 2017	SNLG SIOT 2021	SHEA/IDSA 2022	n. GL
PRE-OPERATIVE (1)							
Patient information	• Provide clear and consistent information throughout all stages of care, including infection risk, preventive measures, and postoperative management. Inform patients about antibiotic prescriptions.	*Not addressed*	*No recommendations*	*No recommendations*	*No recommendations*	• Educate patients and their families on the prevention of surgical site infections (SSIs)	2/5
Screening and decolonization for *S. aureus*	**2008** Not a priority **2019** • Consider the use of nasal mupirocin combined with body washing using chlorhexidine before surgical procedures where *S. aureus* is a likely cause of SSI, based on the type of procedure, individual patient risk factors, and potential impact of infection. Pay attention to the increased risk of side effects in preterm neonates. • Monitor antimicrobial resistance associated with the use of mupirocin	*Not addressed*	• Treat preoperatively with 2% mupirocin (with or without chlorhexidine washing) nasal carriers of *S. aureus* undergoing cardiac or orthopedic surgery. • Treat nasal carriers of *S. aureus* undergoing surgical procedures other than cardiac or orthopedic surgery with a preoperative regimen based on 2% mupirocin, with or without chlorhexidine washing (Conditional recommendation)	*No recommendations*	*No definitive recommendation for decolonization in orthopedic and trauma surgery*	• Decolonize patients undergoing orthopedic and cardiothoracic surgery. • Decolonize surgical patients prior to procedures with a high risk of *Staphylococcus* SSI (e.g., involving prosthetic material)	2/5
Vaginal preparation	*No recommendations*	*Not addressed*	*No recommendations*	*No recommendations*	*No recommendations*	• Use antiseptics for preoperative vaginal preparation in women undergoing cesarean section or hysterectomy	1/5
Hair removal (trichotomy)	• Avoid routine hair removal. If necessary, use clippers with a disposable head on the day of surgery. Razors with traditional blades are not recommended	*Not addressed*	• Avoid hair removal; if necessary, use clippers. Razors with traditional blades are not recommended	• Perform hair removal only if it interferes with the procedure, using clippers on the day of surgery (CDC, 2009)	• Perform hair removal only if it interferes with the procedure, using clippers on the day of surgery	• Avoid hair removal if it does not interfere with the procedure	5/5

Measures	NICE 2008 (rev. 2019)	SNLG 2011	WHO 2018	CDC 2017	SNLG SIOT 2021	SHEA/IDSA 2022	n. GL
PRE-OPERATIVE (2)							
Preoperative showering	**2008** Not a priority • Advise patients to take a shower or bath with soap the day before or the day of surgery	*Not addressed*	• Perform a preoperative shower with soap (antiseptic or not) (Conditional recommendation)	• Inform patients about the need for a soap-based shower (antiseptic or not) the evening before surgery	• Consider antiseptic washing the day before surgery using antimicrobial soap or antiseptic solution (Weak recommendation)	*No recommendations*	1/5
Mechanical bowel preparation	**2008** Not a priority • Do not routinely use mechanical bowel preparation to reduce the risk of SSI	*Not addressed*	• Do not perform mechanical bowel preparation without the use of oral antibiotics to reduce SSIs in adult patients undergoing elective colorectal surgery • Perform mechanical bowel preparation combined with oral antibiotic administration in adult patients scheduled for elective colorectal surgery (Conditional recommendation)	*No recommendations*	*No recommendations*	*No recommendations*	1/5
Jewelry and artificial nails of the surgical team	**2008** Not a priority • Remove hand jewelry, artificial nails, and nail polish before procedures	*Not addressed*	• Remove hand jewelry and nail polish before procedures • Do not wear artificial nails (WHO, 2009)	• Keep nails short and do not wear artificial nails (CDC, 1999)	*No recommendations*	• Keep nails short and natural, not extending beyond the fingertips • Do not use artificial nail extensions for staff working in high-risk areas (e.g., intensive care, surgery) • Regulate the use of nail polish, including gel.	3/5

Measures	NICE 2008 (rev. 2019)	SNLG 2011	WHO 2018	CDC 2017	SNLG SIOT 2021	SHEA/IDSA 2022	n. GL
PERI-OPERATIVE (1)							
Surgical site preparation	**2019** • Prepare the skin at the surgical site immediately before incision using an antiseptic solution • Assess the risks of antiseptic use in neonates, particularly the risk of chemical injuries with chlorhexidine in preterm infants • Prefer chlorhexidine in alcohol-based solution, unless contraindicated or in proximity to mucous membranes. Alternatively, use chlorhexidine in aqueous solution or povidone-iodine in alcohol-based solution	*Not addressed*	• Perform skin preparation using an antiseptic containing chlorhexidine or alcohol-based	• Perform skin preparation using an antiseptic, if not contraindicated	• Perform skin preparation using an antiseptic, if not contraindicated	• Perform skin preparation using an antiseptic, if not contraindicated	5/5
Surgical drapes and gowns	*No recommendations*	*Not addressed*	There is no evidence supporting the superiority of single-use sterile drapes over reusable sterile drapes and gowns in preventing SSIs (Conditional recommendation)	*No recommendations*	*No recommendations*	*No recommendations*	0/5

Measures	NICE 2008 (rev. 2019)	SNLG 2011	WHO 2018	CDC 2017	SNLG SIOT 2021	SHEA/IDSA 2022	n. GL
PERI-OPERATIVE(2)							
Surgical team hand/arm antisepsis	**2008** Not a priority • Wash hands before the first procedure using an aqueous surgical antiseptic solution, cleaning nails with a disposable brush or stick and ensuring they are visibly clean. • For subsequent procedures, use an alcohol-based solution or a surgical antiseptic solution. If hands are dirty, repeat washing with an antiseptic solution	*Not addressed*	• Perform surgical handwashing with antimicrobial soap and water or use an alcohol-based solution before donning sterile gloves (WHO, 2009) • Do not use brushes for surgical hand preparation • Rub hands and forearms with antiseptic soap only for the duration recommended by the manufacturer (2-5 minutes) for antisepsis. Longer durations are not necessary • For alcohol-based hand rubs, apply the product to dry hands in sufficient quantity to completely wet hands and forearms, and allow to dry completely before donning sterile gloves	• Perform preoperative antisepsis of hands and forearms according to the instructions in the product's technical data sheet • Refer to CDC 2002 and WHO 2009 guidelines for additional recommendations on hand hygiene in healthcare settings	*No recommendations*	• Use an FDA-approved surgical hand scrub or apply alcohol-based hand rubs	3/5
Adhesive drapes, incision protectors, antimicrobial surgical sealants	• Cover surgical incisions with an appropriate interactive dressing at the end of the procedure	*Not addressed*	• Avoid the use of plastic adhesive drapes, with or without antimicrobial properties, for SSI prevention (Conditional recommendation) • Avoid the use of antimicrobial skin sealants for preventive purposes (Conditional recommendation) • Consider the use of wound protection devices in clean-contaminated, contaminated, and dirty abdominal surgeries to reduce the risk of infection (Conditional recommendation)	*No recommendations*	• Consider using incise adhesive drapes in major orthopedic surgery, especially prosthetic procedures (although not generally recommended for SSI prevention), as they help in setting up the surgical field and contribute to isolating the incision site • If used, ensure full adhesion throughout the procedure (Weak recommendation)	• Use impermeable plastic wound protectors in gastrointestinal and biliary tract surgery	2/5

Measures	NICE 2008 (rev. 2019)	SNLG 2011	WHO 2018	CDC 2017	SNLG SIOT 2021	SHEA/IDSA 2022	n. GL
PERI-OPERATIVE (3)							
PAP: indications	• Administer antibiotic prophylaxis to patients undergoing clean surgery involving the insertion of a prosthesis or implant, clean-contaminated surgery, or contaminated surgery. • Do not use routine antibiotic prophylaxis for simple, non-prosthetic clean surgery. • Use the local antibiotic formulary and always consider potential adverse effects when selecting specific antibiotics for prophylaxis.	• Administer PAP for the procedures indicated in the guideline.	• Administer PAP before the surgical incision when indicated (depending on the type of procedure).	• Administer PAP only when indicated, based on current guidelines.	• Administer antibiotic prophylaxis for orthopaedic and trauma surgery requiring the implantation of devices (prostheses, fixation systems, biomaterials) in open surgery; for other cases, evaluate individually based on the invasiveness of the procedure and the patient's characteristics.	• Administer PAP for the procedures indicated in the guideline.	6/6
PAP: timing of administration	• Consider administering a single intravenous dose of antibiotic prophylaxis at the start of anaesthesia. • For operations involving a tourniquet, administer prophylaxis before its application.	• Begin prophylaxis immediately before anaesthetic procedures, and in any case within 30–60 minutes before skin incision.	• Administer PAP within 120 minutes before incision, taking into account the antibiotic's half-life.	• Administer PAP to maximize tissue concentration at the time of incision. • Administer SAP before incision in all caesarean sections.	• Administer PAP 30-60 minutes before incision for first- or second-generation cephalosporins, or 2 hours before incision for vancomycin. • Maintain adequate serum and tissue levels for the entire duration of the operation (administer an additional dose if the procedure exceeds twice the antibiotic's half-life).	• Begin administration within 1 hour before incision to maximize tissue concentration (or within 2 hours for vancomycin and fluoroquinolones, due to their longer infusion times). • For caesarean delivery, administer PAP before skin incision rather than after cord clamping.	6/6

Measures	NICE 2008 (rev. 2019)	SNLG 2011	WHO 2018	CDC 2017	SNLG SIOT 2021	SHEA/IDSA 2022	n. GL
PERI-OPERATIVE (4)							
PAP: duration	• Consider administering a single dose of antibiotic prophylaxis intravenously at the start of anesthesia	• Limit antibiotic prophylaxis to the perioperative period. Administer a single dose in the majority of cases. • Avoid continuation beyond 24 hours postoperatively. In prolonged procedures, administer an intraoperative dose if the elapsed time equals twice the drug's half-life. • Administer an additional dose after fluid replacement if blood loss exceeds 1,500 mL or if hemodilution is greater than 15 mL/kg	• Do not prolong surgical antibiotic prophylaxis after completion of the operation for the purpose of preventing an SSI	• In clean and clean-contaminated surgeries, do not administer additional doses of antibiotics after closure of the surgical incision in the operating room, even in the presence of a drainage	• Use a single-dose or short-term (24-hour) regimen	• Discontinue antibiotic administration after closure of the incision in the operating room	6/6
Normo-thermia	• Maintain patient normothermia according to hypothermia guidelines: prevention and management in adults undergoing surgery (NICE, 2009)	*Not addressed*	• Use warming devices in the operating room and during the surgical procedure to warm the patient's body in order to reduce SSIs (Conditional recommendation)	• Maintain perioperative normothermia	*No recommendations*	• For procedures that do not require induced hypothermia, maintain normothermia (temperature >35.5°C) during the perioperative period	3/5
Normo-glycemia	• **2008** Not a priority • Do not routinely administer insulin to non-diabetic patients to optimize postoperative blood glucose as a means of reducing the risk of surgical site infection • Refer to the specific guideline on perioperative care in adults (NICE, 2020)	*Not addressed*	• Measure blood glucose perioperatively in adult patients, both diabetic and non-diabetic, undergoing surgical procedures to reduce the risk of SSI (Conditional recommendation)	• Adequately control blood glucose levels perioperatively in both diabetic and non-diabetic patients, aiming to maintain glucose <200 mg/dL	• Maintain blood glucose <200 mg/dL in the perioperative period to reduce SSI risk in all patients, diabetic and non-diabetic	• Monitor blood glucose levels in all patients during the immediate postoperative period	3/5

Measures	NICE 2008 (rev. 2019)	SNLG 2011	WHO 2018	CDC 2017	SNLG SIOT 2021	SHEA/IDSA 2022	n. GL
PERI-OPERATIVE (5)							
Tissue oxygenation	• **2008** Not a priority Maintain optimal oxygenation during surgery. In particular, provide patients with sufficient oxygen during major surgical procedures and in the recovery period to ensure hemoglobin saturation remains above 95%	*Not addressed*	• Administer FiO_2 at 80% intraoperatively and, if possible, for 2–6 hours postoperatively to reduce the risk of SSI in adult patients undergoing general anesthesia with endotracheal intubation	• Increase FiO_2 before, during, and after surgery in patients with normal lung function undergoing general anesthesia with endotracheal intubation • Maintain normothermia and adequate volume replacement to optimize oxygenation	*No recommendations*	• Optimization of tissue oxygenation at the incision site remains an unresolved issue in this guideline	2/5
Wound dressing	• Cover surgical incisions with an appropriate interactive dressing at the end of the procedure	*Not addressed*	• Do not use any type of advanced dressing over a standard dressing on primarily closed surgical wounds for the purpose of preventing SSIs (Conditional recommendation) • Use prophylactic negative pressure wound therapy for patients with high-risk wounds closed by primary intention, considering available resources (Conditional recommendation)	*No recommendations*	*No recommendations*	*No recommendations*	1/5
Traffic in the Operating Room	*No recommendations*	*Not addressed*	*No recommendations*	*No recommendations*	• Reduce unnecessary traffic in the operating room by limiting the number of people and minimizing door openings	• Minimize traffic in the operating room (Low quality of evidence)	1/5
Laminar airflow ventilation systems	*No recommendations*	*Not addressed*	• Do not use laminar airflow ventilation systems to reduce the risk of SSI in patients undergoing total joint arthroplasty (Conditional recommendation, low to very low quality of evidence)	*No recommendations*	• Laminar airflow systems are not recommended for reducing infection risk (Weak recommendation)	*No recommendations*	0/5

Measures	NICE 2008 (rev. 2019)	SNLG 2011	WHO 2018	CDC 2017	SNLG SIOT 2021	SHEA/IDSA 2022	n. GL
POST-OPERATIVE							
Dressings for second-intention wound healing	• Refer to a nurse specialized in tissue repair (or another healthcare professional with specific expertise) for advice on appropriate dressings for the management of surgical wounds healing by second intention	*Not addressed*	*No recommendations*	*No recommendations*	*No recommendations*	*No recommendations*	**1/5**
GENERAL							
Checklist and bundle	*No recommendations*	*Not addressed*	*No recommendations*	*No recommendations*	*No recommendations*	• Use a checklist and/or a bundle to ensure adherence to best practices for improving surgical patient safety	**1/5**
SSI Surveillance	*No recommendations*	*Not addressed*	• Consider active SSI surveillance as an integral part of the SSI control program	*No recommendations*	*No recommendations*	• Conduct SSI surveillance • Improve surveillance efficiency using computerized data • Measure and provide feedback to healthcare workers on adherence rates to process measures • Provide continuous feedback on SSI rates to surgical and perioperative staff and facility leadership	**2/5**
Monitoring	*No recommendations*	*Not addressed*	*No recommendations*	*No recommendations*	*No recommendations*	• Observe staff behavior and environmental conditions both in the operating room and in the sterilization unit	**1/5**
Training	*No recommendations*	*Not addressed*	*No recommendations*	*No recommendations*	*No recommendations*	• Train surgeons and operating room staff on surgical site infection (SSI) prevention measures	**1/5**

APPENDIX B

Summary table of the bundle measures for the prevention of surgical site infections

Measures included in the bundle

Measures	Actions	Indicators
1. Avoid hair removal. If absolutely necessary, use a clipper		
Avoid hair removal for any surgical procedure. If absolutely necessary, remove hair using only clippers. Traditional blade shaving is strongly discouraged both pre-op and in the OR. If needed, perform hair removal immediately before entering the operating room.	Instruct patients not to shave near the surgical incision site before the operation. Include this information in the informational brochures provided to surgical patients. Share with the surgical team a protocol that defines which procedures can avoid hair removal, allows only the use of clippers when necessary, and specifies the appropriate timing. Balance the risks of performing surgery on non-hairless skin with the risk of colonization and infection. Emphasize the importance of proper timing of hair removal in operative protocols. Replace traditional blade razors with clippers in healthcare facilities. Use disposable clippers or models that can be properly disinfected between patients, using either disposable or reusable heads.	• Effective availability of disposable clippers • Staff knowledge and perceptions regarding the avoidance of hair removal • Assessment by surgical candidates of the informational materials provided to them • Incidence of surgical site infections (SSI) • Adherence to recommended hair removal practices (% of patients undergoing surgery who either had hair removal with a clipper or no hair removal at all, out of the total number of surgeries performed)
2. Administer antibiotics before incision for high-risk surgical procedures or when prosthetic material is implanted, and respect the optimal timing of administration		
Administer perioperative antibiotic prophylaxis (PAP), when indicated (based on the type of surgery), before the surgical incision (within the 120 minutes prior). The appropriate timing within this window depends on the half-life of the antibiotic used. Specifically, the use of glycopeptides should be considered in cases of allergy or in settings with high incidence or elevated risk of MRSA infection. For cesarean section, PAP should be administered before the skin incision rather than after cord clamping.	Develop, with input from hospital management, the pharmacy, infection prevention and control staff, the antimicrobial stewardship team, and the surgical team, an updated and detailed local protocol that is easily accessible to all staff. Ensure the local protocol is developed collaboratively, clearly defining roles and responsibilities. Establish a mechanism to produce and update staff information and training on the protocol, including supporting scientific evidence, and promote focus groups to facilitate discussion among staff. Put in place an appropriate system to ensure the availability of required antibiotics. Ensure, through hospital management, that the necessary resources are allocated for the implementation of the new protocol.	• Staff knowledge and perceptions regarding PAP (Perioperative Antibiotic Prophylaxis) • Availability of the required antibiotics • Antibiotic consumption for PAP • Incidence of surgical site infections (SSI) • Existence of an updated protocol with specific indicators • PAP indications consistent with the protocol • Appropriate antibiotic selected for the specific surgical procedure • Correct antibiotic dose administered • Antibiotic started within 1 hour before incision (with some exceptions: e.g., up to 2 hours allowed for vancomycin, depending on peak plasma concentration and infusion rate) • Adherence to recommended PAP practices; measured as the percentage of procedures in which prophylaxis was appropriately administered = (number of patients who received appropriate antimicrobial prophylaxis / total number of selected procedures performed) × 100

Measures	Actions	Indicators
3. Use alcohol-based antiseptics containing chlorhexidine gluconate for surgical site preparation		
Use alcohol-based antiseptics containing chlorhexidine gluconate (CG) for skin preparation in patients undergoing surgical procedures, or at minimum, use antiseptics in an alcohol-based solution.	Establish a reliable system to ensure the availability of the necessary antiseptic solutions, allocating the required resources to achieve this goal. In collaboration with the surgical staff, develop a local protocol based on updated scientific evidence, and ensure it is easily accessible to all personnel. Implement a dependable mechanism to provide information and training to all staff on proper skin preparation techniques, including the correct application method. Make scientific evidence available to support the use of alcohol-based solutions and chlorhexidine. Facilitate discussion and consultation sessions to identify solutions and overcome barriers. Provide evidence on known risks and how they can be effectively managed	• % of surgical procedures using alcohol-based antiseptics containing chlorhexidine gluconate.
4. Re-administer antibiotics during prolonged procedures and in patients with significant blood loss		
In the case of prolonged surgical procedures, administer an additional intraoperative dose of antibiotics if the surgery is still ongoing after a duration equal to twice the half-life of the antibiotic used. Administer an extra intraoperative antibiotic dose (after fluid resuscitation) in adult patients if blood loss exceeds 1,500 mL or if hemodilution exceeds 15 mL/kg during the procedure.	To promote adherence to the recommendations, it is necessary to assess the local context to identify potential barriers, i.e., factors that hinder the adoption of this measure. Investigate whether failure to re-administer antibiotics during surgery is due to cultural, knowledge-based, or organizational factors, and identify appropriate solutions to overcome these barriers.	• % of patients undergoing surgery who receive appropriate re-administration of prophylactic antibiotics in cases of prolonged procedures or significant blood loss
5. Discontinue antibiotic prophylaxis after surgery		
Discontinue antibiotic administration after closure of the surgical incision in the operating room. Do not administer additional doses after incision closure, even in the presence of a drain.	Investigate the reasons behind the failure to discontinue PAP after the end of surgery.	• Proportion of surgical procedures in which PAP was discontinued at the end of the operation.

APPENDIX C

Summary table of additional measures for the prevention of surgical site infections

Additional measures not included in the bundle

Measures	Actions	Indicators
PRE-OPERATIVE		
Inform the patient scheduled for surgery		
Provide clear and consistent information to surgical candidates and their families about SSI prevention, particularly on the following aspects: • Risk of acquiring a surgical site infection (SSI) • Measures implemented by the facility to minimize such risks • Management plan in the event of an infection • Proper wound care after discharge • Early recognition of signs and symptoms of a potential infection • Possible administration of antibiotics after surgery	Train staff to use clear and accessible language with surgical candidates, avoiding excessive medical jargon Develop written or multimedia educational materials using understandable language to help patients better comprehend the surgical information Create patient leaflets and assess their clarity through testing with a small sample of patients Organize dedicated consultation sessions where patients can meet with the surgical or medical team to thoroughly discuss the procedure Schedule these sessions in advance to ensure adequate time for patient questions and concerns Consider assigning dedicated staff to guide the patient throughout the entire process, providing additional information and support if needed	• % of patients undergoing surgery, out of all surgical procedures performed, who were informed not to remove hair from the surgical site before hospital admission • % of surgical patients who received the specific informational leaflet during the preoperative phase
Perform screening and decolonization of patients colonized with *Staphylococcus aureus*		
Perform preoperative screening for individuals undergoing cardiothoracic or orthopedic surgery. If nasal carriers of *S. aureus* are identified, provide preoperative treatment with 2% mupirocin nasal ointment, applied twice daily for 5–7 days before surgery, and once again immediately before the procedure. Combine mupirocin treatment with body washing using 2–4% chlorhexidine gluconate (CG) soap. Control swabs to assess decolonization effectiveness are not required. Also screen and decolonize individuals undergoing other surgical procedures involving prosthetic implants, based on local evaluation. Maintain surveillance on antimicrobial resistance related to mupirocin use.	Ensure laboratory support for screening by providing specific resources and ensuring the full involvement of the laboratory. Develop a system to guarantee resources and organizational arrangements for effective screening and decolonization. Identify solutions to ensure availability of mupirocin ointment. Establish an operational protocol with instructions for sample collection and decolonization treatment, including defined roles and responsibilities. Properly inform patients about the purpose of screening and benefits of decolonization. Monitor resistance patterns and share data with surgical teams. Develop training programs that include supporting scientific evidence.	• Staff knowledge on the rationale and content of the protocol. • Availability and consumption of mupirocin ointment. • Adherence to the protocol. • Local epidemiology of mupirocin resistance in *S. aureus*. • Incidence of SSIs.

Measures	Actions	Indicators
INTRA-OPERATIVE		
Properly perform surgical hand/arm antisepsis by the surgical team		
Anyone entering the operating block must perform hand hygiene before entry, following the WHO's Five Moments for Hand Hygiene. If hands are visibly contaminated with organic matter, wash with soap and water. Perform surgical hand antisepsis using an appropriate antimicrobial soap or an alcohol-based hand rub (ABHR), preferably one with prolonged activity, before donning sterile gloves. When using antimicrobial soap, wash hands and forearms for the duration recommended by the manufacturer, typically 2–5 minutes. Extended scrubbing times are unnecessary. If using an alcohol-based product with prolonged activity, follow manufacturer's application times, apply only to dry hands, and do not combine surgical scrub and alcohol rub sequentially. When using an ABHR, apply a sufficient quantity to keep hands and forearms wet during the procedure. After application, allow hands and forearms to dry completely before putting on sterile gloves. For the first surgery of the day, wash hands using an ABHR and ensure hands and nails are visibly clean. Before subsequent surgeries, use either an alcohol-based rub or antiseptic surgical soap, unless hands are visibly soiled. If hands are dirty, wash again with surgical antiseptic solution.	Establish a sustainable supply system, defining responsibilities and including a dedicated budget Develop standard operating procedures that include correct products and techniques, following WHO hand hygiene recommendations and create dedicated training pathways Implement educational strategies on proper surgical hand preparation technique, including supporting evidence for alcohol-based hand rubs and related WHO guidance (e.g., avoid nail brushes) Conduct tolerability tests and communicate results to staff	• Staff knowledge on surgical hand preparation • Continuous supply of ABHR and antimicrobial soap • Consumption data of ABHR and antimicrobial soap • Tolerability and acceptability of hand preparation solutions • Correct execution of surgical hand antisepsis • Incidence of SSIs • Evaluation systems for correct execution of surgical team hand/arm antisepsis • Monitoring and feedback on ABHR consumption in the previous year, reported per 1,000 patient-days

Measures	Actions	Indicators
Maintain perioperative normothermia with a target temperature >36°C		
In the operating room • Maintain an ambient temperature of 20–24°C. • Use forced-air warming blankets or a warm blanket covered with a warm sheet. • Monitor and record temperature every 30 minutes. • Ensure the patient is adequately covered throughout the procedure. • Warm infused fluids and blood products to 37°C for procedures >1 hour. Warm irrigation fluids, including those for colorectal surgery, to 38–40°C. • For all patients at high risk of hypothermia, use forced-air warming. • Set forced-air warming to maximum, then reduce to maintain a temperature of ≥36.5°C. Post-anaesthesia recovery room • Monitor temperature every 15 minutes • If temperature drops below 36°C, re-warm the patient until reaching ≥36°C or until they feel warm In the ward • Measure temperature on arrival and then every 4 hours • If temperature <36°C, use forced-air warming until the patient feels warm During warming, monitor temperature every 30 minutes	Initiate a decision-making and resource evaluation process within the facility to assess the use of body warming devices in the OR and during surgery to prevent hypothermia and reduce SSI risk. Develop a standard operating procedure and create training programs that include: • Actions to prevent hypothermia. • Temperature monitoring of surgical patients. • Features and proper use of available warming devices (including practical demonstrations of the identified products and their placement).	• Monitoring of staff knowledge on identifying patients at risk for postoperative hypothermia • Postoperative temperature monitoring of patients • Frequency of unavailability of warming devices when needed • Incidence of SSIs • Integration of active and passive warming measures into preoperative briefings or checklists • Where possible, monitor postoperative complications associated with hypothermia (especially if warming practices do not improve) • % of surgical patients under general anesthesia (excluding cases with induced hypothermia, e.g., coronary bypass), lasting at least 60 minutes, in which intraoperative temperature was 36–38°C (rectal) or 35.5–37.5°C (non-rectal) within 1 hour after the end of surgery

Measures	Actions	Indicators
Maintain intraoperative glycemic control with blood glucose targets levels <150 mg/dL during the 24-48 hours after surgery		
Use perioperative blood glucose monitoring protocols for both diabetic and non-diabetic adult patients undergoing surgery to reduce the risk of SSIs. Monitor blood glucose levels in all patients who have undergone surgery during the immediate postoperative period.	Initiate a decision-making process within the facility to evaluate the implementation of intensive glycemic control protocols for adult surgical patients (both diabetic and non-diabetic). This should include assigning responsibilities and defining the required budget. Develop or adapt an evidence-based protocol to implement and/or standardize this practice safely. Provide training that includes: • Blood glucose monitoring techniques; • Application of intensive perioperative glycemic control; • Prevention and management of hypoglycemia.	• Staff compliance with the perioperative glycemic management protocol. • Availability of resources to monitor blood glucose levels. • Adverse events related to the use of the protocol. • % of surgical patients, out of all procedures performed, in whom an intensive glycemic control protocol was implemented and blood glucose levels were monitored.

APPENDIX D

Checklist for the bundle measures for the prevention of surgical site infections

D1. Checklist - Bundle and additional measures to prevent SSI

PRE-OPERATIVE PHASE

Pre-operative phase	
Department.....	
Patient..... **Date**.....	
Recommendation	**Completed**
Hair removal	
Hair removal was performed	❑ yes ❑no ❑ not applicable
If hair removal was necessary, it was performed using a clipper	❑ yes ❑no ❑ not applicable
If hair removal was necessary, it was performed immediately before entering the operating room	❑ yes ❑no ❑ not applicable
Perioperative Antibiotic Prophylaxis (PAP)	
PAP administered according to institutional guidelines	❑ yes ❑no ❑ not applicable
PAP administered before the surgical incision (within 120 minutes prior to incision)	❑ yes ❑no ❑ not applicable
For caesarean section, PAP administered before skin incision	❑ yes ❑no ❑ not applicable
Information provided to the surgical candidate	
The patient and their family have been informed and educated about: 1. The risk of acquiring a surgical site infection; 2. Measures adopted by the facility to minimize these risks; 3. The management plan in case of infection; 4. Proper wound care after discharge; 5. Early recognition of signs and symptoms of a possible infection; 6. Possible antibiotic administration after surgery.	❑ yes ❑no ❑ not applicable
Screening and decolonization of patients colonized with *S. aureus*	
Preoperative screening of patients undergoing cardiothoracic and orthopaedic surgery, and preoperative treatment with 2% mupirocin nasal ointment, with or without preoperative chlorhexidine showering, for patients identified as nasal carriers of *S. aureus*.	❑ yes ❑no ❑ not applicable
Screening and decolonization of patients undergoing other surgical procedures when prosthetic material is implanted	❑ yes ❑no ❑ not applicable

D2. Checklist - Bundle and additional measures to prevent SSI
INTRA-OPERATIVE PHASE

Intra-operative phase	1/2
Department.....	
Patient..... **Date**.....	
Recommendation	**Completed**
Hand/forearm antisepsis by the surgical team	
Proper hand hygiene before the first scheduled surgery, using an alcohol-based solution, ensuring that hands and nails are visibly clean.	❑ yes ❑no ❑ not applicable
Proper hand hygiene before subsequent surgeries, using an alcohol-based hand rub (unless visibly soiled) or a surgical antiseptic solution.	❑ yes ❑no ❑ not applicable
If surgical antisepsis of hands and forearms is performed: duration of hand and forearm washing follows the manufacturer's recommended time, typically 2-5 minutes.	❑ yes ❑no ❑ not applicable
If using an alcohol-based product with prolonged activity: application time follows manufacturer's instructions, applied on dry hands, with hands and forearms allowed to dry before putting on sterile gloves.	❑ yes ❑no ❑ not applicable
Surgical hand washing and alcohol-based rubbing were not used in sequence before the same procedure.	❑ yes ❑no ❑ not applicable
Perioperative Antibiotic Prophylaxis (PAP)	
PAP administered according to institutional guidelines.	❑ yes ❑no ❑ not applicable
PAP administered before surgical incision (within 120 minutes prior incision).	❑ yes ❑no ❑ not applicable
For caesarean section, PAP administered before skin incision.	❑ yes ❑no ❑ not applicable
Surgical site preparation with alcohol-based disinfectants containing chlorhexidine gluconate (CG)	
Use of alcohol-based antiseptics containing CG, or at least alcohol-based antiseptic solutions	❑ yes ❑no ❑ not applicable

Intra-operative phase 2/2

Department .....

Patient ..... **Date** .....

Recommendation	Completed
Perioperative normothermia with a target temperature >36°C	
Operating room (OR) temperature is maintained between 20–24°C.	❑ yes ❑ no ❑ not applicable
In the OR, use of forced-air warming blankets or a warm blanket covered with a warm sheet.	❑ yes ❑ no ❑ not applicable
In the OR, temperature is monitored and recorded every 30 minutes	❑ yes ❑ no ❑ not applicable
In the OR, the patient is adequately covered throughout the procedure.	❑ yes ❑ no ❑ not applicable
Glycaemic control	
Protocols are used for perioperative blood glucose monitoring in adult patients (both diabetic and non-diabetic), with a target blood glucose level <150 mg/dL within 24–48 hours after surgery.	❑ yes ❑ no ❑ not applicable
Perioperative Antibiotic Prophylaxis (PAP)	
In prolonged surgical procedures, an intraoperative dose was administered (operation still ongoing after a time equal to twice the half-life of the antibiotic used).	❑ yes ❑ no ❑ not applicable
In case of adult blood loss >1,500 mL or haemodilution >15 mL/kg, an additional intraoperative dose of antibiotic was administered (after fluid replacement).	❑ yes ❑ no ❑ not applicable
Antibiotic administration was discontinued after skin closure in the operating room, even in the presence of a drain.	❑ yes ❑ no ❑ not applicable

D3. Checklist – Bundle and additional measures to prevent SSI
POST-OPERATIVE PHASE

Post-operative phase	
Department.....	
Patient..... **Date**.....	
Recommendation	**Completed**
Perioperative normothermia with a target temperature >36°C	
In the post-operative observation room, temperature is checked every 15 minutes	❑ yes ❑no ❑ not applicable
The patient is not transferred to the ward if body temperature is <36°C	❑ yes ❑no ❑ not applicable
If body temperature is <36°C, the patient is adequately warmed until the temperature is ≥36°C or the person feels comfortably warm	❑ yes ❑no ❑ not applicable
In the ward, temperature is measured upon arrival and every 4 hours	❑ yes ❑no ❑ not applicable
In the ward, if body temperature is <36°C, forced-air warming is used until the person feels comfortably warm	❑ yes ❑no ❑ not applicable
In the ward, during the warming process, temperature is measured every 30 minutes	❑ yes ❑no ❑ not applicable
Glycaemic control	
Use of protocols for perioperative blood glucose monitoring in adult patients, both diabetic and non-diabetic, with target blood glucose levels <150 mg/dL within 24–48 hours after the procedure.	❑ yes ❑no ❑ not applicable

APPENDIX E

Infographics for the bundle measures and additional measures for the prevention of surgical site infections

The infographics can be downloaded by clicking on the related titles below:

Infographic of the bundle for the prevention of SSI
Infographic of additional measures to the SSI prevention bundle

E1. Infographic of the bundle for the prevention of SSI

E2. Infographic of additional measures to the SSI prevention bundle