NATIONAL CLINICAL GUIDELINES

THE PREVENTION, DIAGNOSIS & MANAGEMENT OF SURGICAL SITE INFECTION IN ADULTS & CHILDREN

Ministry of Public Health

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المبادئ الإرشادية السريرية لدولة قطر
NATIONAL CLINICAL GUIDELINES FOR QATAR

وزارة الصحـــــة العامـــــة
Ministry of Public Health
State of Qatar • دولـــة قطـــر

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Abbreviations

The abbreviations used in this guideline are as follows:

CRO	Carbapenem-Resistant Organisms
E. faecalis	*Enterococcus faecalis*
E. coli	*Escherichia coli*
ESBL	Extended Spectrum Beta Lactamase
GRE	Glycopeptide-Resistant Enterococci
HBA_{1C}	Haemoglobin A1C
ICU	Intensive Care Unit
MDR	Multi-Drug Resistant
MDRO	Multi-Drug Resistant Organism
MRSA	Methicillin-Resistant *Staphylococcus aureus*
P. aeruginosa	*Pseudomonas aeruginosa*
S. aureus	*Staphylococcus aureus*
SSI	Surgical Site Infection
VAP	Ventilator Associated Pneumonia

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Table of Contents

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1 Information about this Guideline

1.1 Objective and Purpose of the Guideline

The purpose of this guideline is to provide a framework for the prevention, diagnosis, and appropriate management of surgical site infection in both adults and children. The objective is to guide the appropriate care of patients presenting to provider organisations in Qatar. It is intended that the guideline will be used by healthcare professionals in all care settings.

1.2 Scope of the Guideline

This guideline covers the following aspects of care:

- Risk Factors for Surgical Site Infection (SSI).
- Preventative Interventions, Diagnosis and Management of SSI.
- Recommendations for prophylactic antimicrobial therapy in adults and children.

1.3 Editorial Approach

This guideline document has been developed and issued by the Ministry of Public Health of Qatar (MOPH), through a process which aligns with international best practice in guideline development and localisation. The guideline will be reviewed on a regular basis and updated to incorporate comments and feedback from stakeholders across Qatar.

The editorial methodology, used to develop this guideline, has involved the following critical steps:

- Extensive literature search for well-reputed, published evidence relating to the topic.
- Critical appraisal of the literature.
- Development of a draft summary guideline.
- Review of the summary guideline with a Guideline Development Group, comprised of practising healthcare professionals, subject matter experts and patient representatives, from across Qatar.
- Independent review of the guideline by the National Clinical Guidelines & Pathways Committee, appointed by the MOPH, from amongst stakeholder organisations across Qatar.

Whilst the MOPH has sponsored the development of the guideline, the MOPH has not influenced the specific recommendations made within it.

1.4 Sources of Evidence

The professional literature published in the English language has been systematically queried using specially developed, customised, and tested search strings. Search strategies are developed to allow efficient yet comprehensive analysis of relevant publications for a given topic and to maximise retrieval of articles with certain desired characteristics pertinent to a guideline.

For each guideline, all retrieved publications have been individually reviewed by a clinical editor and assessed in terms of quality, utility, and relevance. Preference is given to publications that:

1. Are designed with rigorous scientific methodology.
2. Are published in higher-quality journals (i.e. journals that are read and cited most often within their field).
3. Address an aspect of specific importance to the guideline in question.

Further information about the literature search and appraisal process is included in *Appendix B*.

1.5 Evidence Grading and Recommendations

Recommendations made within this guideline are supported by evidence from the medical literature and where possible the most authoritative sources have been used in the development of this guideline. In order to provide insight into the evidence basis for each recommendation, the following evidence hierarchy has been used to grade the level of authoritativeness of the evidence used, where recommendations have been made within this guideline.

Where the recommendations of international guidelines have been adopted, the evidence grading is assigned to the underlying evidence used by the international guideline. Where more than one source has been cited, the evidence grading relates to the highest level of evidence cited:

- **Level 1 (L1):**
  - Meta-analyses.
  - Randomised controlled trials with meta-analysis.
  - Randomised controlled trials.
  - Systematic reviews.

- **Level 2 (L2):**
  - Observational studies, examples include:
    - Cohort studies with statistical adjustment for potential confounders.
    - Cohort studies without adjustment.
    - Case series with historical or literature controls.
    - Uncontrolled case series.
  - Statements in published articles or textbooks.

- **Level 3 (L3):**
  - Expert opinion.
  - Unpublished data, examples include:
    - Large database analyses.
    - Written protocols or outcomes reports from large practices.

In order to give additional insight into the reasoning underlying certain recommendations and the strength of recommendation, the following recommendation grading has been used, where recommendations are made:

- **Recommendation Grade A (RGA):** Evidence demonstrates at least moderate certainty of at least moderate net benefit.
- **Recommendation Grade B (RGB):** Evidence is insufficient, conflicting, or poor and demonstrates an incomplete assessment of net benefit vs harm; additional research is recommended.
- **Recommendation Grade C (RGC):** Evidence demonstrates potential harm that outweighs benefit; additional research is recommended.
- **Recommendation of the GDG (R-GDG):** Recommended best practice based on the clinical experience of the Guideline Development Group members.

1.6 Guideline Development Group Members

The following table lists members of the Guideline Development Group (GDG) nominated by their respective organisations and the Clinical Governance Group. The GDG members have reviewed and provided feedback on the draft guideline relating to the topic. Each member has completed a declaration of conflicts of interest, which has been reviewed and retained by the MOPH.

Guideline Development Group Members		
Name	**Title**	**Organisation**
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1.7 National Clinical Guidelines & Pathways Committee Members

The following table lists members of the National Clinical Guidelines & Pathways Committee (NCGPC), appointed by the MOPH. The NCGPC members have reviewed and provided their feedback and approval of the guideline document. Each member has completed a declaration of conflicts of interest, which has been reviewed and retained by the MOPH.

National Clinical Guidelines & Pathways Committee (NCGPC) Members		
Name	**Title**	**Organisation**
Ms Huda Amer Al-Katheeri	Chair of the NCGPC, Director- Strategic Planning & Performance Department	Ministry of Public Health
Shk Dr Mohammed Hamad J. Al Thani	Co-Chair of NCGPC, Director of Public Health	Ministry of Public Health
Prof Anthony Akobeng	Chair Clinical Practice Guidelines Committee	Sidra Medicine
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Dr Hani Ben Hassen Al Kilani	Senior Consultant, Executive Director for Corporate Clinical Policy and Guidelines	Hamad Medical Corporation
Dr Egon Toft	VP and Dean	College of Medicine, Qatar University

1.8 Responsibilities of Healthcare Professionals

This guideline has been issued by the MOPH to define how care should be provided in Qatar. It is based upon a comprehensive assessment of the evidence as well as its applicability to the national context of

Qatar. Healthcare professionals are expected to take this guidance into account when exercising their clinical judgement in the care of patients presenting to them.

The guidance does not override individual professional responsibility to take decisions which are appropriate to the circumstances of the patient concerned. Such decisions should be made in consultation with the patient, their guardians, or carers and should consider the individual risks and benefits of any intervention that is contemplated in the patient's care.

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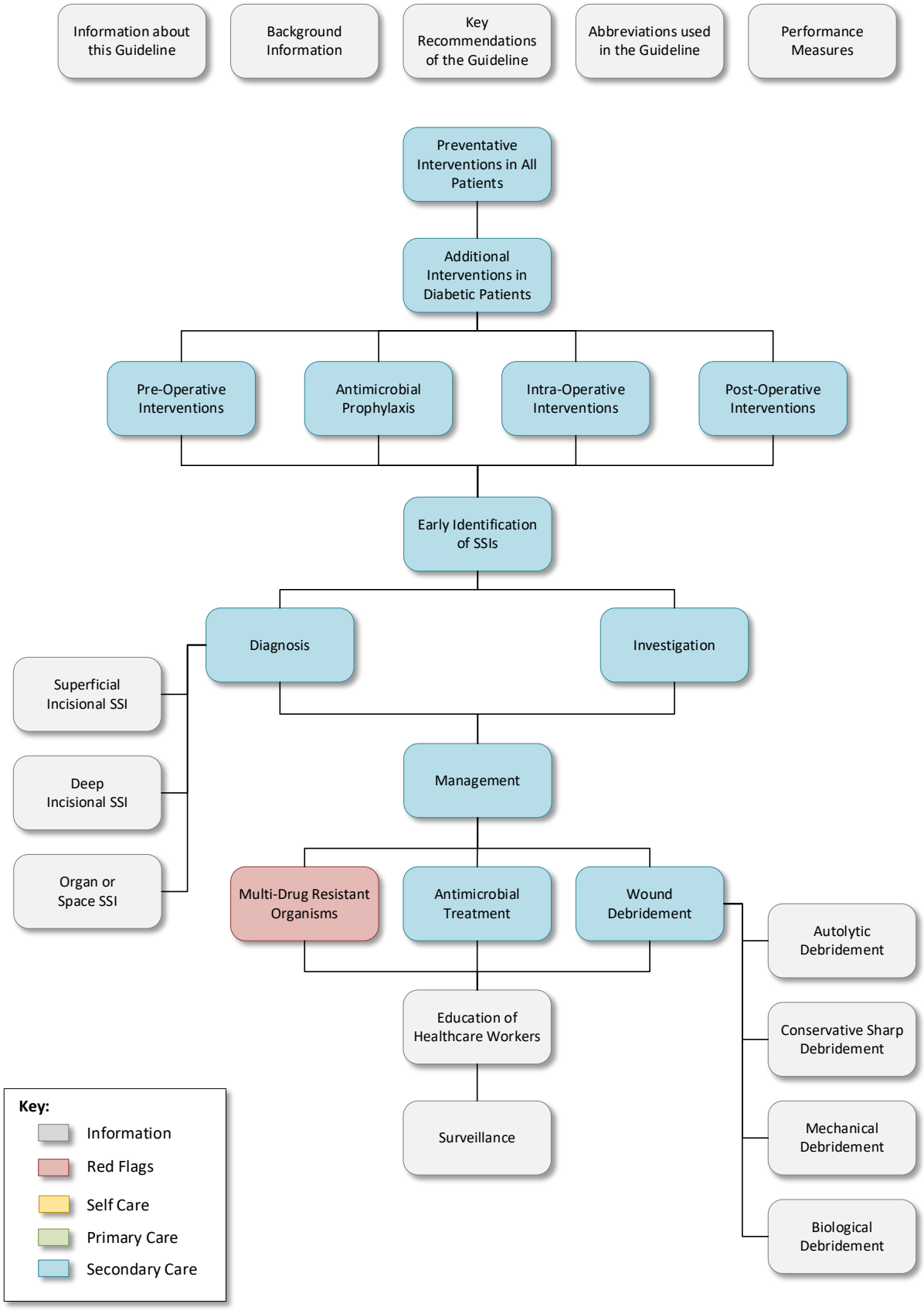
2 Surgical Site Infection Pathway

Click on a box below to see the relevant page of the Pathway.



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3 Key Recommendations of the Guideline

The key recommendations of this guideline are:

Preventative Interventions in All Patients (*Section 5*):

- All patients with potential wound healing problems should be proactively identified by assessing risk factors for developing an SSI (see *Section 4.4*) [**R-GDG**].
- All patients should be advised to shower or bathe, using soap one day prior to surgery *and* on the day of surgery[1–4].
    - The necessity of nasal decolonisation before surgery should be determined locally[2] [**L1**].
- All patients should be kept warm before, during, and after surgery, to minimise the risk of postoperative complications[5] [**L1, RGA**].
- Hair removal should not be used routinely due to the increased the risk of SSI[1,21,3] [**L1, RGC**].
    - If necessary, remove hair on the day of surgery using electric clippers with a single-use head [1–3].
- Bowel preparation is not recommended for routine use[2] [**L1, RGC**].
    - If required (e.g. for colorectal surgery), bowel preparation must be combined with antimicrobial prophylaxis[1,33,6] [**L1, RGA**].

Antimicrobial Prophylaxis (*Section 5.1.3*):

- Antimicrobial prophylaxis is not recommended for routine use in every patient undergoing a surgical procedure[1,2,4] [**L1, RGC**].
- Antimicrobial administration will depend on the type and nature of the procedure and **is required** for the following types of surgery[1,2,4] [**L1, RGA**]:
    - Clean surgery involving the placement of a prosthesis or implant.
    - Clean-contaminated surgery.
    - Contaminated surgery.
    - Dirty or infected surgery.
- Refer to *Appendix A* for recommendations on antimicrobial prophylaxis regimens by procedure.

Additional Preventative Measures in Diabetic Patients (*Section 6*):

- Impaired immunity and disruption of the inflammatory mechanisms in diabetic patients, diminish healing capability following surgery and increase the risk of SSI[7,7,8].
- Screen all diabetic patients for MRSA prior to surgery [**R-GDG**].
- Glycaemic control should be evaluated with both HBA_{1C} and blood glucose, according to the criteria in *Table 6.1*[9] [**L1, RGA**].
- Basal insulin should never be discontinued in patients with type 1 diabetic patients because of the risk of ketoacidosis[9] [**L1, RGC**].
- Metformin may be continued in cases of minor or ambulatory surgery unless severe renal failure is present[9] [**L1, RGA**].
- Metformin should be stopped the night before major surgery[9] [**L1, RGA**].
- Intra-operative and perioperative blood glucose control and appropriate management is required (see *Table 6.2*)[1,4,10] [**L1, RGA**].
- Transition from intravenous to subcutaneous insulin should be performed when[9] [**L1, RGA**]:
    - Blood glucose levels are stable for at least 24 hours; and
    - Eating has resumed.
- Metformin should not be restarted within 48 hours of major surgery[9] [**L1, RGC**].
- Metformin may be restarted only after acceptable renal function is confirmed[9] [**L1, RGA**].

Early Recognition of Surgical Site Infection (*Section 7*):

- After surgery, the patient should be regularly inspected for the signs and symptoms of SSI20 [L1, RGA].
- Non-complicated SSIs exhibit local signs of infection[2,11,12].
- Severe cases of SSI are accompanied by systemic signs of infection (e.g. fever, raised white blood cell count)[2,11,12].

Investigation (*Section 8*):

- The following investigations should be considered and performed when ≥1 sign or symptoms of SSI is identified or reported [**R-GDG**].
- Clinical specimens, wound swabs, or synovial fluid, or tissue cultures33 [L1, RGA]:
    - NB: Negative wound cultures do not reliably exclude infection[13] [**L1, RGC**].
    - Not all isolated organisms are considered to be significant. If unsure, the Medical Microbiologist can be contacted for interpretation and advice [**R-GDG**].
- Blood tests for infection markers:
    - C-reactive protein[13] [**L1, RGA**].
    - Erythrocyte sedimentation rate should not be used alone to exclude SSI[13] [**L1, RGB**].
    - Blood cultures if any evidence of sepsis[14] [**L1, RGA**].
    - Procalcitonin may also be beneficial in identifying patients with post-operative infections[15].
- Imaging studies may be considered when necessary[13] [**L1, RGB**].

Diagnosis (*Section 9*):

- Primary Care physicians should primarily focus on the diagnosis of SSI [**R-GDG**].
- All but the most minor SSIs should be managed in Specialist Care settings [**R-GDG**].
- The diagnosis of SSI must reflect **the deepest tissue level** where SSI criteria are met[16], i.e.:
    - If several types of SSI are observed at one site, the deepest tissue level affected must be reported[16] [**L1**].
    - If severity of SSI progresses over the surveillance period, the deepest tissue level affected must be reported[16] [**L1**].

Management (*Section 10*):

- The core principles of wound management, include:
    - Infected wounds should not be closed without[17] [**L1, RGC**]:
        - Thorough wound cleansing (see *Section 5.3.1*).
        - Debridement (see *Section 10.2*).
    - Contaminated wounds and clean wounds that are >6 hours old, should not be closed[17] [**L1, RGA**].
    - Antimicrobial treatment should be combined with appropriate debridement and wound cleansing[17–19] [**L1, RGA**]:
        - Topical antimicrobials and irrigation of wounds with antimicrobial solutions are not recommended[17] [**L1, RGB**].
    - To prevent further wound infection[17] [**L1, RGA**]:
        - Oxygenation and circulation should be optimised.
        - Wound cleansing and debridement should be performed regularly.

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Antimicrobial Treatment (*Section 10.1*):

- Before initiating antimicrobial therapy:
  - Ensure appropriate clinical samples are obtained from the patient.
  - These samples should depend on the type of infection such blood culture, urine sample, pus swab etc.
- Empirical broad-spectrum therapy to cover the most likely pathogens is recommended as the initial step, until microbiological data become available[20] [**L1, RGA**].
- Empirical antimicrobial therapy should be narrowed when culture tests and susceptibility results become available[20] [**L1, RGA**].

Wound Debridement (*Section 10.2*):

- Not all SSI wounds require debridement[19] [**L1, RGC**]:
- When debridement is required, consider one of the following methods[2,21] [**L1, RGA**]:
  - Autolytic Debridement (see *Section 10.2.1*).
  - Conservative Sharp Debridement (see *Section 10.2.2*).
  - Mechanical Debridement (see *Section 10.2.3*).
  - Biological Debridement (see *Section 10.2.4*).

4 Background Information

4.1 Definition

A **Surgical Procedure** refers to[1]:

- An operation where at least one incision is made through the skin or a mucous membrane, or:
- A reoperation through an incision that was left open during a prior operative procedure.

A **Surgical Wound** is a wound created when an incision is made with a scalpel or other cutting device and then closed. The procedure usually results in close approximation of the skin edges[1].

Surgical wounds are classified into one of the following categories[1,2,10,16]:

- **Clean (uninfected):**
  - No contamination encountered; and
  - The respiratory, alimentary, or genitourinary tracts are not entered.
  - Operative incisional wounds that follow non-penetrating (blunt) trauma.
- **Clean-contaminated:**
  - No contamination encountered; but
  - An incision through which the respiratory, alimentary, genital, or urinary tract is entered.
- **Contaminated:**
  - Acute, non-purulent inflammation is encountered; or
  - A major break in sterile technique or gross spillage from the gastrointestinal tract.
  - Open, fresh, accidental wounds >12-24 hours old.
  - Necrotic tissue without evidence of purulent drainage (for example, dry gangrene).
- **Dirty or infected:**
  - Acute inflammation with pus is encountered (e.g. emergency surgery for faecal peritonitis); or
  - The viscera are perforated.
  - Old traumatic wounds with faecal contamination or retained devitalised tissue and delayed treatment.

Surgical Site Infection (SSI) is:

- A surgical wound with local signs and symptoms of infection (e.g. heat, redness, pain and swelling) and:
- Systemic signs of fever, or a raised white blood cell count in more severe cases[2], that occurs within either 30 days[1,10,16] or 90 days (when an implant is involved), depending on the type of operation[16].

4.2 Classification of Surgical Site Infection

Surgical Site Infection can be any of the following types[1,11,12,16,22]:

- **Superficial incisional:**
  - Involving the skin or subcutaneous tissue only (see *Section 8.1*).
- **Deep incisional:**
  - Involving muscle and the tissues surrounding the muscles (see *Section 8.2*).
- **Organ or space:**
  - Involving organs, space between them or some implanted material (see *Section 8.3*).

4.3 Aetiology & Incidence

Surgical site infections (SSI) usually develop due to pathogens originating from the patient's endogenous flora[23]. In some cases, SSI pathogens may originate from preoperative infections or exogenous sources (e.g. instruments, surgical team or room environment)[23].

Common pathogens associated with SSI include[1,18,23,24]:

- *Staphylococcus aureus* (*S. aureus*)
- Coagulase-negative staphylococci.
- *Escherichia coli* (*E. coli*).
- *Enterococcus faecalis* (*E. faecalis*).
- *Pseudomonas aeruginosa* (*P. aeruginosa*).
- *Enterobacter spp*.
- *Klebsiella spp*.
- Streptococci.
- *Acinetobacter spp.*
- Fungi (e.g. *Aspergillus spp.*, *Candida spp.*, *Cryptococcus spp.*).

Across all hospitals in Qatar, the rate of surgical site infection was reported to be 0.38% in 2018, and 0.62% in 2019[25].

4.4 Risk Factors

Patient-related factors associated with an increased risk of SSI, include[1,3,12]:

- Preoperative risk factors:
  - Increasing age (until age of 65 years).
  - Recent radiotherapy and history of skin or soft tissue infection.
  - Previous colonisation, or infection, with a multi-drug resistant organism.
  - A current systemic infection.
  - History of heart or renal failure.
  - Diabetes mellitus.
  - Anaemia.
  - Obesity.
  - Malnutrition.
  - Immunosuppression and immunodeficiency states.
  - Mental health problems (e.g. depression, dementia).
  - Preoperative albumin <3.5 g/dL.
  - Total bilirubin >1.0 mg/dL.
  - High or low glycated haemoglobin (HBA_{1C}) or blood glucose level (see *Section 6.1*).
  - Preoperative hospital stay ≥2 days.
  - Alcohol abuse.
  - Smoking.
- Intraoperative risk factors:
  - Hypoxia.
  - Hypothermia.
  - Poor glycaemic control.
- Postoperative risk factors:
  - Hyperglycaemia.
  - Diabetes mellitus.
  - Immunosuppressive medications.

Procedure-related (exogenous) factors associated with increased risks of SSI include[1,3]:

- Perioperative risk factors:
  - Emergency procedure.
  - Higher wound risk (contaminated or dirty wound).
  - Complicated open surgery.
  - Inadequate antiseptic skin preparation.
  - Preoperative hair removal.
  - Inappropriate antimicrobial choice, administration, and/or duration.
- Intraoperative risk factors:
  - Long operating duration.
  - Blood transfusion.
  - Inadequate aseptic surgical technique.
  - Inadequate general infection prevention and control practices.
- Postoperative risk factors:
  - Poor postoperative wound care.
  - Blood transfusion.

5 Preventative Interventions in All Patients

5.1 Pre-Operative Preventative Interventions

All patients with potential wound healing problems should be proactively identified by assessing risk factors for developing an SSI (see *Section 4.4*) [**R-GDG**]. The final decision on whether to proceed with surgery, should be taken jointly between the surgeon, the anaesthetist, and the patient[1] [**L1, RGA**].

5.1.1 Patient-Related Interventions

Interventions related to patients that prevent surgical site infections, include:

Pre-Operative Washing:

- All patients should be advised to shower or bathe, using soap one day prior to surgery *and* on the day of surgery[1–4].
- If the patient is considered to be at increased risk of a multidrug resistant (MDR) colonisation or infection:
    - An antiseptic wash (e.g. chlorhexidine) is recommended over plain soap[2,3] [**L1, RGB**].
- Appropriate assistance should be provided to patients who are unable to bathe independently[2] [**L1, RGA**].

Nasal Bacterial Decolonisation:

- The necessity of nasal decolonisation before surgery should be determined locally[2] [**L1**]:
    - Conduct a risk assessment to review individual patient risk factors, the type of procedure, potential impact of infection, etc[2].
- Nasal mupirocin 2% cream is recommended if the patient is suspected or known to have colonisation with *S. aureus* (including MRSA)[2,3] [**L1, RGA**].

Clothing:

- The patient should be provided with specific theatre wear, which should be[2] [**L1**]:
    - Appropriate for the procedure and clinical setting.
    - Provide easy access to the operative site and areas for placing devices (e.g. intravenous cannulas).
    - Comfortable, easy to use, and provide dignity.

Temperature Regulation:

- All patients should be kept warm before surgery, to minimise the risk of postoperative complications[5] [**L1, RGA**]:
    - The patient may bring additional clothing from home to keep them comfortably warm[5].
    - The patient's temperature should be measured and documented in the hour before the patient leaves the ward or emergency department[5] [**L1**]:
    - If temperature is <36.0°C, active warming should be started immediately[5] [**L1, RGA**].
    - If temperature is ≥36.0°C, active warming should be started at least 30 minutes before induction of anaesthesia[5] [**L1, RGA**].
- NB: Active warming may be omitted to avoid delays in case of clinical urgency (e.g. bleeding or critical limb ischaemia)[5].

Hair Removal:

- Hair removal should not be used routinely due to the increased the risk of SSI[1,2,13] [**L1, RGC**].
- If necessary, remove hair on the day of surgery using electric clippers with a single-use head [1–3].
- Use of razors for hair removal, is prohibited [1–3] [**L1, RGC**].

Bowel Preparation:

- Bowel preparation is not recommended for routine use[2] [**L1, RGC**].
- If required (e.g. for colorectal surgery), bowel preparation must be combined with antimicrobial prophylaxis[1,3,16] [**L1, RGA**].
    - Orally with mechanical bowel preparation; and
    - Intravenously 1 hour before the operation.

Nutritional Support:

- Consider enhanced nutritional support for patients at risk of malnourishment, who are due to undergo major surgical procedures, especially oncological and cardiovascular operations[1,3,26] [**L1, RGB**].
- Consider, nutrient-enhanced nutritional formulas that contain a combination of arginine, glutamine, omega-3 fatty acids, and nucleotides[1].

5.1.2 Healthcare Staff Interventions

Interventions related to healthcare staff that prevent surgical site infections, include:

Clothing:

- Medical personnel should wear specific, clean, non-sterile, theatre wear in all areas where operations are undertaken and minimise their movements in and out of the operating area[2,27] [**L1**].
- Hair coverings should be used in the preoperative care unit and should cover all hair[27] [**L1**]. If surgical or other healthcare personnel have beards or other facial hair, this must also be covered[27] [**L1**].
- The operating team should not wear hand jewellery, artificial nails, or nail polish during operations[2] [**L1, RGC**].

Personal Protective Equipment:

- Surgical masks are required for personnel in the operating theatre at all times[27] [**L1**].
- If there is a risk of facial or mucous membrane splashing or contamination, then goggles, or visors should also be worn in line with infection prevention and control policy [**R-GDG**].

Hygiene:

- Hands and forearms should be washed using surgical scrubbing techniques prior to surgery[2,3] [**L1, RGA**]. If the surgical staff become contaminated after scrubbing, they should re-scrub[2] [**L1, RGA**].

5.1.3 Antimicrobial Prophylaxis

Antimicrobial prophylaxis is not recommended for routine use in every patient undergoing a surgical procedure[1,2,4] [**L1, RGC**].

Antimicrobial administration will depend on the type and nature of the procedure and **is required** for the following types of surgery[1,2,4] [**L1, RGA**]:

- Clean surgery involving the placement of a prosthesis or implant:
  - Additional prophylactic antimicrobial doses after the surgical incision is closed in the operating room are not recommended.
- Clean-contaminated surgery:
  - Additional prophylactic antimicrobial doses after the surgical incision is closed in the operating room are not recommended.
- Contaminated surgery:
  - Additional prophylactic antimicrobial doses after the surgical incision is closed in the operating room **may be** considered.
- Dirty or infected surgery:
  - Antimicrobial treatment, in addition to prophylaxis, is recommended.

When selecting antimicrobials for prophylaxis, consider the following[2,3,20] [**L1, RGA**]:

- Antimicrobial recommendations (See *Table 5.1.2)*.
- Health status of the patient (e.g. lean body weight, kidney function, liver function, etc.).
- Type of possible infective agents causing SSI (e.g. MDRO).
- Epidemiology of local antimicrobial resistance.
- Characteristics of the antimicrobial:
  - Spectrum of activity against potential organisms:
    - Narrower spectrum of antimicrobials are always encouraged to serve antimicrobial stewardship[3,28].
  - Antimicrobial infusion time.
  - Pharmacokinetics of the antimicrobial agent and its half-life.
  - Potential adverse effects.

Consult with both Infectious Disease Specialists and Medical Microbiologists, as required, to seek advice on any aspect of antimicrobial prophylaxis against SSIs [**R-GDG**]. Effective communication between surgeons and patients on antimicrobial prophylaxis is also necessary [**R-GDG**]. Patients should be involved in the decision-making process in determining whether antimicrobial prophylaxis is necessary [**R-GDG**].

Refer to *Appendix A* for recommendations on antimicrobial prophylaxis regimens in adults and children, according to the nature of the surgical procedure that is planned.

5.2 Intra-Operative Preventative Interventions

The intraoperative phase is the time from induction of anaesthesia until the surgical procedure is complete and the surgical wound is closed[10].

5.2.1 Healthcare Staff Interventions

The surgeon and operating team should wear sterile gowns and gloves during the operation[1–3,27] [**L1, RGA**]:

- Double-gloving is not required[1] but may be considered if there is a high risk of glove perforation[2] [**L1, RGB**].

- Changing of gloves during the operation or using specific types of gloves is not normally required[1] [**L1**].

All surgical team must take all precautions to prevent sharps and needle stick injuries in line with policy [**R-GDG**].

5.2.2 Skin Preparation

The use of non-iodophor-impregnated incise drapes should be avoided[2–4] [**L1, RGC**]. If an incise drape is required (e.g. in orthopaedic or cardiac surgical procedures), an iodophor-impregnated drape should be used unless the patient has an iodine allergy or other contraindication[2,3] [**L1, RGA**]. Plastic adhesive incise drapes are not recommended[1] [**L1, RGB**].

The skin at the surgical site should be prepared using an antiseptic agent (unless contraindicated) immediately prior to incision[1–4] [**L1, RGA**].

When selecting the antiseptic agent, consider the following:

- Surgical site.
- Pre-operative health status of the patient.
- Recommendations in *Table 5.2.2* below.

Antiseptic agent	Notes
First-Choice:	
Alcohol-based solution of chlorhexidine	Preferred over the aqueous solution unless the surgical site is next to a mucous membrane.
Aqueous solution of chlorhexidine	If the surgical site is next to a mucous membrane.
Second-Choice:	
Alcohol-based solution of povidone-iodine	If chlorhexidine is contraindicated.
Third-Choice:	
Aqueous solution of povidone-iodine	If both an alcohol-based solution and chlorhexidine are unsuitable.

Table 5.2.2: Selection of an Antiseptic for Skin Preparation[1–4,29]**.**

5.2.3 Maintaining Patient Homeostasis

Maintaining body temperature during surgery is important to avoid hypothermia and minimise the risks of developing an SSI[1–5] [**L1, RGA**]:

- The patient's temperature should be measured and documented[5] [**L1**]:
  - Before induction of anaesthesia.
  - Every 30 minutes until the end of surgery.
- If a patient arrives at the theatre suite with a temperature <36.0°C:
  - The incident should be reported as per the standard protocol.
  - Anaesthesia should not begin unless there is a clinical urgency for the surgery.
- Normothermia should be maintained at all times during the operation[1–5] [**L1, RGA**]:
  - Consider using warming devices according to the operative circumstances, including [1,3,5]:
    - Forced-air warming system.

        - Waterbed system.
        - Resistive heating mattress or blankets.
    - Patient should be covered with a warmed blanket at any time if an active warming device cannot be used [**R-GDG**].
- All fluids (e.g. intravenous or irrigation fluids, blood products) should be warmed[5] [**L1, RGA**].

During surgery and recovery, ensure maintenance of:

- Optimal oxygenation[1,2,4]:
    - Haemoglobin saturation should be >95%[2] [**L1, RGA**].
- Normovolaemia and adequate perfusion[2,3] [**L1, RGA**]:
    - Prevents tissue hypoxia.
    - Consider using hemodynamic goal-directed therapy[1,3] [**L1, RGA**].
- Control of blood glucose levels to prevent hypoglycaemia [4,10,7,8] [**L1**]

5.2.4 Wound Manipulation and Closure

The following manipulations are not recommended for routine use:

- Diathermy for surgical incisions[2] [**L1**].
- Using wound protector devices[3] [**L1, RGB**].
- Wound irrigation with saline or aqueous PVP-I solutions or with antimicrobials[1–4] [**L1, RGB**].
- Intracavity lavage[2,4] [**L1**].
- Application of a topical antimicrobial agent (including vancomycin powder) to the wound[2–4] [**L1, RGB**].
- Impregnating prosthetic devices in antiseptic solutions prior to implantation[4] [**L1, RGB**].

Consider the following methods of wound closure:

- Sutures:
    - Consider either absorbable or non-absorbable sutures[30].
    - Sutures should be considered rather than staples to close the skin after a caesarean section[2] [**L1, RGA**].
    - Antimicrobial triclosan-coated sutures are preferred in all types of surgery (especially in paediatric population [2,31])[1–4] [**L1, RGB**].
- Staples:
    - Useful for minor wounds with linear laceration[30] [**L2**].
- Adhesive tapes and skin glues:
    - May be considered for percutaneous wounds or simple paediatric cases[30] [**L2**].
    - May be used as an adjunct to sutures or staples to strengthen the closure[30] [**L2**].

After wound closure, the incision should be covered with an appropriate dressing [1,2] [**L1, RGA**].

- Antimicrobial and advanced dressings (hydrocolloid, hydroactive, silver-containing (metallic or ionic), and polyhexamethylene biguanide) are not preferred over a standard dry absorbent dressing[1,16] [**L1, RGB**].
- There is insufficient evidence to recommend colorimetric band-aids for routine use[32].

No recommendation can be given for the appropriate surgical duration due to numerous independent variables that can impact the time (age, wight and medical conditions of the patient, skills and experience of the surgeon, etc.) [**L1**][33]. Nevertheless, operative times should be kept to the minimum as the likelihood

of SSI increases linearly: 5% for every 10 min of time, 13% for every 15 min of time, 17% for every 30 min of time, and 37% for every 60 min of time[33].

5.3 Post-Operative Preventative Interventions

5.3.1 Maintaining Patient Wellbeing

Maintain the patient's temperature post-operatively[5] [**L1, RGA**]:

- Do not wash the patient with cold water [**R-GDG**].
- The patient's temperature should be measured and documented:
  - On admission to the recovery room.
  - Every 15 minutes while in the recovery room.
  - On arrival at the ward.
  - At 4-hourly observations while on the ward (if temperature is normal); or
  - At least every 30 minutes while on the ward (if warming was applied).
- If the patient's temperature is <36.0°C, they should be actively warmed until they are comfortably warm:
  - Consider using a forced-air warming system.

Glycaemic control is required postoperatively in patients with and without diabetes[1,2,4]:

- Hypo- and hyperglycaemia should be avoided.
- Blood glucose target levels should not exceed 200 mg/dL[4] [**L1, RGB**].
- Insulin should not be given routinely to patients who do not have diabetes to optimise blood glucose.

Patients should be advised to not take showers until 48 hours after surgery[2] [**L1**].

5.3.2 Post-Operative Wound Care

All wounds should be kept as clean as possible:

- The wound should remain untouched for up to 48 hours after surgery unless cleansing is necessary[18] [**L2, RGA**].
- An aseptic non-touch technique should be practised when undertaking wound dressings and wound management[2,3,18] [**L1, RGA**].

If cleansing is required:

- It should be performed with[2] [**L1, RGA**]:
  - Warm sterile saline up to 24-48 hours post-surgery.
  - Tap water after 48 hours post-surgery, or if the wound has separated or has been surgically opened to drain pus.
- The removal of normal exudates is not required[18] [**L2, RGB**].
- One of these two antiseptics may be applied to the wound after cleansing[17] [**L1, RGA**]:
  - Povidone-iodine 10% solution undiluted twice daily.
  - Cetrimide 15% + chlorhexidine gluconate 1.5%.
- Excessive cleansing should be avoided[18] [**L2, RGC**].

Any drain or drain site should be inspected to ensure that it is functioning properly and that there are no signs of infection[27] [**L1, RGA**]. When the volume of fluid drain reduces to acceptable levels, the drain should be removed[27].

Wound healing by primary intention occurs when the wound edges are approximated together, and the wound is closed [27]. Such wounds should **not** be treated with[2] [**L1, RGB**]:

- Topical antimicrobial agents.
- Irritating solutions (e.g. hydrogen peroxide).

Wound healing by secondary intention occurs when the wound is left open to heal and closes by granulation[27]. Such wounds should **not** be treated with[2] [**L1, RGB**]:

- Eusol and gauze.
- Moist cotton gauze.
- Mercuric antiseptic solutions.
- Irritating solutions (e.g. hydrogen peroxide).

6 Additional Preventative Interventions in Diabetic Patients

Impaired immunity and disruption of the inflammatory mechanisms in diabetic patients, diminish healing capability following surgery and increase the risk of SSI[7,7,8]. Therefore, diabetic patients should be given special attention[9] [**L1, RGA**].

6.1 Pre-Operative Interventions

Screen all diabetic patients for MRSA prior to surgery [**R-GDG**].

During the preoperative consultation[9] [**L1, RGA**]:

- Glycaemic control should be evaluated with both HBA_{1C} and blood glucose, according to the criteria in *Table 6.1*.
- Recent acute events of hyperglycaemia or hypoglycaemia should be identified.
- Risk of specific diabetes complications (e.g. gastroparesis, heart disease, or kidney disease) should also be evaluated.

HBA_{1C}	Blood Glucose	Recommendation
<5.0%	**<60 mg/dL**	Surgery should be postponed if possible
5.0 - 5.9%	**60 - 119 mg/dL**	Advice of a diabetologist is required
6.0% - 8.0%	**120 - 180 mg/dL**	Surgery may be performed
8.1 – 9.0%	**181 - 300 mg/dL**	Advice of a diabetologist is required
>9.0%	**>300 mg/dL**	Surgery should be postponed if possible

Table 6.1: Evaluation of Preoperative Levels of Glycated Haemoglobin (HBA_{1C}) and Blood Glucose in Diabetic Patients Requiring Surgery[9]**.**

Note:

- For each 1% increase in HBA_{1C}, the risk of complications increases by 40%[34].
- HBA_{1C} levels >7.0% have a negative prognostic value in unrecognised diabetic patients[35].
- Basal insulin should never be discontinued in patients with type 1 diabetic patients because of the risk of ketoacidosis[9] [**L1, RGC**].
- Metformin may be continued in cases of minor or ambulatory surgery unless severe renal failure is present[9] [**L1, RGA**].
- Metformin should be stopped the night before major surgery[9] [**L1, RGA**].

6.2 Peri-Operative Interventions

Perioperative blood glucose control and appropriate management is required (see *Table 6.2*)[9] [**L1, RGA**]:

- Appropriate blood measurements should be carried out using arterial or venous blood.
- Glycaemia should be monitored every 1-2 hours.
- Hyperkalaemia should be controlled by insulin.
    - Potassium level target 4-4.5 mmol/L [**R-GDG**].
    - Potassium blood concentration should be measured [**R-GDG**]:
        - Every 4 h if potassium concentration is stable.
        - 1 h after each change of insulin flow rate.

Blood Glucose	Recommendation	Methods of Glycaemic Control
Critically Ill Patients		
<110 mg/dL	Surgery is not recommended	Intravenous insulin
140 - 180 mg/dL	Target levels	
200 mg/dL	The upper limit	
>200 mg/dL	Surgery is not recommended	
Non-Critically Ill Patients		
<100 mg/dL	Surgery should be avoided	Scheduled subcutaneous insulin, supplementing this with basal, nutritional, and sliding scale components
100 - 140 mg/dL	Target levels	
140 - 180 mg/dL	Permissible random glucose values	
200 mg/dL	The upper limit	
>200 mg/dL	Surgery is not recommended	

Table 6.2: Perioperative Glycaemic Management in Hospitalised Diabetic Patients[1,4,9,36].

The following methods of perioperative glycaemic control are not recommended[36]:

- Oral hypoglycaemic medications.
- Exclusive use of a sliding scale insulin regimen.

6.3 Intra-Operative Interventions

During and after surgery, plasma insulin levels decrease and blood glucose levels rise due to surgical stress, bringing surgical patients at high risk for hyperglycaemia[1,9] [**L1**]:

- Intraoperative blood glucose measurement and appropriate management is required[1,4,10] [**L1, RGA**].
- The severity of hyperglycaemia depends on[9]:
  - The type of surgery.
  - Invasiveness of the procedure.
  - Duration of surgery.
  - Patient's medical condition (e.g. obesity, hypoxia, etc.).

Sufficient pain management should be provided, as uncontrolled pain increases the risk of hyperglycaemia[9] [**L1, RGA**]. Patients with poor glycaemic control may require higher analgesic needs[9].

6.4 Post-Operative Interventions

Postoperative care of diabetic patients depends on[9] [**L1**]:

- Patients' glucose control.
- Type and stage of diabetes.
- The patient's pre-operative treatment regimen.

Postoperative blood glucose control[4,9] [**L1, RGA**]:

- Sampling should be performed regularly, even in the absences of hypoglycaemia symptoms.
- Glucose should be administered immediately:
    - If hypoglycaemia is detected but clinical signs are absent.
    - If signs of hypoglycaemia are present.
- Insulin should be administered if hyperglycaemia is detected.
- If hyperosmolar coma is suspected:
    - Blood electrolytes should be immediately measured.
    - Specific management should be provided in an Intensive Care Unit (ICU).

Transition from intravenous to subcutaneous insulin should be performed when[9] [**L1, RGA**]:

- Blood glucose levels are stable for at least 24 hours; and
- Eating has resumed.

Metformin should not be restarted within 48 hours of major surgery[9] [**L1, RGC**]. It may be restarted only after acceptable renal function is confirmed [9] [**L1, RGA**].

7 Early Recognition of Surgical Site Infection

After surgery, the patient should be regularly inspected for signs and symptoms of SSI[27] [**L1, RGA**]. The drain and the drain site should be also inspected to ensure proper functioning and to detect signs of infection[27] [**L1, RGA**].

Non-complicated SSIs exhibit local signs of infection, such as[2,11,12]:

- Heat (calor).
- Redness (rubor).
- Swelling (tumor).
- Pain and tenderness (dolor).
- Purulent drainage from the wound site.
- Loss of function of affected site or organ (functio laesa).
- Delayed healing.

Severe cases of SSI are accompanied by systemic signs of infection (e.g. fever, raised white blood cell count, and raised CRP)[2,11,12].

Progression of SSIs and extension to deep tissue can lead to complications, including[11,12]:

- Abscess surrounded by inflammation.
- Wound separation (dehiscence).
- Herniation.
- Life-threatening conditions (necrosis, gangrene, necrotizing fasciitis, severe sepsis including septic shock):
    - The patient must be immediately referred to hospital, if not already an inpatient.
    - If sepsis is suspected, refer to the MOPH National Clinical Guideline on *The Diagnosis and Management of Sepsis*[14].

8 Investigation

The following investigations should be considered and performed when ≥1 sign or symptoms of SSI is identified or reported [**R-GDG**]:

- Clinical specimens, wound swabs, or synovial fluid, or tissue cultures[13] [**L1, RGA**]:
  - Recommended for patients with hospital-acquired or with community-acquired infections at risk of resistant pathogens (e.g. previous antimicrobial therapy) and in critically ill patients[20] [**L1, RGA**].
    - It is preferable to send clinical specimens such as pus, fluids, and tissues in sterile containers rather than sending swabs [**R-GDG**].
    - When swabs are taken, they should be inserted in their transport media and promptly sent to the clinical microbiology Laboratory [**R-GDG**].
  - NB: Negative wound cultures do not reliably exclude infection[13] [**L1, RGC**].
  - NB: Not all isolated organisms are considered to be significant. If unsure, the Medical Microbiologist can be contacted for interpretation and advice [**R-GDG**].

- Blood tests for infection markers:
  - C-reactive protein[13] [**L1, RGA**].
  - Erythrocyte sedimentation rate should not be used alone to exclude SSI[13] [**L1, RGB**].
  - Blood cultures if any evidence of sepsis[14] [**L1, RGA**].
    - Cultures should be performed before the administration of antimicrobial agents[20][**L1, RGA**]. This should be carried out aseptically to prevent blood culture contamination.
  - Procalcitonin may also be beneficial in identifying patients with post-operative infections[15].

- Imaging studies may be considered when necessary (e.g. in patients with suspected bone, joint, or implant infection)[13] [**L1, RGB**].

9 Diagnosis

Primary Care physicians should primarily focus on the diagnosis of SSI [**R-GDG**]. All but the most minor SSIs should be managed in Specialist Care settings [**R-GDG**].

The type of SSI should be specified in the diagnosis[16] [**L1**]:

- One of the following types should be considered[1,11,12,16,22]:
  - Superficial Incisional SSI (see *Section 9.1*).
  - Deep Incisional SSI (see *Section 9.2*).
  - Organ or Space SSI (see *Section 9.3*).

- The diagnosis of SSI must reflect **the deepest tissue level** where SSI criteria are met[16], i.e.:
  - If several types of SSI are observed at one site, the deepest tissue level affected must be reported[16] [**L1**].
  - If severity of SSI progresses over the surveillance period, the deepest tissue level affected must be reported[16] [**L1**].

9.1 Superficial Incisional SSI

Diagnosis of a superficial incisional SSI should be made by a physician or other trained healthcare professional [**R-GDG**].

A superficial incisional SSI should be diagnosed when[16]:

- The infection occurs within 30 days of surgery (day 1 is the day of the surgical procedure) *and*:
- Infection involves only skin and subcutaneous tissue; *and*:
- At least one of the following is present:
  - Purulent drainage from the incision.
  - Microorganism(s) identified in the incision or subcutaneous tissue by a culture or non-culture based microbiological testing:
    - Not all isolated organisms are considered to be significant.
    - If unsure, the Medical Microbiologist can be contacted for interpretation and advice [**R-GDG**].
  - Superficial incision opened by a doctor and the patient has at least one of the following signs or symptoms:
    - Heat.
    - Redness.
    - Localised swelling.
    - Localised pain or tenderness.

Superficial incisional SSI should be diagnosed as either[16]:

- Primary:
  - Occurs in the primary incision in a patient that has had an operation with one or more incisions; or
- Secondary:
  - Occurs in the secondary incision in a patient that has had an operation with more than one incision.

The following **do not** qualify as a superficial incisional SSI[16]:

- Primary cellulitis.
- A stitch abscess alone, i.e. minimal inflammation and discharge at the points of suture penetration.
- A localised stab wound or pin site infection (a laparoscopic trocar site is not a stab wound).
- Sero-sanguinous discharge and not pus.

9.2 Deep Incisional SSI

Diagnosis of a deep incisional SSI should be made by a physician or other trained healthcare professional [**R-GDG**].

A deep incisional SSI should be diagnosed when[16]:

- The infection occurs within 30 or 90 days of surgery (day 1 is day of the surgical procedure) according to the surgical procedure performed (see *Table 9.2)*; and:
- Infection involves deep soft tissues (e.g. fascial and muscle layers); and:
- At least one of the following is present:
    - Purulent drainage from the incision.
    - The incision spontaneously dehisces or was opened by a doctor and:
        - Significant microorganism(s) identified in the incision or deep tissue by a culture or non-culture based microbiological testing; *or*:
        - The patient has fever (>38°C) and/or localised pain or tenderness.
    - An abscess or other evidence of infection involving the deep incision is detected on gross anatomical or histopathologic exam, or imaging test.

NB: Not all isolated organisms are considered to be significant. If unsure, the Medical Microbiologist can be contacted for interpretation and advice [**R-GDG**].

Deep incisional SSI should be diagnosed as either primary or secondary (see *Section 9.1* for definition)[16]:

- Secondary incisional SSIs are only followed for a 30-day period regardless of the surveillance period for the primary site.

Operative Procedures	
30-Day Surveillance	
• Abdominal aortic aneurysm repair • Abdominal hysterectomy • Appendix surgery • Bile duct, liver, or pancreatic surgery • Caesarean section • Carotid endarterectomy • Colon surgery • Exploratory laparotomy • Gallbladder surgery • Gastric surgery • Heart transplant • Kidney surgery • Kidney transplant • Hernial repair	• Laminectomy • Limb amputation • Liver transplant • Neck surgery • Ovarian surgery • Prostate surgery • Rectal surgery • Shunt for dialysis • Small bowel surgery • Spleen surgery • Thoracic surgery • Thyroid and/or parathyroid surgery • Vaginal hysterectomy
90-Day Surveillance	
• Breast surgery • Cardiac surgery • Coronary artery bypass graft with chest incision only or with both chest and donor site incisions • Craniotomy • Spinal fusion • Open reduction of fracture	• Herniorrhaphy • Hip prosthesis • Knee prosthesis • Pacemaker surgery • Peripheral vascular bypass surgery • Ventricular shunt • Any surgery involving an implant or foreign body.

Table 9.2: Surveillance Periods for Deep Incisional SSI[16].

9.3 Organ or Space SSI

Organ or space SSI should be diagnosed when all four criteria listed below are met[16]:

- The infection occurs within 30 or 90 days of surgery (day 1 is day of the surgical procedure) according to the surgical procedure performed (see *Table 9.2) and*:
- Infection involves any part of the body deeper than the fascial or muscle layers that is opened or manipulated during the operative procedure, *and*:
- Infection occurs at a specific organ or space site listed below; and
    - Artery or vein.
    - Bone.
    - Breast.
    - Deep pelvic tissue infection or other infection of the male or female reproductive tract.
    - Intervertebral disc space.
    - Mastoid.
    - Endocardium.
    - Endometrium.
    - Gastrointestinal tract.
    - Intra-abdominal space not otherwise defined.
    - Intracranium.
    - Joint or bursa.
    - Lower respiratory tract.
    - Mediastinium.
    - Meninges or brain ventricles.
    - Myocardium or pericardium.
    - Oral cavity (mouth, tongue, or gums).
    - Peri-prosthetic joint.
    - Sinuses.
    - Spinal cord.
    - Upper respiratory tract: pharynx, larynx, epiglottis.
    - Urinary tract.
    - Vaginal cuff.
- At least one of the following is present:
    - Purulent drainage from a drain that was placed into the organ or space.
    - Significant microorganism(s) identified from fluid or tissue in the organ or space by a culture or non-culture based microbiologic testing.
    - An abscess or other evidence of infection involving the organ or space incision is detected on gross anatomical or histopathologic exam, or imaging test.

10 Management

The core principles of wound management, include:

- Infected wounds should not be closed without[17] [**L1, RGC**]:
  - Thorough wound cleansing (see *Section 5.3.1*).
  - Debridement (see *Section 10.2*).
- Contaminated wounds and clean wounds that are >6 hours old, should not be closed:
  - Apply the delayed primary closure approach to such wounds[17] [**L1, RGA**].
- Antimicrobial treatment should be combined with appropriate debridement and wound cleansing[17–19] [**L1, RGA**]:
  - Topical antimicrobials and irrigation of wounds with antimicrobial solutions are not recommended[17] [**L1, RGB**].
- To prevent further wound infection[17] [**L1, RGA**]:
  - Oxygenation and circulation should be optimised.
  - Wound cleansing and debridement should be performed regularly.

10.1 Administration of Antimicrobials

The aim of treatment is to ensure most effective antimicrobial therapy but at the same time preventing or minimising the emergence of multi-drug resistant organisms in addition to other infections such as those caused by *Clostridium difficile* [**R-GDG**].

Antimicrobial stewardship practices include:

- The antimicrobial dose should be tailored to the patient's needs[20] [**L1, RGA**].
- Serum therapeutic drug monitoring should be performed for anti-infective agents with narrow toxic/therapeutic index such as aminoglycosides and glycopeptides[37] [**L1, RGA**].
- Evaluation of the appropriateness and need for antimicrobial treatment should be carried out on a daily basis[20] [**L1, RGA**].

If infection develops after surgery, antimicrobial therapy should be initiated as soon as the infection has been recognised[17,20]:

- Before initiating antimicrobial therapy:
  - Ensure appropriate clinical samples are obtained from the patient. These samples should depend on the type of expected infection such blood culture, pus or tissue sample, urine sample, etc.
  - Check for previous particularly recent microbiology reports for significant organisms and particularly alert organisms (such as MRSA, MDRO, etc.) which would influence choice of empirical therapy [**R-GDG**].
- Empirical broad-spectrum therapy to cover the most likely pathogens is recommended as the initial step based on local epidemiology of organisms and antibiograms (antimicrobial susceptibility patterns), until microbiological until microbiological critical verbal or documented reporting become available[20] [**L1, RGA**].
- Empirical antimicrobial therapy should be narrowed down to least possible broad-spectrum agents once culture tests and susceptibility results become available[20] [**L1, RGA**].

When selecting antimicrobials for empirical antimicrobial therapy, consider the following[2,3,20] [**L1, RGA**]:

- Likely microorganism(s), local epidemiology, and known sensitivity patterns in Qatar.
- Site of infection.
- Clinical severity and preferred route of administration.
- Relevant drug interactions.
- Recent antimicrobial use (past 90 days).
- Health status of the patient, including:

  - Allergies.
  - Renal or hepatic impairment.
- History of any previous colonisation or infection with alert organisms such as MRSA, MDROs etc.
- Characteristics of the medication:
  - Spectrum of antimicrobial activity.
  - Pharmacokinetics of the antimicrobial and its half-life.
  - Potential adverse effects.
  - Potential interactions with other concurrently used medications.

NB:

- Rifampicin should not be used on its own for antimicrobial therapy[38] [**L1, RGC**] because of rapid emergence of rifampicin resistance.
- If uncertainty of appropriate patient-specific antimicrobial therapy remains, consult infectious disease team[39] [**L1**].

Duration of treatment:

- Depends upon the microorganism identified on culture and the clinical course of the patient[37,40] [**L1, RGA**]. Procalcitonin may be useful as a biomarker to guide duration and cessation of antimicrobial therapy[20] [**L1, RGA**].
- Intra-abdominal infection:
  - 4 days are usually sufficient in moderately ill patients[20] [**L1, RGA**].
  - 8 days is not required[20] [**L1, RGB**].
- Blood stream infection:
  - 5-7 days are usually sufficient[20] [**L1, RGA**].
  - 7-21 days is not usually required[20] [**L1, RGB**] except for certain infective agents such as *S. aureus* whereby in bacteraemia 14 days of therapy is at least recommended[41,42] [**L1, RGA**].
- Ventilator associate pneumonia (VAP):
  - 8 days are usually sufficient[20] [**L1, RGA**].
  - 15 days is not required[20] [**L1, RGB**].

10.1.1 Drug Resistant Infections Organisms

In case of high-risk MRSA and other high-risk multi-drug resistant organisms, the following agents are recommended or according to known susceptibility profiles [**R-GDG**]:

- MRSA:
  - Vancomycin, Teicoplanin, Linezolid, Daptomycin or Clindamycin when susceptibility is known[37,39,43] [L1, RGA].
- Extended Spectrum Beta-Lactamase (ESBL)-Producing Organisms:
  - Meropenem, Ertapenem, Aminoglycosides or Quinolones such as Ciprofloxacin if sensitive.
- Carbapenem-Resistant Organisms (CRO):
  - Amikacin, Colistin, Tigecycline and other combination antimicrobial agents according to Microbiology Laboratory susceptibility results.
- Glycopeptide-Resistant Enterococci (GRE):
  - Linezolid, Daptomycin or according to susceptibility results.

10.2 Wound Debridement

Wound debridement may be necessary for wound healing [18,19][**L1, RGA**]:

- Not all SSI wounds require debridement[19] [**L1, RGC**]:
    - Consider leaving hardened eschar in place rather than remove it and create an open wound (e.g. in case of dry gangrene).
    - The following methods are not recommended[2,19,21] [**L1, RGC**]:
        - Enzymatic debridement.
        - Chemical debridement with eusol and gauze.

When debridement is required, consider one of the following methods[2,21] [**L1, RGA**]:

- Autolytic Debridement (see *Section 10.2.1*).
- Conservative Sharp Debridement (see *Section 10.2.2*).
- Mechanical Debridement (see *Section 10.2.3*).
- Biological Debridement (see *Section 10.2.4*).

10.2.1 Autolytic Debridement

Autolytic debridement is the most conservative and natural form of debridement[19]. The process is very selective but slow[19]. Autolytic debridement is indicated as adjunctive therapy in infected wounds[19] [**L1, RGA**] but is contraindicated in patients at risk of severe infection or sepsis[19] [**L1, RGC**].

The following should be considered when applying the autolytic process[19]:

- The wound may increase in size.
- Odour may increase.
- Exudate may increase.
- Maceration of skin around the wound may occur.

Consider using[21]:

- Moisture donating products:
    - Hydrocolloids.
    - Hydrogels.
    - Honey-based ointments.
    - Silver sulfadiazine.
- Moisture absorbing products:
    - Alginates.
    - Cadexomer iodine.
    - Hydrofiber®.
- Protection for the skin surrounding the wound is recommended to prevent further damage[19,21] [**L1, RGA**].

10.2.2 Conservative Sharp Debridement

Conservative sharp debridement is the fastest method of wound debridement[21]. It may be performed by a skilled clinician (a surgeon is not required), using sterile instruments and aseptic techniques[19] [**L1, RGA**].

Sharp debridement is contraindicated in the following situations[19] [**L1, RGC**]:

- The interface between viable and nonviable tissue is difficult to determine.
- Extensive undermining or tunnelling.
- Excessive or unexpected bleeding.
- Bleeding disorders.
- Wounds on face, hands, and feet near nerves, vascular structures, grafts, prosthesis, dialysis fistulae, or joints.
- Presence of an abscess.

- Uncontrolled pain.
- Malignant cutaneous wounds.

The following should be considered when applying sharp debridement[19,21]:

- Devitalised tissue should be removed with caution from infected wounds[19] [**L1, RGA**].
- The wound may increase in size.
- Minimal pain and bleeding usually occur but in rare cases pain management may be required.
- Patients taking anticoagulant medications should be treated with caution.
- Antimicrobial coverage may be required.
- Repeated debridement is often required.

10.2.3 Mechanical Debridement

Mechanical debridement is nonselective, physical method of removing both viable and nonviable tissue and debris[19]. It is indicated for[19] [**L1, RGA**]:

- Infected wounds.
- Wounds with minimally viable tissue.
- Heavily necrotic wounds with nonviable tissue greater than 50%.

Mechanical debridement is contraindicated in the following situations[19] [**L1, RGC**]:

- The wound is superficial or with small amounts of necrotic tissue.
- Presence of significant healthy granulation tissue.
- Uncontrolled pain.

The following should be considered when applying the mechanical debridement[19]:

- The wound may increase in size.
- Pain management is required.

10.2.4 Biological Debridement

Biological debridement (maggot debridement therapy) may be performed only with sterile, medical grade larvae (maggots) from an approved supplier[19] [**L1, RGA**]:

- Maggots should be used as soon as possible after delivery (ideally within 24 hours).
- If storage is required, refer to the manufacturer's recommendations.
- Maggots may be allowed to move freely within the cage dressing.
- Killing or bursting maggots in the wound is prohibited[19] [**L1, RGC**] as patients may have anaphylactic reactions to larval protein.
- Used maggots should be considered biohazardous waste and disposed of accordingly.

Biological debridement is indicated for various types of wounds[19,21] [**L1, RGA**]:

- Infected and heavily colonised wounds.
- Surgical or traumatic wounds.
- Abscesses.
- Leg wounds: venous, ischemic, or neuropathic.

Biological debridement is contraindicated in the following situations[19] [**L1, RGC**]:

- Presence of active haemorrhage.
- Bleeding disorders.
- Copious wound exudate that may flush maggots out of the wound.
- Wounds are in deep body cavities, fistulae, or sinus tracts of an unknown origin.
- Wounds are near large blood vessels or organs.
- Presence of a life-threatening, acute infection.

- Acute wounds that require frequent inspection.
- Devitalised bone or tendons.
- Inadequate circulation for healing.
- Acute or rapidly advancing tissue necrosis.
- Allergy or sensitivity to larval proteins or the nutrient media used to ship the maggots (including yeast, soy, chicken egg).
- Non-sterile, nonmedical grade maggots.

The following should be considered when applying biological debridement[19]:

- The wound may increase in size.
- Odour is controlled by the larvae.
- Minor bleeding may occur.
- Pain management may be required.
- Wound dressings should be changed every 24-48 hours, no longer than 72 hours[19] [**L1, RGA**].
- Protection for the skin surrounding the wound with barrier ointments is recommended[19] [**L1, RGA**].
- Multiple courses of maggot debridement therapy may be required depending on the severity of the wound[19].
- Cultural issues may prevent use in some patients [**R-GDG**].

10.3 Education of Healthcare Workers

It is important that all relevant staff are trained in the identification, diagnosis, and treatment of SSI, at the stage of orientation when they are recruited, as part of the annual mandatory refresher training and on-going CPD training [**R-GDG**].

A structured approach to care should be used to improve overall management of surgical wounds[2] [**L1, RGA**]. This should include:

- Preoperative assessments to identify people with potential wound healing problems[1].
- Close adherence to preventative protocols and interventions to minimise the risk of SSI.
- Following additional interventions in patients within the risk group (e.g. in patients with diabetes).
- Patients' education about their health conditions, wound management, and preventative measures[2,9].

The following are important to prevent SSIs from developing or being transmitted [**R-GDG**]:

- Universal precautions in infection prevention and control.
- Strict adherence to all aspects of infection prevention and control practices, including hand decontamination and asepsis technique.
- Wearing of appropriate personal protective equipment.
- Strict adherence to local protocols.
- Appropriate management of surgical wounds.

Staff qualification, education, training, and sharing of clinical expertise should be continually promoted and pursued regularly[1,2,27] [**L1, RGA**]. Awareness and education on the rational use of antimicrobials and antimicrobial stewardship should be promoted and pursued for both healthcare workers and patients[1] [**L1, RGA**].

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11 Surveillance

Surveillance includes the ongoing, systematic collection, analysis, interpretation and evaluation of health data closely integrated with the timely dissemination of these data to those who need it[1,44]. It is vital that surveillance data are presented on a regular basis to the local Infection Prevention and Control Committee as part of overall clinical governance within provider organisations [**R-GDG**].

The SSI surveillance of surgical patients:

- Required in both inpatient and outpatient care settings[16,27] [**L1, RGA**].
- Surveillance should also include a post-discharge follow-up component as most SSIs are not evident until after discharge[16,27] [**L1, RGA**].
- If the patient remains in hospital after surgery, the wound should be assessed periodically and when the dressing is changed for the presence of signs and symptoms of SSI[27] [**L1, RGA**].
- If the patient is discharged shortly after surgery, the patient and/or family caregiver should be:
    - Contacted to assess for SSI[27] [**L1, RGA**]:
        - Within 24-48 hours after surgery.
        - 7 days to 30 days (or 90 days) after surgery – depending on the type of surgery (see *Table 9.1*) *.
    - Approached about the following[27] [**L1, RGA**]:
        - Amount, colour, and odour of any wound discharge.
        - Fever.
        - Redness at the incision site
        - Pain, swelling, or any other problems.
    - Directed to return to hospital for a face-to-face assessment of the wound and a wound culture obtained (if required) if SSI symptoms are present[27] [**L1, RGA**].

The minimal requirements for ensuring quality of surveillance include[1,27,45]:

- Written plan with clear objectives and necessary actions to implement the surveillance process.
- Constant rigour of intensity of surveillance.
- Consistent elements of surveillance (e.g. definitions, calculation methodologies, etc.).
- Professionals trained in epidemiology.
- Informatic services and information technology support.
- Proper validated methodologies.

12 Key Considerations for Patient Preferences

Patient preferences refer to patient perspectives, beliefs, expectations, and goals for health and life, and to the steps employed by individuals in assessing the potential benefits, harms, costs, and limitations of the management options in relation to one another. Patients may have preferences when it comes to defining their problems, identifying the range of management options, and selecting or ranking the outcomes used to compare these options.

It is important for healthcare professionals to develop an understanding of the patient as an individual and the unique way in which each person experiences a condition and its impact on their life. Therefore, as part of robust clinical governance it is so important to ensure optimal engagement with patients and the public in order to capture their views and act upon them. Patient satisfaction feedback should also be captured through surveys not only of the surgical service as a whole, but also on individual surgeons [**R-GDG**].

The following recommendations are therefore made for physicians and other healthcare professionals regarding general principles of patient care in Qatar:

- **Respect Patients:** Treat patients with respect, kindness, dignity, courtesy and honesty. Ensure that the environment is conducive to discussion and that the patient's privacy is respected, particularly when discussing sensitive, personal issues. Ask the patient how they wish to be addressed and ensure that their choice is respected and used.

- **Maintain Confidentiality:** Respect the patient's right to confidentiality and avoid disclosing or sharing patients' information without their informed consent. In this context, students and anyone not directly involved in the delivery of care should first be introduced to the patient before starting consultations or meetings, and let the patient decide if they want them to stay.

- **Clarify Third-Party Involvement:** Clarify with the patient at the first point of contact whether and how they like their partner, family members or carers to be involved in key decisions about their care or management and review this regularly. If the patient agrees, share information with their partner, family members or carers.

- **Obtain Informed Consent:** Obtain and document informed consent from patients, in accordance with MOPH policy and guidance.

- **Encourage Shared Decision Making:** Ensure that patients are involved in decision making about their own care, or their dependent's care, and that factors that could impact the patient's participation in their own consultation and care including physical or learning disabilities, sight, speech or hearing impairments and problems with understanding, reading or speaking English are addressed.

- **Disclose Medical Errors:** Disclose errors when they occur and show empathy to patients.

- **Ensure Effective Communication:** Explore ways to improve communication including using pictures, symbols or involving an interpreter or family members. Avoid using medical jargon. Use words the patient will understand and confirm understanding by asking questions.

- **Ensure Continuity of Care:** Provide clear and timely sharing of patient information between healthcare professionals especially at the point of any transitions in care.

13 Performance Measures

A list of potential performance measures is given below in *Table 13.1*[46].

Number	Numerator	Denominator
SSI01	The number of surgical site infections diagnosed in the last 12 months.	The number of surgical procedures performed in the past 12 months.
SSI02	The number in the denominator for which the patient is recorded to have received antimicrobial prophylaxis with an appropriate antimicrobial agent and correct dose in line with local antimicrobial policy prior to incision.	The number of surgical procedures performed in the last 12 months, for which antimicrobial prophylaxis is indicated.
SSI03	The number in the denominator for which the patient diagnosed with an SSI received appropriate antimicrobial treatment.	The number of surgical site infections diagnosed in the last 12 months.

13.1: Performance Measures.

14 References

1. World Health Organization. *Global guidelines for the prevention of surgical site infection.* (WHO, 2018).
2. National Institute for Health and Care Excellence (NICE). Surgical site infections: prevention and treatment. NICE guideline [NG125]. (2019).
3. Ling, M. L. *et al.* APSIC guidelines for the prevention of surgical site infections. *Antimicrob Resist Infect Control* **8**, 174 (2019).
4. Berríos-Torres, S. I. *et al.* Centers for Disease Control and Prevention Guideline for the Prevention of Surgical Site Infection, 2017. *JAMA Surg* **152**, 784 (2017).
5. National Institute for Health and Care Excellence (NICE). Hypothermia: prevention and management in adults having surgery. NICE clinical guideline [CG65]. Last updated: December 2016. (2008).
6. Nelson, R. L., Gladman, E. & Barbateskovic, M. Antimicrobial prophylaxis for colorectal surgery. *Cochrane Database Syst Rev* CD001181 (2014) doi:10.1002/14651858.CD001181.pub4.
7. Jeon, C. Y., Furuya, E. Y., Berman, M. F. & Larson, E. L. The role of pre-operative and post-operative glucose control in surgical-site infections and mortality. *PLoS ONE* **7**, e45616 (2012).
8. Latham, R., Lancaster, A. D., Covington, J. F., Pirolo, J. S. & Thomas, C. S. The association of diabetes and glucose control with surgical-site infections among cardiothoracic surgery patients. *Infect Control Hosp Epidemiol* **22**, 607–612 (2001).
9. Cosson, E. *et al.* Practical management of diabetes patients before, during and after surgery: A joint French diabetology and anaesthesiology position statement. *Diabetes & Metabolism* **44**, 200–216 (2018).
10. Liu, Z. *et al.* Intraoperative interventions for preventing surgical site infection: an overview of Cochrane Reviews. *Cochrane Database Syst Rev* **2018**, (2018).
11. Nichols, R. L. & Florman, S. Clinical Presentations of Soft-Tissue Infections and Surgical Site Infections. *CLIN INFECT DIS* **33**, S84–S93 (2001).
12. University of Rochester Medical Center Rochester. Surgical Site Infections. Health Encyclopedia. https://www.urmc.rochester.edu/encyclopedia/content.aspx?contenttypeid=134&contentid=144.
13. Lundy, D. *et al.* The American Academy of Orthopaedic Surgeons 2019 Clinical Practice Guideline on the Management of Surgical Site Infections. 71 (2019).
14. Ministry of Public Health (MOPH) Qatar. The Diagnosis and Management of Sepsis. (2020).
15. Li, Q. *et al.* The diagnostic accuracy of procalcitonin in infectious patients after cardiac surgery: a systematic review and meta-analysis. *J Cardiovasc Med (Hagerstown)* (2020) doi:10.2459/JCM.0000000000001017.
16. Centers for Disease Control and Prevention (CDC). Procedure-Associated Module. Surgical Site Infection (SSI) Event. 36 (2020).
17. World Health Organization (WHO). Prevention and management of wound infection. Guidance from WHO's Department of Violence and Injury Prevention and Disability and the Department of Essential Health Technologies. (2013).
18. Yao, K., Bae, L. & Yew, W. P. Post-operative wound management. *Aust Fam Physician* **42**, 867–870 (2013).
19. Laurel, N. Methods of Wound Debridement: Best Practice for Clinicians. (2015).
20. Global Alliance for Infections in Surgery Working Group *et al.* A Global Declaration on Appropriate Use of Antimicrobial Agents across the Surgical Pathway. *Surgical Infections* **18**, 846–853 (2017).
21. Debridement in wound care. *Wound Essentials* **6**, 88–89 (2011).
22. *ICD-10: International statistical classification of diseases and related health problems.* (World Health Organization, 2011).
23. Owens, C. D. & Stoessel, K. Surgical site infections: epidemiology, microbiology and prevention. *Journal of Hospital Infection* **70**, 3–10 (2008).
24. Taj-Aldeen, S. J., Chandra, P. & Denning, D. W. Burden of fungal infections in Qatar. *Mycoses* **58**, 51–57 (2015).
25. Pesonal communication with MOPH HSPA Team. (2020).
26. Weimann, A. *et al.* ESPEN guideline: Clinical nutrition in surgery. *Clinical Nutrition* **36**, 623–650 (2017).

27. Soule, B. M. Evidence-Based Principles and Practices for Preventing Surgical Site Infections. in *Evidence-Based Principles and Practices for Preventing Surgical Site Infections* 191 (Joint Commission International, 2018).
28. Bratzler, D. W. *et al.* Clinical practice guidelines for antimicrobial prophylaxis in surgery. *American Journal of Health-System Pharmacy* **70**, 195–283 (2013).
29. Charles, D. *et al.* Alcoholic versus aqueous chlorhexidine for skin antisepsis: the AVALANCHE trial. *CMAJ* **189**, E1008–E1016 (2017).
30. Waheed, A. & Council, M. Wound Closure Techniques. in *StatPearls* (StatPearls Publishing, 2020).
31. Ford, H. R., Jones, P., Gaines, B., Reblock, K. & Simpkins, D. L. Intraoperative handling and wound healing: controlled clinical trial comparing coated VICRYL plus antibacterial suture (coated polyglactin 910 suture with triclosan) with coated VICRYL suture (coated polyglactin 910 suture). *Surg Infect (Larchmt)* **6**, 313–321 (2005).
32. Sun, Y., Zhao, C., Niu, J., Ren, J. & Qu, X. Colorimetric Band-aids for Point-of-Care Sensing and Treating Bacterial Infection. *ACS Cent. Sci.* **6**, 207–212 (2020).
33. Cheng, H. *et al.* Prolonged Operative Duration Increases Risk of Surgical Site Infections: A Systematic Review. *Surg Infect (Larchmt)* **18**, 722–735 (2017).
34. Halkos, M. E. *et al.* Elevated Preoperative Hemoglobin A1c Level is Associated With Reduced Long-Term Survival After Coronary Artery Bypass Surgery. *The Annals of Thoracic Surgery* **86**, 1431–1437 (2008).
35. O'Sullivan, C. J. *et al.* Haemoglobin A1c (HbA1C) in Non-diabetic and Diabetic Vascular Patients. Is HbA1C an Independent Risk Factor and Predictor of Adverse Outcome? *European Journal of Vascular and Endovascular Surgery* **32**, 188–197 (2006).
36. Moghissi, E. S. *et al.* American Association of Clinical Endocrinologists and American Diabetes Association Consensus Statement on Inpatient Glycemic Control. *Diabetes Care* **32**, 1119–1131 (2009).
37. Hamad Medical Corporation (HMC). *HMC/Sidra Guidelines for Sepsis.* (2018).
38. Aristo, L. & et al. Annual Antibiogram Report – 2017. Annual cumulative report of the antimicrobial susceptibility rates of common microbial pathogens to antimicrobials available in Hamad General Hospital Formulary. (2017).
39. Rhodes, A. *et al.* Surviving Sepsis Campaign: International Guidelines for Management of Sepsis and Septic Shock. *Critical Care Medicine* **45**, 486–552 (2017).
40. IDSA Sepsis Task Force *et al.* Infectious Diseases Society of America (IDSA) POSITION STATEMENT: Why IDSA Did Not Endorse the Surviving Sepsis Campaign Guidelines. *Clinical Infectious Diseases* **66**, 1631–1635 (2018).
41. Chong, Y. P. *et al.* Treatment Duration for Uncomplicated Staphylococcus aureus Bacteremia To Prevent Relapse: Analysis of a Prospective Observational Cohort Study. *Antimicrobial Agents and Chemotherapy* **57**, 1150–1156 (2013).
42. Liu, C. *et al.* Clinical practice guidelines by the infectious diseases society of america for the treatment of methicillin-resistant Staphylococcus aureus infections in adults and children. *Clin Infect Dis* **52**, e18-55 (2011).
43. National Health Service (NHS). Guidelines for Antibiotic Prescribing in the Community 2018.
44. Centers for Disease Control (CDC). Guidelines for evaluating surveillance systems. *MMWR supplements* **37**, 1–18 (1988).
45. Lee, T. B. *et al.* Recommended practices for surveillance: Association for Professionals in Infection Control and Epidemiology (APIC), Inc. *Am J Infect Control* **35**, 427–440 (2007).
46. National Institute for Health and Care Excellence (NICE). Surgical site infection. NICE quality standard [QS49]. (2013).
47. Hamad Medical Corporation (HMC). *HMC Guideline: Antimicrobial Prescribing*. (2020).

Appendix A: Antimicrobial Prophylaxis Recommendations

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The following recommendations on prophylactic antimicrobial choices are made according to the type of surgery[47]:

A.1 Antimicrobial Prophylaxis in Adults

Cardio-Thoracic Surgery			
Type of Surgery	**Preferred Regime**	**Alternative**	**Comments**
Coronary Artery Bypass Graft **Left Ventricular Assist Device**	**Cefazolin** 1-2 gm iv q8h for maximum 48 hours	**Vancomycin** 1 gm iv q12h for maximum 24 hours	• Pre-operative screening and eradication of S-aureus / MRSA carriage is desirable. • Vancomycin is preferred if MRSA is suspected. • Consider adding 1-2 doses of vancomycin plus cefazolin for patients staying preoperative in the hospital more than 3 days. • Give additional dose of cefazolin if surgery lasts more than 4 hours or if there is blood loss more than 1500 ml.
Valve Surgery	**Cefazolin** 1-2 gm iv q8h for maximum 48 hours **+** **Vancomycin** 1 gm iv 1-2 doses.	**Clindamycin** 600-900 mg iv q8h for maximum 24 hours + **Gentamicin** 1.5 mg/kg iv max (120mg) Single dose	• Pre-operative screening and eradication of S-aureus / MRSA carriage is desirable. • Vancomycin is preferred if MRSA is suspected. • For patients who are under treatment for endocarditis no need for additional prophylactic antimicrobial.
Intra-Cardiac Device Pacemaker Placement / Defibrillators	**Cefazolin** 1-2 gm iv 1-2 doses.	**Vancomycin** 1 gm one dose.	
Thoracic Surgery Pneumonectomy, Lobectomy Plurodesis, Decortication Video Assisted Thoracoscopy	**Cefazolin** 1-2 gm iv q8h for maximum 48 hours	**Vancomycin** 1 gm iv q12h for maximum 24 hours **or** **Clindamycin** 600-900 mg	• For patients who are under treatment with antimicrobials no need to give antimicrobial prophylaxis except for patients on Anti-TB treatment.
Angioplasty, stent insertion	**Cefazolin** 1-2 gm iv q8h for maximum 48 hours	**Vancomycin** 1 gm iv q12h for maximum 24 hours	

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Vascular Surgery			
Type of Surgery	**Preferred Regime**	**Alternative**	**Comments**
Major Surgery: • Aortic graft. • Carotid Endarterectomy. • Repair of thoraco-abdominal aortic aneurysm. • All traumatic vascular injures that require repair. • Arterial bypass for ischemia.	**Cefazolin** 1-2 gm iv q8h for maximum 48 hours	**Vancomycin** 1 gm iv q12h for maximum 48 hours	
Minor Surgery: • Vascular access for end stage renal patients. • Patients with cancer, laser or radiofrequency ablation, varicose veins. • Ligation of arterio-venous. • Fistula, removal of vascular access).	**Cefazolin** 1-2 gm iv stat.	**Vancomycin** 1 gm IV stat.	
General Surgery & Trauma Surgery			
Type of Surgery	**Preferred Regime**	**Alternative**	**Comments**
Gastric Surgery	**Cefuroxime** 0.75 - 1.5 gm iv q8h for maximum 24 hours	**Clindamycin** 600-900 mg iv q8h for maximum 24 hours	• Prophylaxis not given routinely. Only given if there is malignancy, perforation, bleeding obstruction or gastric banding.
Hepato-Biliary Tract Surgery including Laparoscopic Cholecystectomy	**Cefuroxime** 0.75 - 1.5 gm iv q8h for maximum 24 hours	**Clindamycin** 600-900 mg iv q8h for maximum 24 hours + **Gentamicin** 1.5 mg/kg iv max (120mg) Single dose	• Prophylaxis not given routinely. • Prophylaxis given for patients >70 years, obstructive jaundice, recent cholecystitis (<30 days) and previous biliary surgery. • With cholecystitis give full therapeutic course. • For open cholecystectomy antimicrobial prophylaxis is recommended.

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General Surgery & Trauma Surgery			
Type of Surgery	**Preferred Regime**	**Alternative**	**Comments**
Colorectal Surgery **Small bowel surgery**	**Cefuroxime** 0.75 - 1.5 gm iv q8h + **Metronidazole** 500 mg iv q8h (for maximum 24 hours)	**Clindamycin** 600-900 mg iv q8h for maximum 24 hours + **Gentamicin** 1.5 mg/kg iv max (120mg) Single dose	• Oral Neomycin and Metronidazole may be used in some elective surgeries. • In case of bowel perforation give full therapeutic dose.
Appendectomy **Exploratory Laparotomy**	**Cefuroxime** 0.75 - 1.5 gm iv q8h + **Metronidazole** 500 mg iv q8h (for maximum 24 hours**)**	**Clindamycin** 600-900 mg iv q8h for maximum 24 hours + **Gentamicin** 1.5 mg/kg iv max (120mg) Single dose	• For gangrenous or perforated appendicitis, abscess and appendicular mass give full therapeutic course.
Abdominal Wall Hernia Repair with Prosthetic Material	**Cefazolin** 1-2 gm iv q8h for maximum 24 hours	**Clindamycin** 600-900 mg iv q8h for maximum 24 hours	
Chest Tube Insertion	**Cefazolin** 1 gm IV single dose	**Clindamycin** 600- 900 mg IV single dose	
PEG Placement for All Patients	**Cefazolin** 1 gm IV single dose	**Clindamycin** 600- 900 mg IV single dose	
Breast Surgery	**No antimicrobial prophylaxis**		• Antimicrobials are indicated if implant is inserted and axillary surgery. • The antimicrobial choice is the same as (abdominal wall hernia repair with prosthetic material).
Thyroid Surgery	**No antimicrobial prophylaxis**		

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General Surgery & Trauma Surgery			
Type of Surgery	**Preferred Regime**	**Alternative**	**Comments**
Pancreatic Surgery	**Cefuroxime** 0.75 - 1.5 gm iv q8h for maximum 48 hours	**Clindamycin** 600-900 mg iv q8h for maximum 48 hours + **Gentamicin** 1.5 mg/kg iv max (120mg) Single dose	
Liver Resection	**Cefuroxime** 0.75 - 1.5 gm iv q8h for maximum 48 hours	**Clindamycin** 600-900 mg iv q8h for maximum 48 Hours **+** **Gentamicin** 1.5 mg/kg iv max (120mg) Single dose	
Complex Biliary Reconstruction	**Pipracillin/tazobactam** 4.5 gm IV Q8h for maximum 48 h	**Clindamycin** 600-900 mg iv q8h for maximum 48 hours + **Gentamicin** 1.5 mg/kg iv max (120mg) Single dose	
Orthopaedic Surgery			
Type of Surgery	**Preferred Regime**	**Alternative**	**Comments**
Joint replacement **Internal fixation of fracture**	**Cefazolin** 1-2 gm IV q8h for maximum 24 hours (2 gm for patients weighing >86 kg)	**Clindamycin** 600-900 mg IV	• Pre- operative screening /eradications of S-aureus and MRSA is desirable. • If a tourniquet is used eg. For total knee replacement, then antimicrobial prophylaxis must be given 10-15 min before the tourniquet is applied.

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Orthopaedic Surgery			
Type of Surgery	**Preferred Regime**	**Alternative**	**Comments**
Open Fracture **Type I & II**	**Cefazolin** 1-2 gm IV q8h (2 gm for patients weighing >86 kg)	**Clindamycin** 600-900 mg IV	• Antimicrobials discontinued 24 Hours after successful wound closure.
Open Fracture **Type IIIA-C**	**Cefazolin** 1-2 gm IV q8h (2 gm for patients weighing >86 kg)	**Clindamycin** 600-900 mg IV	• Antimicrobials should be continued for 72 hours after the injury or 24 hours after successful soft tissue coverage of the wound.
Potential Faecal Contamination (e.g. farmyard injury or open pelvic fracture)	**Cefazolin** 1-2 gm IV (2 gm for patients weighing >86 kg) **+** **Gentamicin** 1.5 mg/kg IV + **Metronidazole** 500 mg IV	**Clindamycin** 600-900 mg IV + **Gentamicin** 1.5 gm/kg IV	• Duration up to 72 hours.
Central Nervous System Surgery			
Type of Surgery	**Preferred Regime**	**Alternative**	**Comments**
Penetrating Craniocerebral Injuries	**Ampicillin/sulbactam** 3 gm IV single dose	**Clindamycin** 600-900 mg IV single dose + **Gentamicin** 1.5 mg/kg IV max (120mg) single dose	• A 5-day course is recommended for penetrating intracranial injuries.
Head and Neck Surgery with Entry via the Oral Cavity	**Ampicillin/sulbactam** 3 gm IV single dose	**Clindamycin** 600-900 mg IV single dose + **Gentamicin** 1.5 mg/kg IV max (120mg) single dose	

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Central Nervous System Surgery			
Type of Surgery	**Preferred Regime**	**Alternative**	**Comments**
Craniotomy **Spinal Surgery** with use of Fixation Material or with Malignancy	**Cefazolin** 1-2 gm IV Single dose	**Vancomycin** 1 gm iv single dose	• In lower spine surgery (sacral area) use **ceftriaxone.**
CSF shunt	**Cefazolin** 1-2 gm IV single dose	**Vancomycin** 10 mg + **Gentamicin** 3 mg into cerebral ventricles	• In lower spine surgery (sacral area) use **ceftriaxone.**
Obstetric & Gynaecological Surgery			
Type of Surgery	**Preferred Regime**	**Alternative**	**Comments**
Caesarean Section Emergency or Elective without Rupture of Membranes.	**Cefazolin** 1-2 gm IV	**Clindamycin** 900 mg IV	• Prophylaxis should be given 15-60 mins prior to skin incision. • Cefazolin 3g IV dose for patients with pre-operative weight ≥120 kgs. • GBS-colonised women who have planned Caesarean Section should not receive routine prophylaxis for GBS disease prevention. • If allergic to penicillin use Clindamycin. • If GBS is resistant to clindamycin use vancomycin as alternative. • If GBS is sensitive to clindamycin use clindamycin 900 mg IV. • Teicoplanin bolus instead of vancomycin IV for Emergency Caesarean or in case of vancomycin allergy.
Major Vaginal or Abdominal Gynaecological Surgery	**Cefazolin** 1-2 gm IV	**Clindamycin** 900 mg IV	
Emergency Caesarean Section of Women Colonised with GBS	**Cefazolin** 1-2 gm IV **+** **Penicillin G** 2 Million Units IV	**Vancomycin** 1 gm Q12h Until Delivery **or** **Teicoplanin bolus** for Emergency Caesarean Section	
Surgery in Patients Colonised with MRSA	**Cefazolin** 1-2 gm IV + **Vancomycin** 1 gm IV		• Prophylaxis should be given 15-60 mins prior to skin incision.

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Ophthalmic Surgery			
Type of Surgery	**Preferred Regime**	**Alternative**	**Comments**
Intraocular surgeries All Surgeries Without Penetrating Injury	**Povidine iodine 5% eye drops** 3 minutes before surgery	**Topical polymixin B**	• Consider **Moxifloxacin** eye drops preoperatively and/or intacameral cefuroxime intraoperatively in high risk patients
Penetrating Globe Injuries With or Without Presence of Foreign Body	**Ciprofloxacin** 400 mg IV Single dose	**Cefuroxime** 0.75 - 1.5 gm IV Single dose	• Shift to oral **ciprofloxacin** for 5-7 days
Urological Surgery			
Type of Surgery	**Preferred Regime**	**Alternative**	**Comments**
Transurethral or Percutaneous Endoscopic Surgery **Open Surgery** Involving Entry to Urinary Tract	**Cefuroxime** 0.75 - 1.5 gm IV q8h for maximum 24 hours	**Gentamicin** 1.5 mg/kg IV max (120mg) Single dose	• If the urine is infected, it is preferable to sterilise it before beginning any elective procedure. • Alternative agents may be necessary based on results of prior urine cultures.
Urological Prosthetic Implants	**Ceftriaxone** 2 gm IV Single dose	**Clindamycin** 600-900 mg IV q8h for maximum of 24 hours + **Gentamicin** 1.5 mg/kg iv max (120mg) Single dose	
Penile Prosthesis Prophylaxis Pre-operative	**Gentamicin IV** + **Vancomycin** IV for 24 hours	**Rifampicin** **+** **Gentamicin IV** for 24 hours.	• Alternative to vancomycin will be: ○ PO/IV Rifampicin + IV Gentamicin for 24 hours.
Penile Prosthesis Prophylaxis Post-operative	**Floroquinolone** (ciprofloxacin or Levofloxacin) PO for 5-14 days. **+** **Ceftriaxone IV** for 5-7 days.	**Septrin** (Trimethoprim-Sulfamethoxazole) PO for 14 days + **IV Ceftriaxone f**or 5-7 days.	• Alternative to Fluoroquinolone in case of suspecting resistance to E. coli or allergy will be: ○ Septrin (Trimethoprim-Sulfamethoxazole) PO for 14 days + IV Ceftriaxone for 5-7 days.

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Urological Surgery			
Type of Surgery	**Preferred Regime**	**Alternative**	**Comments**
Trans-Rectal Prostate Biopsy	**Amikacin** 15 mg/kg single dose, followed by: **Cefuroxime** 500 mg PO q12h for 24 hours	**Gentamicin** 1.5 mg/kg IV single dose (120 mg), followed by: **Ciprofloxacin** 500 mg PO Q12 h for 24 hours	
Open Surgery Using Bowel Loop Elective or Emergency	**Amikacin** 15 mg/kg single dose + **Clindamycin** 600-900 mg IV q8h for maximum of 24 hours	**Ceftriaxone** 2 gm IV single dose **+** **Metronidazole** 500 mg IV q8h (for maximum of 24 hours)	• Mechanical bowel cleaning with **neomycin** and **metronidazole** • may be recommended.
Open or Laparoscopic Surgery Without Entry into Urinary Tract	**Cefazolin** 1-2 g IV Once on Induction	**Clindamycin** 600-900 mg IV on Induction	
Maxillofacial and Otorhinolaryngological Surgery			
Type of Surgery	**Preferred Regime**	**Alternative**	**Comments**
Maxillofacial Surgery Extensive Surgery with Incision of Oro-Pharyngeal Mucosa Open Reduction of Maxillofacial fracture. Implantation of Prosthetic Material	**Ampicillin** 2 gm IV single dose + **Metronidazole** 500 mg IV single dose	**Clindamycin** 600-900 mg IV single dose	
Head and Neck Surgery with Entry Via the Oral Cavity or Nose	**Ampicillin/sulbactam** 3 gm IV single dose	**Clindamycin** 600-900 mg IV single dose	
Ventilation Tube Insertion. (Dry ear)	**Topical Antibiotics**		
Cochlear implant	**Cefazolin** Adult: 2 gm IV single dose Paediatric: 25mg/kg IV	**Clindamycin** 600-900 mg IV single dose	

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Plastic Surgery			
Type of Surgery	**Preferred Regime**	**Alternative**	**Comments**
Body Contouring (Abdominoplasty-thigh lifting-lipofilling)	**Cefazolin** 2 gm IV followed by: 1 gm IV qh8 for 24 hours	**Clindamycin** 600-900 mg IV Single dose	
Hand surgery Emergency Case (Contaminated)	**Augmentin** 1.2 gm IV q8h	**Clindamycin** 600-900 mg IV q8h	• For emergency cases the duration of prophylaxis should be 48 hours.
Hand surgery Elective Case (Clean)	**Cefazolin** 1 gm IV single dose	**Clindamycin 600-** 900 mg IV single dose	
Reconstructive Surgery	**Cefazolin** 2 gm IV followed by: 1 gm IV qh8 for 24 hours	**Clindamycin** 600-900 mg IV single dose	
Facial Surgery (Rhinoplasty-face lifting – blepharoplasty)	**Cefazolin** 1-2 gm IV single dose	**Clindamycin** 600-900 mg IV single dose	
Burns surgery	**Cefazolin** 1-2 gm IV single dose	**Clindamycin** 600-900 mg IV single dose	
Paediatric Surgery (Cleft Lip or Congenital Malformation)	**Cefazolin** 1-2 gm IV single dose	**Clindamycin** 600-900 mg IV single dose	
Breast Reduction or Augmentation	**Cefazolin** 1-2 gm IV q8h for 48 hours	**Clindamycin** 600 mg IV 8h 48 hours	

View Pathway

Transplant Surgery			
Type of Surgery	**Preferred Regime**	**Alternative**	**Comments**
Liver Transplant	**Piperacillin/tazobactam** 4.5 gm IV q8h for 3 days	**Cefotaxime** 1 gm IV Q6h for 3 days + **Ampicillin** 1 gm IV Q6h for 3 days	
Kidney Transplant	**Cefazolin** 2 gm IV single dose	**Clindamycin** 600-900 mg IV single dose	

Table A.1: Prophylactic Antimicrobial Recommendations in Adults[47].

A.2 Antimicrobial Prophylaxis in Children

View Pathway

Type of Surgery	Preferred Regime	Alternative	Comments
Cardiothoracic Surgery	**Cefazolin**	**Vancomycin**	• Pre-operative screening and eradication of S-aureus/ MRSA carriage is desirable. • In case of allergy or suspected MRSA use vancomycin.
Gastric Surgery	**Cefazolin**	**Clindamycin** + **Amikacin**	• Prophylaxis is not given routinely. • Prophylaxis is given only if there is malignancy, perforation, or obstruction of the upper gastrointestinal tract.
Biliary Tract Surgery	**Ceftriaxone** + **Metronidazole**	**Clindamycin** + **Amikacin**	• With cholecystitis give a full therapeutic course.
Laparoscopic Cholecystectomy	**Ceftriaxone** + **Metronidazole** (High Risk Patients)	**Clindamycin** + **Amikacin**	• With cholecystitis give a full therapeutic course.
Colorectal Surgery **Small bowel Surgery,** **Appendicectomy,** **Exploratory Laparotomy**	**Ceftriaxone** + **Metronidazole**	**Clindamycin** + **Amikacin**	• For gangrenous or perforated appendicitis give a full therapeutic course.
Orthopaedic Surgery: • Internal Fixation of Fracture	**Cefazolin**	**Cefazolin**	• Pre-operative screening and eradication of *S-aureus* and MRSA is desirable. • Most clean procedures without prosthetic material do not require prophylaxis.
Head & Neck Surgery with Entry via the Oral Cavity • Neonates & Children	**Co- Amoxiclav**	**Gentamicin** **+** **Clindamycin**	• Most clean procedures without prosthetic material do not require prophylaxis.
Neurosurgery	**Cefazolin**	**Vancomycin**	

Table A.2: Prophylactic Antimicrobial Recommendations in Children[47].

Appendix B: Detailed Description of the Literature Search

A systematic search for existing literature on the early disabilities was performed in the period May 10th – June 02nd, 2020.

The search for clinical practice guidelines on dementia diagnosis and/or management was performed in the *PubMed* database and websites of relevant organisations and societies including the *Down Syndrome International, World Health Organisation (WHO), Centers for Disease Control and Prevention (CDC), University of Rochester Medical Center Rochester* and other. The present guideline is primarily based on UK NICE, CDC, WHO, and APSIC guidelines and is supplemented with other relevant studies.

Peer-reviewed scientific publications were found in PubMed and via *Google Scholar* Internet search engine. Non-peer reviewed studies were identified in *bioRxiv*. Books were checked on PubMed. Information published on medical websites and drug prescribing information sheets were found via Google search engine.

The included publications were identified using the term "surgical site infection" and specified with the following terms in combinations:

Wound, prevalence, classification, aetiology, risk factor(s), prevention, preventative, interventions, prophylaxis, antibiotic, antimicrobial, diabetes, diabetic, care, dressing, colorimetric band-aids, closure, screening, symptoms, investigation, test, diagnosis, debridement, education, referral, primary/secondary care, surveillance, quality measure(s)/standard(s), Qatar.

Figure B.1 on the next page demonstrates graphically the results of the search and application of exclusion criteria.

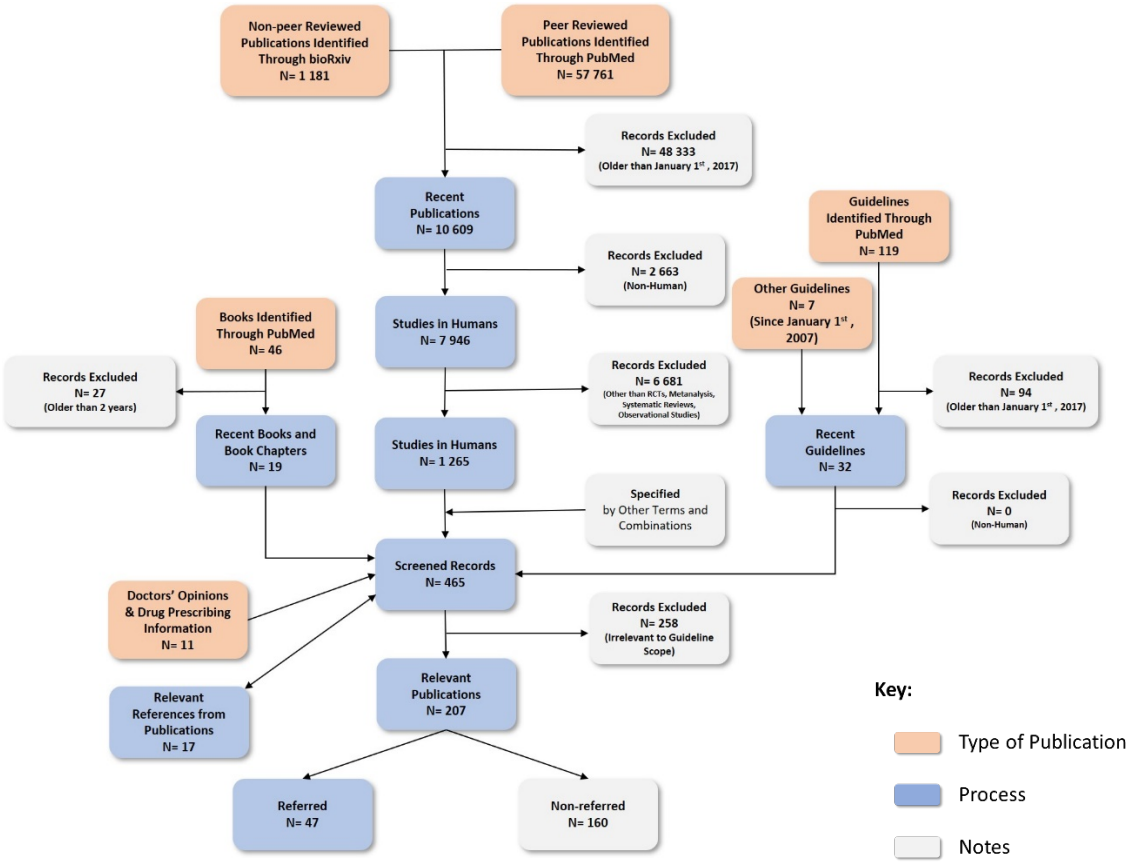

Fig B.1: Literature search results and application of exclusion criteria.

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