Advanced Infection Prevention and Control Training

Prevention of surgical site infection: student handbook

Introduction
Welcome to the “Prevention of surgical site infections” module. This advanced module is part of a broader infection prevention and control (IPC) training package targeting individuals and teams in IPC who work or intend to work as IPC focal points. It is designed to support implementation of the WHO global guidelines for the prevention of surgical site infection (SSI)\(^1\) at the national and health care facility levels, as part of a multifaceted approach to capacity-building.\(^2\) It introduces recommended best practices and a multimodal approach for successful implementation and improvement.

Target audience
This training module is designed for individuals and teams who aim to acquire specific competencies in IPC and who work or intend to work as an IPC focal point at the national, subnational or health facility level. Trainees are expected to possess at least basic experience and competence in IPC. They could include IPC professionals, IPC hospital teams, facility administrators, hospital epidemiologists, microbiologists and other relevant health care professionals, among others. The package complements a basic training package intended for all front-line health care workers.

Objectives of the module
The module aims to equip the IPC focal point to:

- describe the interconnection between SSI prevention and overall IPC efforts and how preventing SSI should be a critical part of a strong and effective IPC programme;
- describe and explain the burden and epidemiological factors that influence SSI, understand the importance of reviewing existing and emerging data to aid SSI reduction within the local context;
- explain the content of the WHO SSI prevention recommendations and understand the evidence supporting them;
- describe adaptive and technical improvement approaches and the role of process and outcome indicators, which form part of an improvement project applied to SSI prevention;


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- explain how evidence-based recommendations on SSI can be implemented effectively in the local context and in real life situations;
- describe and explain the WHO multimodal improvement strategy designed to implement SSI prevention recommendations.

Purpose and content of the student handbook
This module comprises a blend of PowerPoint presentations, videos and group work (including case studies and interactive question-and-answer sessions). The student handbook contains supplementary information to support learning, handouts that will be referred to during the training, reflective reading for homework and group work instructions. Together with the PowerPoint slides it will form a valuable resource for students.

The table below sets out the module’s sessions and lists the associated resources contained within the handbook.

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Handout 1. Common abbreviations

FourEs – engage, educate, execute, evaluate
ABHR – alcohol-based handrub
AMR – antimicrobial resistance
CDC – [United States] Centers for Disease Control and Prevention
CHG – chlorhexidine gluconate
CUSP – comprehensive unit-based safety programme
HAI – health care-associated infection
IPC – infection prevention and control
LMICs – low- and middle-income countries
MBP – mechanical bowel preparation
MRSA – methicillin-resistant *Staphylococcus aureus*
NNIS – national nosocomial infection surveillance
PPE – personal protective equipment
SAP – surgical antibiotic prophylaxis
SSI – surgical site infection
SUSP – surgical unit-based safety programme
VAP – ventilator-associated pneumonia
WHO – World Health Organization
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Group work 1. Acknowledging the current status of your SSI prevention

Take a few minutes to talk to the person next to you – take it in turns to describe your top three challenges with SSI prevention.

Here are some examples to start the discussion.
- I am unaware of the problem in my institution.
- I can't get the surgical team to listen my recommendations for better practices.
- I don’t know how best to start a journey of SSI prevention improvement.

<table>
<thead>
<tr>
<th>Top three challenges:</th>
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<tbody>
<tr>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
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</tbody>
</table>

Then take it in turns to tell each other one thing that is currently working really well in your infection prevention work – it can be anything, small or big – concerning a technical piece of work or building relationships.

<table>
<thead>
<tr>
<th>One thing working well in your infection prevention programme:</th>
</tr>
</thead>
</table>

You will then be asked to share your thoughts and discussion points.
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Handout 2. Visual representation of the core components of IPC programmes

The (illustration-based) infographic is available to download from: http://www.who.int/infection-prevention/publications/core-components/en/
Visual representation of the core components of infection prevention and control (IPC) programmes.*

*Note how they are interconnected to improve IPC practices and reduce infection outcomes.
Handout 3. Health care-associated infection (HAI) infographic

The (illustration-based) infographic is available to download from: http://www.who.int/infection-prevention/publications/core-components/en/
**WHAT'S THE PROBLEM?**

1 IN 10 PATIENTS get an infection while receiving care.

UP TO 32% OF SURGICAL PATIENTS get a post-op infection, up to 85% antibiotic resistant.

UP TO 90% OF HEALTH CARE WORKERS do not clean their hands in some facilities.

INFECTIONS CAUSE UP TO 56% OF DEATHS among hospital-born babies.

UP TO 20% OF AFRICAN WOMEN get a wound infection after a caesarean section.

50-70% OF INJECTIONS given in some developing countries are unsafe.

INFECTIONS can lead to disability, ANTIBIOTIC RESISTANCE, increased hospital time and death.

**WHAT'S THE SOLUTION?**

HAVE ACTIVE INFECTION PREVENTION AND CONTROL PROGRAMMES and target antibiotic resistance.

USE CLEAN PRACTICES and asepsis for interventions.

PRACTICE HAND HYGIENE to prevent infections and reduce the spread of antibiotic resistance.

HAVE ENOUGH STAFF, a clean and hygienic environment and don't overcrowd health care facilities.

MONITOR INFECTIONS and make action plans to reduce their frequency.

NEVER RE-USE needles and syringes.

Only dispense antibiotics when TRULY NEEDED to REDUCE THE RISK OF RESISTANCE.
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Handout 4. WHO guidelines on core components of IPC programmes at the national and acute health care facility level

The two-page summary is available to download from: http://www.who.int/gpsc/ipc-components/en/
WHO Guidelines on Core Components of Infection Prevention & Control Programmes at the National and Acute Health Care Facility Level

The 2016 World Health Organization (WHO) Guidelines on Core Components of Infection Prevention and Control (IPC) Programmes at the National and Acute Health Care Facility Level build on the original WHO Core Components for Infection Prevention and Control Report published in 2009. They have been developed by international experts adhering to WHO’s Guideline Development Process, to support IPC in every country and every health facility across the world, in particular acute health care facilities.

Summary
The objectives of the new Guidelines are:
1. to provide evidence- and expert consensus-based recommendations on the core components of IPC programmes needed at the national and facility level, to effectively prevent health care-associated infections (HAIs) and combat antimicrobial resistance (AMR);
2. to support countries and health care facilities to develop or strengthen IPC programmes and AMR action plans, and improve IPC practices through a feasible, effective and acceptable framework that can be adapted to the local context, while taking account of available resources and public health needs.

Why a new set of guidelines?
1. Increasing acknowledgement of the threats posed by epidemics, pandemics and AMR and international support for IPC as one important part of the solution to protect people from these threats.
2. Renewed focus on the International Health Regulations (IHR) which position IPC as a key strategy for dealing with public health threats of international concern.
3. Sustainable Development Goals 3 and 6 and the requirement for effective, integrated IPC programmes to support quality health service delivery in the context of universal health coverage and water, sanitation and health (WASH) at national and facility levels.

What’s new in these Guidelines?
Many of the principles of what constitute the central elements of IPC programmes remain the same as those presented in 2009. However, the following aspects are highlighted as new:

<table>
<thead>
<tr>
<th>The Approach</th>
<th>New Recommendations</th>
<th>Implementation Focus</th>
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</thead>
<tbody>
<tr>
<td>- Evidence-based: 3 systematic reviews</td>
<td>- Evidence selection based on quality</td>
<td>Commitment to supporting implementation in low-and-middle-income countries</td>
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<tr>
<td>- Based on country experience and expert consensus</td>
<td>- Based on country experience and expert consensus</td>
<td>Focus on multimodal behaviour change approaches and bundles</td>
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<tr>
<td></td>
<td></td>
<td>Focus on WASH-IPC integration, environment &amp; human factors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Focus on AMR, IHR and IPC interface</td>
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</table>

See next page for summary recommendations/good practice statements
### Guideline Recommendations (R) & Good Practice Statements (GPS)

<table>
<thead>
<tr>
<th>No.</th>
<th>Topic</th>
<th>Recommendation</th>
<th>Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>IPC programmes</td>
<td>An IPC programme with a dedicated, trained team should be in place in each <strong>acute health care facility</strong> for the purpose of preventing HAI and combating AMR through IPC good practices.</td>
<td><strong>R1a</strong> Strong</td>
</tr>
<tr>
<td>1b</td>
<td></td>
<td>Stand-alone, active <strong>national</strong> IPC programmes with clearly defined objectives, functions and activities for the purpose of preventing HAI and combating AMR through IPC good practices should be established. National IPC programmes should be linked to other relevant national programmes and professional organizations.</td>
<td>GPS</td>
</tr>
<tr>
<td>2</td>
<td>Evidence-based guidelines</td>
<td>Evidence-based guidelines should be developed and implemented for the purpose of reducing HAI and AMR. Education and training of the relevant health care workers on guideline recommendations and monitoring of adherence with guideline recommendations should be undertaken to achieve successful implementation.</td>
<td><strong>R2</strong> Strong</td>
</tr>
<tr>
<td>3</td>
<td>Education &amp; training</td>
<td>At the <strong>facility</strong> level, IPC education should be in place for all health care workers by utilizing team- and task-based strategies that are participatory and include bedside and simulation training to reduce the risk of HAI and AMR. The <strong>national</strong> IPC programme should support education and training of the health workforce as one of its core functions.</td>
<td><strong>R3a</strong> Strong</td>
</tr>
<tr>
<td>3b</td>
<td></td>
<td>Facility-based HAI surveillance should be performed to guide IPC interventions and detect outbreaks, including AMR surveillance with timely feedback of results to health care workers and stakeholders and through national networks. <strong>National</strong> HAI surveillance programmes and networks that include mechanisms for timely data feedback and with the potential to be used for benchmarking purposes should be established to reduce HAI and AMR.</td>
<td>GPS</td>
</tr>
<tr>
<td>4</td>
<td>Surveillance</td>
<td>At the <strong>facility</strong> level, IPC activities should be implemented using multimodal strategies to improve practices and reduce HAI and AMR.</td>
<td><strong>R4a</strong> Strong</td>
</tr>
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<td>4b</td>
<td></td>
<td><strong>National</strong> IPC programmes should coordinate and facilitate the implementation of IPC activities through multimodal strategies at the national or sub-national level.</td>
<td><strong>R4b</strong> Strong</td>
</tr>
<tr>
<td>5</td>
<td>Multimodal Strategies</td>
<td>Regular monitoring/audit and timely feedback of health care practices should be undertaken according to IPC standards to prevent and control HAIs and AMR at the health care <strong>facility</strong> level. Feedback should be provided to all audited persons and relevant staff. A <strong>national</strong> IPC monitoring and evaluation programme should be established to assess the extent to which standards are being met and activities are being performed according to the programme's goals and objectives. Hand hygiene monitoring with feedback should be considered as a key performance indicator at the national level.</td>
<td><strong>R5a</strong> Strong</td>
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<td>In order to reduce the risk of HAI and the spread of AMR, the following should be addressed: (1) bed occupancy should not exceed the standard capacity of the facility; (2) health care worker staffing levels should be adequately assigned according to patient workload.</td>
<td><strong>R5b</strong> Strong</td>
</tr>
<tr>
<td>6</td>
<td>Monitoring, audit &amp; feedback</td>
<td>In order to reduce the risk of HAI and the spread of AMR, the following should be addressed: (1) bed occupancy should not exceed the standard capacity of the facility; (2) health care worker staffing levels should be adequately assigned according to patient workload.</td>
<td><strong>R6a</strong> Strong</td>
</tr>
<tr>
<td>6b</td>
<td></td>
<td>At the <strong>facility</strong> level, patient care activities should be undertaken in a clean and/or hygienic environment that facilitates practices related to the prevention and control of HAI, as well as AMR, including all elements around the WASH infrastructure and services and the availability of appropriate IPC materials and equipment.</td>
<td><strong>R6b</strong> Strong</td>
</tr>
<tr>
<td>7</td>
<td>Workload, staffing &amp; bed occupancy</td>
<td>At the <strong>facility</strong> level, patient care activities should be undertaken in a clean and/or hygienic environment that facilitates practices related to the prevention and control of HAI, as well as AMR, including all elements around the WASH infrastructure and services and the availability of appropriate IPC materials and equipment.</td>
<td><strong>R7</strong> Strong</td>
</tr>
<tr>
<td>8</td>
<td>Built environment, materials &amp; equipment</td>
<td>At the <strong>facility</strong> level, materials and equipment to perform appropriate hand hygiene should be readily available at the point of care.</td>
<td><strong>R8a</strong> GPS</td>
</tr>
<tr>
<td>8b</td>
<td></td>
<td></td>
<td><strong>R8b</strong> Strong</td>
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Handout 5. Centers for Disease Control and Prevention (CDC) SSI classifications

The figure below is a cross-section of an abdominal wall depicting the CDC classifications of SSI.

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Handout 6. CDC SSI definitions


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**CDC DEFINITIONS (1)**

**Superficial incisional SSI: case definition**

- Infection within 30 days* post surgery
- Involves only skin and subcutaneous tissue

*Day 1 = procedure date

- Purulent drainage from superficial incision
- Organisms isolated from aseptically obtained culture from superficial incision
- SSI superficial incision deliberately opened by a surgeon, attending physician or other designee
- SSI diagnosed by surgeon, attending physician or other designee

- Erythema/pain/swelling/heat/no culture done

**Source:** CDC/NHSN surveillance definitions for specific types of infections. Atlanta (GA): Centers for Disease Control and Prevention; 2018.
CDC DEFINITIONS (2)
Deep incisional SSI: case definition

- Infection within 30 or 90* days** post surgery
  - *In presence of an implant
  - **Day 1 = procedure date

- Involves soft tissue of incision (e.g. fascial and muscle layers)

- And one of the following
  - Purulent drainage from deep incision not from organ/space component
  - Abscess involving deep incision found during radiological or direct examination or re-operation
  - Surgeon deliberately opens incision or incision dehiscence spontaneously and organisms isolated from aseptically obtained culture from deep incision
  - Fever/ localized pain/ tenderness

CDC DEFINITIONS (3)
Organ/space SSI: case definition
(e.g. osteomyelitis, myocarditis, meningitis, breast abscess, mediastinitis)

Infection within 30 or 90* days** post surgery
*In presence of an implant
**Day 1 = procedure date

Any part of anatomy (e.g. organs or spaces) deeper than the fascial/muscle layers, opened or manipulated during surgery

And one of the following

- Purulent drainage from drain placed in organ/space
- Abscess involving organ/space found during radiological or direct examination or re-operation
- Organisms isolated from aseptically obtained culture of tissue or fluid from organ/space

Source: CDC/NHEON surveillance definitions for specific types of infections. Atlanta (GA): Centers for Disease Control and Prevention; 2018.

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Handout 7. Stop infections after surgery infographic

The (illustration-based) infographic is available to download from: http://www.who.int/infection-prevention/publications/ssi-guidelines/en/
Patients develop infections when bacteria get into incisions made during surgery. These affect patients in both low- and middle-income countries (LMICs) and high-income countries (HICs).

**LOW- AND MIDDLE-INCOME COUNTRIES**

- More than 9 in 10 people who have surgery in LMICs get surgical site infections (SSIs).
- People’s risk of SSIs is 3 to 5 TIMES HIGHER than in high-income countries.
- Up to 1 in 10 women in Africa who deliver their baby by cesarean section get a wound infection.

**HIGH-INCOME COUNTRIES**

- In Europe, SSIs affect more than 3.8 million people per year costing up to €19 BILLION.
- Around 1% of people who have surgery in the USA get an SSI.
- In the USA, SSIs contribute to patients spending more than 400,000 hours in hospital, costing USD 10 BILLION per year.

**WHAT’S THE PROBLEM?**

- SSIs can be caused by bacteria that are resistant to community-used antibiotics.
- SSIs threaten the lives of millions of surgical patients and contribute to the spread of antibiotic resistance.

**WHAT’S THE SOLUTION?**

A range of precautions — before, during, and after surgery — reduces the risk of infection.

### BEFORE SURGERY

- Ensure patients bathe or shower.
- Do not shave patients.
- Only use antibiotics when recommended.

### DURING SURGERY

- Limit the number of people and doors being opened.
- Ensure all surgical equipment is sterile and maintain asepsis throughout surgery.

### AFTER SURGERY

- Do not continue antibiotics to prevent infection — this is unnecessary and contributes to the spread of antibiotic resistance.
- Check wounds for infection and use standard dressings on primary wounds.

Correct use of antibiotics and surgical techniques help stop the spread of antibiotic resistance. SSIs surveillance needs to be integral part of programmes to prevent infections.

Team work, good communication and staff education support SSI prevention.

**WHO’s Guidelines for the Prevention of Surgical Site Infections** provide recommendations for the care of patients before, during and after surgery. For more information visit www.who.int/gpsc/en.

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Handout 8. How an SSI can occur

Summary: how an SSI can occur

• Source of pathogens:
  o **endogenous flora** on the patient’s skin, mucous membranes and hollow viscera
  o **exogenous organisms** (air in the operating room, surgical equipment, implants, gloves/hands, medications administered during operative procedure) – including various pathogens

• Routes of entry:
  o hands, equipment, intravenous, air, ways of controlling the whole surgical patient environment/experience (skin preparation, including hair removal, intraoperative temperature)

• **We can protect surgical patients from endogenous and exogenous organisms.**

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Handout 9. WHO global guidelines for the prevention of SSI

The two-page summary is available to download from: http://www.who.int/infection-prevention/publications/ssi-guidelines/en/
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Handout 10. Recommendations for safe surgical care posters

The (illustration-based) infographic is available to download from: http://www.who.int/infection-prevention/tools/surgical/reminders-advocacy/en/
### PREOPERATIVE PERIOD
**PATIENT, CLINICAL AND SUPPORT STAFF AND SURGICAL TEAM ACTIONS**

<table>
<thead>
<tr>
<th>ACTION</th>
<th>SUPPORTED BY</th>
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<tbody>
<tr>
<td>Patient bathes or showers prior to surgery with either plain or antimicrobial soap</td>
<td>PATIENT</td>
</tr>
<tr>
<td>Use 2% mupirocin decolonization in known nasal carriers of <em>Staphylococcus aureus</em> in cardiac and orthopaedic surgery (consider for other surgeries)</td>
<td>WARD NURSE, DOCTOR, PHARMACY</td>
</tr>
<tr>
<td>Do NOT remove patient hair, or if absolutely necessary, remove with a clipper, do not shave</td>
<td>SURGICAL TEAM, PATIENT INFORMATION AND EDUCATION</td>
</tr>
<tr>
<td>Administer surgical antibiotic prophylaxis in the 120 minutes preceding surgical incision (depending on the type of operation and the half life of the antibiotic)</td>
<td>ANAESTHETIST, IPC TEAM/PHARMACY</td>
</tr>
<tr>
<td>Prepare hands for surgery by scrubbing, using the correct technique with a suitable antimicrobial soap and water OR an alcohol-based handrub (before donning sterile gloves)</td>
<td>SURGEON, PHARMACY/PROCUREMENT</td>
</tr>
</tbody>
</table>

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**SURGICAL SITE INFECTION PREVENTION RECOMMENDATIONS**
### PREOPERATIVE PERIOD

**PATIENT, CLINICAL AND SUPPORT STAFF AND SURGICAL TEAM ACTIONS**

**ACTION** | **SUPPORTED BY**
--- | ---
Carry out mechanical bowel preparation always combined with administering preoperative oral antibiotics in adult patients undergoing elective colorectal surgery | SURGICAL TEAM, PHARMACY/PROCUREMENT
Consider administering oral or enteral multiple nutrient-enhanced formulas in underweight patients (undergoing major surgical operations) | SURGICAL TEAM, PHARMACY/PROCUREMENT AND CLINICAL STAFF
Do NOT discontinue immunosuppressive medication | SURGICAL AND WARD TEAM, PHARMACY AND CLINICAL STAFF
Clean and sterilize/decontaminate surgical instruments and other equipment | SURGICAL TEAM, PROCUREMENT/STERILIZATION UNIT
Clean and prepare operating room environment | CLEANING STAFF, SURGICAL TEAM
**Surgical Site Infection Prevention Recommendations**

**Intraoperative Period - Surgical Team Actions**

1. **Do NOT use laminar airflow ventilation systems** (not beneficial for patients undergoing total arthroplasty surgery)
   - Supported by: Procurement/Estates and Maintenance Staff

2. **Use either disposable sterile non-woven or reusable sterile woven drapes and surgical gowns**
   - Supported by: Surgical Team, Procurement

3. **Do NOT use plastic adhesive incise drapes** (neither those with nor those without antimicrobial properties)
   - Supported by: Surgical Team, Procurement

4. **Use alcohol-based solution containing chlorhexidine gluconate for skin preparation**
   - Supported by: Surgical Team, Pharmacy/Procurement

5. **Do NOT use antimicrobial sealants after surgical site skin preparation**
   - Supported by: Surgical Team, Procurement

6. **Administer 80% fraction of inspired oxygen (FiO₂)** (in adults undergoing general anaesthesia with endotracheal intubation)
   - Supported by: Surgical Team, Estates and Maintenance Staff

7. **Consider using a warming device**
   - Supported by: Surgical Team, Procurement

8. **Consider using a protocol for intensive blood glucose control** (for both diabetic and non-diabetic adult patients)
   - Supported by: Surgical Team, Clinical Staff
SURGICAL SITE INFECTION PREVENTION RECOMMENDATIONS

**INTRAOPERATIVE PERIOD**

**Surgical Team Actions**

- Consider using goal-directed therapy
  - **ACTION**: SURGICAL TEAM
  - **SUPPORTED BY**: PROCUREMENT

- Consider irrigating incisional wound with an aqueous povidone iodine solution before closure
  - (in clean and clean-contaminated wounds)
  - **ACTION**: SURGICAL TEAM
  - **SUPPORTED BY**: PROCUREMENT

- Do NOT perform antibiotic wound irrigation
  - **ACTION**: SURGICAL TEAM
  - **SUPPORTED BY**: PROCUREMENT

- Consider using wound protector devices
  - (in clean-contaminated, contaminated and dirty abdominal procedures)
  - **ACTION**: SURGICAL TEAM
  - **SUPPORTED BY**: PROCUREMENT

- Consider prophylactic negative pressure wound therapy
  - (primarily in closed surgical incisions in high-risk wounds)
  - **ACTION**: SURGICAL TEAM
  - **SUPPORTED BY**: PROCUREMENT

- Consider using triclosan-coated sutures
  - **ACTION**: SURGICAL TEAM
  - **SUPPORTED BY**: PROCUREMENT

- Maintain asepsis and discipline in the operating room
  - **ACTION**: SURGICAL TEAM
  - **SUPPORTED BY**: CLINICAL STAFF
POSTOPERATIVE PERIOD
SURGICAL TEAM, CLINICAL STAFF ACTIONS

- Do NOT prolong surgical antibiotic prophylaxis in the postoperative period
  - SUPPORTED BY: CLINICAL STAFF, SURGEON, PHARMACY AND POLICY (STOPPING DELIVERY)

- Do NOT continue surgical antibiotic prophylaxis due to the presence of a drain
  - Remove wound drain when clinically indicated
  - SUPPORTED BY: SURGICAL TEAM AND CLINICAL STAFF, ANTIBIOTIC POLICY IN PLACE

- Administer 80% FiO₂ for 2–6 hours post-op
  - SUPPORTED BY: WARD NURSE, DOCTOR PRESCRIPTION (AND PROTOCOL IN PLACE), ESTATES/MAINTENANCE STAFF

- Evaluate and manage wound appropriately, including cleansing, dressing and care, according to the given wound situation
  - SUPPORTED BY: CLINICAL STAFF, DOCTOR REVIEW

- Do NOT use advanced dressings of any sort
  - (use standard dressings instead)
  - SUPPORTED BY: WARD NURSE, PROCUREMENT AND SURGICAL TEAM

SURGICAL SITE INFECTION PREVENTION RECOMMENDATIONS
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Handout 11. Key facts on decolonization of nasal carriers of *Staphylococcus aureus*

The two-page summary is available to download from: [http://www.who.int/infection-prevention/tools/surgical/training_education/en/](http://www.who.int/infection-prevention/tools/surgical/training_education/en/)
SURGICAL SITE INFECTION PREVENTION

Key facts on decolonization of nasal carriers of Staphylococcus aureus

**WHAT should be done?**

- **Involve patients** and ask for their collaboration and compliance with this recommendation as part of their care delivery by providing instructions.
  - Outpatients: provide clear instructions on how to correctly administer intranasal applications of mupirocin 2% ointment and, if advised locally, to perform a CHG body wash before the operation (for more detailed information, see below “When should the recommendation be applied?”). If used, CHG 2-4% soap body wash should be applied in combination with clean, running water.
  - Inpatients: the same instructions for patients apply as above or procedures can be supported by clinical staff.

- **Support access** to necessary products – provision to patients may be required or desirable in some countries:
  - nasal mupirocin 2% ointment
  - CHG 2-4% soap body wash.

- **Monitor mupirocin resistance**, if mupirocin is used. Decolonization with mupirocin ointment should be performed on known S. aureus carriers only in order to avoid unnecessary treatment and the spread of resistance.

- **Record information** on mupirocin applications in surveillance forms and patient records.

- **Support the local screening policy** of patients to detect S. aureus carriage – consider the local rates of S. aureus and methicillin-resistant S. aureus (MRSA) and patient-related factors.
  - Specifically look for previous S. aureus infections, known carrier status of community-acquired MRSA, and colonization by S. aureus in body sites other than the nose.

- **For other types of surgery**, undertake a careful local evaluation about whether and how to apply this recommendation. In particular, regarding feasibility of carrier identification in a broader surgical patient population, priority of this intervention over other preventive measures should be considered, as well as cost effectiveness.

- **Ensure that potential allergic reactions** to mupirocin and CHG are investigated and recorded.

- **Support colleagues** to adhere to this recommendation and be an advocate for it.

**THINGS YOU SHOULD KNOW**

What does the World Health Organization (WHO) recommend?

The 2016 WHO Global guidelines for the prevention of surgical site infections recommend that patients with known nasal carriage of *Staphylococcus aureus* undergoing:

- **Cardiothoracic and orthopaedic surgery** should be decolonized using intranasal applications of mupirocin 2% ointment with or without a combination of chlorhexidine gluconate (CHG) body wash (strong recommendation);

- **Other types of surgery** – treatment with intranasal applications of mupirocin 2% ointment with or without a combination of CHG body wash may be considered (conditional recommendation).

This recommendation applies to facilities where screening for *S. aureus* is feasible and may not apply to settings with a high prevalence of mupirocin resistance.

Based on the lack of evidence, this recommendation is **not** applicable to paediatric patients.
WHEN should the recommendations be applied?

- This recommendation is applicable in the preoperative period.
- Nasal application of mupirocin 2% ointment: two times daily for five days before the operation + once in the immediate preoperative period on the day of surgery.
- A CHG 2-4% soap body wash: once a day for five days before the operation + once in the immediate preoperative period on the day of surgery.

WHO should support these recommendations to ensure successful implementation?

- Patient education and engagement are critical in achieving this recommendation.
- Depending on where the facility/surgical services stand with regards to this recommendation, the following staff should be involved in putting it in place or updating local policies/standards or improving compliance with the recommendation:
  
  1. **Surgical teams** including outpatient clinic staff involved in preoperative patient information and preparation, and surgical ward staff;

  2. **Infection prevention and quality improvement** teams to facilitate uptake/update of standard procedures and best practices related to the recommendation and to support monitoring of compliance;

  3. **Pharmacists and procurement services** to obtain nasal mupirocin 2% ointment and CHG 2-4% soap body wash (if used);

  4. **Senior administrators** (including finance managers) should be involved in the decision-making on implementing the recommendation and to ensure that an adequate budget is available for continuous product provision, thus motivating staff to comply with the recommendation in the context of an institutional safety climate and culture.

KEY FACTS

WHY are these recommendations important?

- *S. aureus* is a leading health care-associated pathogen worldwide.

- Nasal carriage of *S. aureus* is a risk factor for subsequent infection in a patient. It has been shown repeatedly that a large proportion of health care-associated infections due to *S. aureus* originate from the patients’ own flora.

- Local capacity for screening of patients for *S. aureus* varies between and within countries and is dependent on several factors, including cost-effectiveness and local epidemiology.

- Antimicrobial resistance is an important possible harm associated with the use of mupirocin. Treating all patients, regardless of their carriage status, instead of carriers only increases the likelihood of resistance to mupirocin.


- *S. aureus* infections impose a high burden on the patient and the health system and are a known cause of postoperative wound infections, which can be very serious.

- The scientific evidence shows that the use of mupirocin 2% ointment with or without a combination of CHG body wash in surgical patients with *S. aureus* nasal carriage has significant benefit when compared to placebo/no treatment in reducing the *S. aureus* surgical site infection rates, as well as the overall *S. aureus* health care-associated infection rates. This is most clear for the cardiothoracic and orthopaedic patient population. For other types of surgery, there is a need for careful local evaluation about whether and how to apply this recommendation.

Handout 12. Key facts on patient bathing and hair removal

The two-page summary is available to download from:  
**THINGS YOU SHOULD KNOW**

What does the World Health Organization (WHO) recommend?

The 2016 WHO Global guidelines for the prevention of surgical site infections (SSIs) recommend that:

- It is good clinical practice for patients to **bathe or shower before surgery** with either a plain or antimicrobial soap.
- In patients undergoing any surgical procedure, **hair should either NOT be removed or, if absolutely necessary, only removed with a clipper**. Shaving is strongly discouraged at all times, both preoperatively and in the operating room.

The evidence base is focused on adult patients, but the recommendations are also considered valid for paediatric patients.

---

**WHAT should be done?**

**Preoperative bathing/showering**

- **Instruct patients** – provide clear instructions to perform a thorough bath or shower before the operation.
- **Type of soap** – use either plain or antimicrobial soap to body wash with clean, running water.
- **Provide soap to patients** – this may be required or desirable in some countries.
- **In paediatric patients**, follow manufacturers’ instructions on the use of antimicrobial soap.
- **Record** known information on preoperative bathing on surveillance forms and in patient records.
- **Support patients and colleagues** to adhere to this recommendation and be an advocate for it.

**Hair removal**

- **Instruct patients** – provide information on NOT shaving prior to coming to the facility or to surgery. Woman who shave the genital area as a cultural habit should be targeted for specific education.
- **Avoid hair removal** – unless the surgeon considers that it might interfere with the operation site. In this case, the surgeon should carefully evaluate if hair removal is necessary, with the help of a nurse.
- **Clean and decontaminate** clippers after use before being used on another patient, if single-use disposable clippers are not available.
- **Decontaminate** by carefully disassembling the blades using **personal protective equipment**, cleaning with soap and water, drying, and then wiping them with alcohol or another suitable product according to manufacturer’s instructions.
- **Support colleagues** to adhere to this recommendation and be an advocate for it.

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World Health Organization
WHEN should the recommendations be applied?

- These recommendations are applicable in the preoperative period.
- It is useful to perform patient bathing or showering on the day of the operation or the day or night before.
- Hair removal, if absolutely necessary, should be done shortly before the operation.

WHO should support these recommendations to ensure successful implementation?

- Patient education and engagement are critical to achieve these recommendations.

- Depending on where the facility/surgical services stand with regards to these recommendations, the following staff should be involved in putting them in place or updating local policies/standards or improving compliance with the recommendations:
  
  1. **Surgical teams**, including outpatient clinic staff involved in preoperative patient information and preparation, and surgical ward staff;
  2. **Operating room and surgical teams**, in particular surgeons regarding the avoidance of hair removal or performing it with clippers;
  3. **Infection prevention and quality improvement teams** to facilitate uptake/update of standard procedures and best practices related to the recommendations and to support monitoring of staff compliance;
  4. **Procurement services** to obtain plain or antimicrobial soap;
  5. **Senior administrators** (including finance managers) should be involved in decision-making on implementing the recommendation and to ensure that an adequate budget is available for the provision of necessary supplies (for example, soap, clippers), thus motivating staff to comply with the recommendations in the context of an institutional safety climate and culture.

KEY FACTS

WHY are these recommendations important?

- Infection is the **most frequent complication of surgery in Africa** and SSIs are the most frequent type of infection acquired in health care in low- and middle-income countries. In Europe and the United States of America, SSIs are the second most frequent type of health care-associated infection and the most frequent type on admission.

- The scientific evidence shows that either no hair removal or clipping is associated with a significantly lower risk of SSI when compared to shaving. The risk of SSI is higher when hair removal is performed by razor than by a clipper because shaving causes small abrasions to the skin.

  Evidence shows that the use of a depilatory cream has neither benefit nor harm when compared to shaving for the prevention of SSI. Additional drawbacks are the necessity to leave them in place for approximately 15-20 minutes for the hair to be dissolved and the potential for allergic reactions.

- A preoperative shower or bath ensures that the skin is as clean as possible and reduces the skin bacterial load, especially bacterial colony counts at the site of surgical incision. Scientific evidence shows that preoperative bathing with antimicrobial soap containing chlorhexidine gluconate has no benefit in reducing the SSI rate compared to plain soap.

- Additional WHO implementation tools and resources are available at [http://www.who.int/infection-prevention/tools/surgical/en/].
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Handout 13. Key facts on surgical site skin preparation

The two-page summary is available to download from: http://www.who.int/infection-prevention/tools/surgical/training_education/en/
**SURGICAL SITE INFECTION PREVENTION**

**Key facts on surgical site skin preparation**

**THINGS YOU SHOULD KNOW**

What does the World Health Organization (WHO) recommend?

The 2016 WHO Global guidelines for the prevention of surgical site infections (SSIs) recommend that:

- Alcohol-based antiseptic solutions containing chlorhexidine gluconate (CHG) should be used for surgical site skin preparation in patients undergoing surgical procedures.

Surgical site skin preparation is the preoperative treatment (cleaning and disinfection) of the patient’s intact skin done prior to surgery within the operating room (OR).

**WHAT should be done?**

- Carefully **wash and clean** the skin around the incision site. Full-body washing with detergents or antiseptics should be performed before the operation and outside of the OR (see “Key facts on patient bathing and hair removal”).

- Ensure that the **drapes** are not saturated with alcohol or that the alcohol-based solution has not formed a pool underneath the patient before operating.

- Support colleagues to adhere to this recommendation and be an advocate for it.

- Use an **alcohol-based CHG solution** (usually, a 2% chlorhexidine isopropanol solution) for surgical site skin preparation.

- Ensure that any **adverse events** associated with the solutions used are **investigated and recorded**.

- Apply the solution using **sterile gauze and instruments** with movements from clean to dirty areas starting from the centre of the incision site and moving outwards, maintaining an aseptic technique. Then, allow to dry fully before incision.

- Record known information on surgical site skin preparation on surveillance forms and in patient records (for example, that it has been performed according to standard procedures and no adverse event occurred, time, and product used).

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**Local production**

- If the commercial availability of CHG in an alcohol-based solution is limited or too expensive, the use of a 2% chlorhexidine isopropanol solution for skin disinfection produced locally according to the following formula might be an option:
  - isopropanol 62.7% g/g;
  - chlorhexidine 12.1% g/g taken from a 18.8% g/g chlorhexidine digluconate water solution, and
  - distilled water up to 100%.

- Alcohol-based solutions should not be used on neonates or be in contact with mucosa or eyes. CHG solutions must not be allowed to come into contact with the brain, meninges, eye or middle ear. The effectiveness of using alcohol-based CHG solutions is not proven for paediatric patients.

- A video on the appropriate procedure to be used for surgical site skin preparation is available from WHO at [http://www.who.int/infection-prevention/tools/surgical/training_education/en/](http://www.who.int/infection-prevention/tools/surgical/training_education/en/).
Infection is the most frequent complication of surgery in Africa and SSIs are the most frequent type of infection acquired in health care in low- and middle-income countries. In Europe and the United States of America, they are the second most frequent type of health care-associated infection and the most frequent type on admission.

A large proportion of health care-associated infections originate from the patients’ own flora. The aim of this procedure is to reduce the microbial load on the patient’s skin as much as possible before incision of the skin barrier.

Scientific evidence shows that the use of alcohol-based antiseptic solutions for the surgical preparation of the intact skin is more effective compared to aqueous solutions in reducing SSI as alcohol has a superior antimicrobial activity.

Unfortunately, the effectiveness of using alcohol-based CHG solutions is not proven for paediatric patients as most commercially-available products have no indications for their use in this population due to the lack of studies. Although it is unlikely that high-quality evidence will be available in the future on paediatric patients, mainly due to ethical reasons, logical reasoning might point to a possible beneficial use on intact and mature skin in general, but not in neonates (that is, a child under 28 days of age).

Evidence also points to alcohol-based CHG solutions as more effective in reducing SSI rates compared to alcohol-based povidone-iodine.

Summaries of the systematic reviews of the evidence supporting these recommendations can be found in the Global guidelines for the prevention of SSIs [http://www.who.int/infection-prevention/publications/ssi-guidelines/en/] and their Appendices [http://www.who.int/infection-prevention/publications/ssi-web-appendices/en/].

WHO provides further implementation support in the form of tools [http://www.who.int/infection-prevention/tools/surgical/en/].
Group work 2. Resource considerations

Take a few moments to discuss with the two people next to you the resource implications of the SSI recommendations in your setting and make some notes. The slide gives some examples for you to talk about, but think of others too.

Also, consider how you might identify areas of cost off-setting where a specific SSI recommendation implementation needs resource attention.

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<th>SSI recommendation</th>
<th>Resource consideration</th>
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Handout 14. WHO poster on hand hygiene and postoperative wound management

The poster is available to download from: http://www.who.int/infection-prevention/tools/surgical/training_education/en/
My 5 Moments for Hand Hygiene

Focus on caring for a patient with a post-operative wound

Immediately before touching the post-operative wound dressing/site, for example:

2a. Before physically examining the post-operative wound site, including before taking wound samples for microbiological investigations, if required
2b. Before touching the wound to remove stitches/clips
2c. Before preparing the necessary items for replacing the wound dressing
2d. Before replacing the actual post-operative wound dressing

Immediately after any task involving potential body fluid exposure, such as:

3a. After post-operative wound examination/sample collection
3b. After removing stitches/clips
3c. After undertaking a post-operative wound dressing change

Key additional considerations for post-operative wounds

- Avoid unnecessary touching of the post-operative wound site, including by the patient.
- Wear gloves if contact with body fluids is anticipated; the need for hand hygiene does not change even if gloves are worn, as per the WHO 5 Moments.
- Follow local procedures regarding use of aseptic non-touch technique for any required dressing changes/wound procedures.
- Don’t touch dressings for at least 48 hours after surgery, unless leakage or other complications occur.
- Routine post-operative wound dressings should be basic dressing types (e.g. absorbent or low adherence dressings).
- When approaching a patient for the examination of a wound, the health worker may also perform other tasks (e.g. accessing a venous catheter, drawing blood samples, checking urinary catheter). Hand hygiene may be needed before and after these specific tasks, to once again fulfill Moments 2 and 3, for example (refer to WHO dedicated 5 Moments posters for line or catheter management).
- When indicated, pre-operative surgical antibiotic prophylaxis (SAP) should be administered as a single parenteral dose 2 hours or less before the surgical incision, while considering the half-life of the antibiotic. Do not prolong administration of SAP after completion of the operation.
- Antibiotic therapy for any proven surgical site infection should ideally be administered based on wound sample culture and sensitivity results.
- Common signs and symptoms of wound infection are: pain or tenderness; localized swelling; erythema; heat, or purulent drainage from the superficial incision.
- This guidance does not include information on complicated post-operative wound care, when specific treatments or therapies may be required.
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Group work 3. Hand hygiene workflow

The WHO poster on hand hygiene and postoperative wound management (handout 11) gives examples of critical times for hand hygiene.

After completing this module, in your own setting, plan as an exercise with colleagues to list, step by step, every single action involved in the flow of care when dealing with a surgical wound. Use the following sheet to do this.

Once you have completed the steps (not yet thinking about hand hygiene), consider the application of the five moments for hand hygiene and where these are required in the context of how the workflow occurs locally. For example, an item for the removal of a dressing might be forgotten (such as gloves, a dressing or sterile pot for sample collection) or a nurse might be called to do something else while removing a dressing – everyone has to understand when hand hygiene is necessary in their busy working days to keep the patient and the surgical wound safe.

Add to the end of each line the relevant moment for hand hygiene. Although not based on a surgical patient, an example is given here for you to further understand how to write this exercise (see next page).

Refer to the WHO hand hygiene technical reference manual to be sure that the five moments for hand hygiene are applied accurately: http://www.who.int/infection-prevention/tools/hand-hygiene/training_education/en/

For further information and recommendations, refer to the 2009 WHO guidelines on hand hygiene in health care (http://www.who.int/gpsc/5may/tools/9789241597906/en/), and see the video on surgical hand preparation technique at: https://www.youtube.com/watch?v=h16JPBOlGs
Visit to a general practitioner's office

Hand hygiene opportunities according to the My Five Moments for Hand Hygiene

The doctor is in his office and the patient enters the room.
The patient and doctor sit down and talk to each other while the doctor goes through the patient’s record.
The doctor asks the patient to lie down on the couch.

The doctor performs the physical examination by listening to the patient’s heart and chest, checks the patient’s tendon reflexes with a hammer, and measures the blood pressure.

At the end of the physical examination, the doctor helps the person to get up.

The doctor walks back to his desk, makes notes on a computer, and writes a prescription.
The patient sits down again and they discuss his condition.
The patient leaves and the next patient enters the room.

Comments
- In this example, social contacts such as hand shaking between the patient and the doctor at the beginning and end of the consultation are not included. The occurrence of this gesture may change according to the culture and habits. If it does occur, this type of contact might increase the transmission risk and represents an additional opportunity for hand hygiene.
- If an invasive procedure or contact with mucous membranes or non-intact skin (clean/aseptic task) takes place during the examination, additional hand hygiene opportunities occur (Moments 2 & 3).

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Workflow template: hand hygiene
Group work 4. Using SSI guidelines in your setting

Take a few moments with the 2–3 people sitting next to you to think about the following questions and prepare to feed your answers back to the group. There are no right or wrong answers.

1. Do you have SSI prevention guidelines in your institution? If not, can you explain why not?

2. Have you taken time to read the WHO global guidelines for the prevention of SSI?

3. If you have your own guidelines, have you compared them to the WHO recommendations?

4. If you do not have your own guidelines, have you considered how you would present the WHO recommendations in your institution to initiate their implementation?

5. Have you identified from the WHO recommendations which one is the most challenging to implement in your setting?
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Handout 15. WHO multimodal improvement strategy

The infographic is available to download from: http://www.who.int/infection-prevention/publications/core-components/en/
WHO multimodal improvement strategy

Multimodal implementation strategies are a core component of effective infection prevention and control (IPC) programmes according to the WHO Guidelines on Core Components of IPC programmes at the National and Acute Health Care Facility Level. The guidelines’ recommendation 5 states that IPC activities using multimodal strategies should be implemented to improve practices and reduce HAI and AMR. In practice, this means the use of multiple approaches that in combination will contribute to influencing the behaviour of the target audience (usually health care workers) towards the necessary improvements that will impact on patient outcome and contribute to organizational culture change. Implementation of IPC multimodal strategies needs to be linked with the aims and initiatives of quality improvement programmes and accreditation bodies both at the national and facility levels.

Five key elements to focus on when improving IPC

The multimodal strategy consists of several elements (3 or more; usually 5) implemented in an integrated way to guide action and provide a clear focus for the implementer. Targeting only ONE area (i.e. unimodal), is highly likely to result in failure. All five areas should be considered, and necessary action taken, based on the local context and situation informed by periodic assessments.

WHO identifies five elements for IPC multimodal strategies in a health care context:

1. **Build it** (system change)
   - What infrastructures, equipment, supplies and other resources (including human) are required to implement the intervention?
   - Does the physical environment influence health worker behavior? How can ergonomics and human factors approaches facilitate adoption of the intervention?
   - Are certain types of health workers needed to implement the intervention?
   - Practical example: when implementing hand hygiene interventions, ease of access to handrubs at the point of care and the availability of WASH infrastructures (including water and soap) are important considerations. Are these available, affordable and easily accessible in the workplace? If not, actions are needed.

2. **Teach it** (training & education)
   - Who needs to be trained? What type of training should be used to ensure that the intervention will be implemented in line with evidence-based policies and how frequently?
   - Does the facility have trainers, training aids, and the necessary equipment?
   - Practical example: when implementing injection safety interventions, timely training of those responsible for administering safe injections, including care and community workers, are important considerations, as well as adequate disposal methods.

3. **Check it** (monitoring & feedback)
   - How can you identify the gaps in IPC practices or other indicators in your setting to allow you to prioritize your intervention?
   - How can you be sure that the intervention is being implemented correctly and safely, including at the bedside? For example, are there methods in place to observe or track practices?
   - How and when will feedback be given to the target audience and managers? How can patients also be informed?

4. **Sell it** (reminders & communication)
   - How are you promoting an intervention to ensure that there are cues to action at the point of care and messages are reinforced to health workers and patients?
   - Do you have capacity/funding to develop promotional messages and materials?
   - Practical example: when implementing injection safety interventions, the use of key tools are important considerations, such as surveillance data collection forms and the WHO checklist (adapted to local conditions).

5. **Live it** (culture change)
   - Is there demonstrable support for the intervention at every level of the health system? For example, do senior managers provide funding for equipment and other resources? Are they willing to be champions and role models for IPC improvement?
   - Are teams involved in co-developing or adapting the intervention? Are they empowered and do they feel ownership and the need for accountability?
   - Practical example: when implementing hand hygiene interventions, the way that a health facility approaches this as part of safety and quality improvement and the value placed on hand hygiene improvement as part of the clinical workflow are important considerations.

In other words, the WHO multimodal improvement strategy addresses these five areas:

1. Build it
   - System change
   - What infrastructures, equipment, supplies and other resources (including human) are required to implement the intervention?
   - Does the physical environment influence health worker behavior? How can ergonomics and human factors approaches facilitate adoption of the intervention?
   - Are certain types of health workers needed to implement the intervention?

2. Teach it
   - Training and education
   - Who needs to be trained? What type of training should be used to ensure that the intervention will be implemented in line with evidence-based policies and how frequently?

3. Check it
   - Monitoring and feedback
   - How can you identify the gaps in IPC practices or other indicators in your setting to allow you to prioritize your intervention?

4. Sell it
   - Reminders and communications
   - How are you promoting an intervention to ensure that there are cues to action at the point of care and messages are reinforced to health workers and patients?

5. Live it
   - Culture change
   - Is there demonstrable support for the intervention at every level of the health system? For example, do senior managers provide funding for equipment and other resources? Are they willing to be champions and role models for IPC improvement?
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Group work 5. Case study

Instructions

• Work in groups of 5–7 people – a facilitator will join each group.
• Each group will be allocated one of the five elements of the WHO multimodal improvement strategy (see handout 12).
• Take 20 minutes to read the paper, focusing most on the methods and the results and the appendix, which focuses on the table of activities undertaken in the hospitals. Be ready to use this information to discuss what activities implemented in the study reflect the element of the multimodal strategy you have been assigned – take 15 minutes to discuss.
• You will then have 5 minutes to discuss your conclusions in plenary.
A multimodal infection control and patient safety intervention to reduce surgical site infections in Africa: a multicentre, before–after, cohort study

Benedetta Allegranzi, Alexander M Aiken, Nejla Zeynep Kubilay, Peter Ntumwaba, Jack Barasa, Gabriel Okumu, Robert Mugurura, Alexander Elobu, Josepah Jombwe, Mayaba Maimbo, Joseph Musowoya, Angle Gayet-Ageron, Sean M Berenholtz

Summary

Background
Surgical site infections (SSIs) are the most frequent health-care-associated infections in developing countries. Specific prevention measures are highly effective, but are often poorly implemented. We aimed to establish the effect of a multimodal intervention on SSIs in Africa.

Methods
We did a before–after cohort study, between July 1, 2013, and Dec 31, 2015, at five African hospitals. The multimodal intervention consisted of the implementation or strengthening of multiple SSI prevention measures, combined with an adaptive approach aimed at the improvement of teamwork and the safety climate. The primary outcome was the first occurrence of SSI, and the secondary outcome was death within 30 days post surgery. Data on adherence to SSI prevention measures were prospectively collected. The intervention effect on SSI risk and death within 30 days post surgery was assessed in a mixed-effects logistic regression model, after adjustment for key confounders.

Findings
Four hospitals completed the baseline and follow-up; three provided suitable (ie, sufficient number and quality) data for the sustainability period. 4322 operations were followed up (1604 at baseline, 1827 at follow-up, and 891 in the sustainability period). SSI cumulative incidence significantly decreased post intervention, from 8·0% (95% CI 6·8–9·5; n=129) to 3·8% (3·0–4·8; n=70; p=0·0001), and this decrease persisted in the sustainability period (3·9%, 2·8–5·4; n=35). A substantial improvement in compliance with prevention measures was consistently observed in the follow-up and sustainability periods. The likelihood of SSI during follow-up was significantly lower than pre-intervention (odds ratio [OR] 0·40, 95% CI 0·29–0·54; p<0·0001), but the likelihood of death was not significantly reduced (OR 0·72, 0·42–1·24; p=0·2360).

Interpretation
Implementation of our intervention is feasible in African hospitals. Improvement was observed across all perioperative prevention practices. A significant effect on the overall SSI risk was observed, but with some heterogeneity between sites. Further large-scale experimental studies are needed to confirm these results and to improve the sustainability and long-term effect of such complex programmes.

Funding
US Agency for Healthcare Research and Quality, WHO.

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Introduction
Health-care-associated infections are one of the most common adverse events during care delivery.1 Little evidence exists on the morbidity, mortality, and effect of health-care-associated infections in low-income and middle-income countries, but WHO estimates indicate that the overall prevalence in these countries is double the average reported in high-income countries.2,3 According to WHO, surgical site infection (SSI) is the most surveyed and most frequent health-care-associated infection in countries of low and middle income, and can affect up to one-third of surgical patients. The significantly increased risk of SSI in countries of low and middle income affects all types of procedure, including clean surgery.2 SSI is also the second most common health-care-associated infection in Europe and the USA.4,5 Given the increasing recognition of the need for wider access to essential and safe surgical services in countries of low and middle income by organisations such as WHO,6 a reduction of the risks associated with surgery and health care in general will be key to the achievement of this goal.

SSI prevention is complex, because the risk of SSI results from multiple factors affecting the patient’s entire surgical journey, including after hospital discharge. However, similar to other health-care-associated infections, SSIs are largely avoidable. In 2016, WHO published new recommendations for the prevention of SSIs, which span the preoperative, intraoperative, and postoperative periods to tackle the multifactorial nature of these infections.6–11 Evidence and expert consensus indicate that the effective implementation of recommendations for the prevention and control of infections requires multimodal strategies and multidisciplinary
Research in context

Evidence before this study

Surgical site infections are the most frequent health-care-associated infections in countries of low and middle income. Prevention of surgical site infections is complex because of their multifactorial determinants and surveillance is difficult to do in low-resource settings. The evidence of effective prevention approaches in low-income and middle-income countries is scarce and mostly limited to single interventions focusing on surgical antibiotic prophylaxis improvement. We searched the PubMed, Embase, CINAHL, Cochrane Library, WHO regional databases, and AFROLIB and Africa-Wide Information for articles published from Jan 1, 1990, to Oct 23, 2017. We used search terms related to “surgical wound infection” and “infection control”, “checklists”, “patient safety”, “leadership”, “education”, or “communication”. We restricted our search to publications in English, French, and Spanish. We selected studies describing strategies to reduce surgical site infections and increase compliance with evidence-based infection prevention measures. We identified 270 eligible studies of which only 44 (16%) were done in low-income and middle-income countries. Multifaceted approaches and multidisciplinary teams supported implementation in most studies in high-income countries, but the large majority of interventions in countries of low and middle income aimed at improving the appropriateness of surgical antibiotic prophylaxis only, rather than addressing multiple perioperative prevention measures.

Added value of this study

Our study is the first report based on multicentre surgical site infections surveillance and a multimodal intervention aimed at improving multiple surgical site infection prevention measures at hospitals in sub-Saharan African countries. The risk of surgical site infections during follow-up was significantly lower than pre-intervention and a substantial improvement in compliance with prevention measures was consistently observed.

Implications of all the available evidence

To date, the available evidence on the effectiveness of multimodal surgical site infections prevention interventions is only from high-income countries. Our study shows the feasibility and successful effect of such strategies in low-resource settings in sub-Saharan Africa. Our study proposes an innovative approach on the basis of local adaptation and co-development of a complex surgical site infection prevention intervention, including the use of adaptive tools for the promotion of a wider patient safety culture. However, our results need to be confirmed by an experimental study.

Methods

Study design

We did a before–after intervention cohort study between July 1, 2013, and Dec 31, 2015, in the surgical services of five hospitals in Kenya, Uganda (two hospitals), Zambia, and Zimbabwe. We hypothesised that a multimodal intervention aimed at increasing compliance with infection prevention measures would lead to a reduction in the risk of SSI. Implementation was supported by an adaptive approach aimed at improvement of teamwork and the safety climate in the surgical services by the placement of emphasis on local leadership. We did SSI surveillance throughout the study using an adapted protocol, based on methods described by the US Centers for Disease Control and Prevention National Health Care Safety Network. The characteristics of the included hospitals and interventions are described in figure 1.

The project was named the African Surgical Unit-based Safety Programme, and was adapted from a similar study done simultaneously in the USA under the coordination of the Johns Hopkins Armstrong Institute for Patient Safety and Quality (Baltimore, MD, USA). Our study was approved by the WHO ethics review committee and the institutional ethics committees of all participating hospitals. Because these activities were done as a planned quality improvement programme of normal surgical services, verbal assent to participation in surveillance was sought from all patients, rather than written consent.

Procedures

A step-wise implementation protocol, including five planned periods supported by a range of tools, was used across all sites. The first period was a so-called preparatory period, during which experts from WHO and Johns Hopkins Armstrong Institute for Patient Safety and Quality and senior surgeons (surgical team leads) from the African hospitals adapted or co-developed tools and protocols. During this period, local core teams also identified the key SSI prevention measures to be prioritised, and prepared all necessary conditions for the start of SSI surveillance.
### Table: Characteristics of the four participating hospitals and activities implemented during the intervention

<table>
<thead>
<tr>
<th>Hospital type</th>
<th>Setting</th>
<th>Intervention implementation activities common to all sites</th>
<th>Additional activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kijabe AIC Hospital, Kenya</td>
<td>Rural</td>
<td>Technical SSI preventive measures*: patient preoperative bathing with plain or antiseptic soap; appropriate hair removal (avoidance of or using clippers); optimise patient skin preparation, including local production of alcohol-based and chlorhexidine-based skin disinfection product; optimise surgical hand preparation, including local production of alcohol-based hand rub product and appropriate rubbing technique; appropriate antibiotic prophylaxis based on locally formulated policy, given within 1-h preoperatively and discontinued postoperatively; improved operating theatre discipline, including limitation of the number of individuals and reduction of intraoperative movement.</td>
<td>Provision of antiseptic soap to patients for bathing; addition of food dye to alcohol-based skin preparation to aid visualisation of the application area around the incision site; leaflets explaining the intervention</td>
</tr>
<tr>
<td>Mulago Hospital, Uganda</td>
<td>Urban</td>
<td>Adaptive (team-working and safety) elements†: formation of local SUSP perioperative team; engagement of surgical leads and senior executives; patient safety culture survey; patient safety video played by local surgical leaders; use of CUSP adaptive tools, including Staff safety assessment and Learning from defects; morbidity and mortality meetings; participation in monthly multisite SUSP webinars; conduct of local educational meetings; feedback of data on SSI surveillance and compliance with the SSI preventive measures, including SSI rates.</td>
<td>Better management of students to reduce crowding in operating theatres; work with hospital pharmacy to ensure an antibiotic supply for surgical prophylaxis; patient information card on surveillance in English and local language</td>
</tr>
<tr>
<td>Kisizi Hospital, Uganda</td>
<td>Rural</td>
<td>Acceptance of approach aimed at the creation or improvement of the local safety climate, and the motivation of local teams to comply with SSI prevention measures implemented through the intervention. In brief, the Comprehensive Unit-based Safety Programme developed in the USA. The surgical team leads identified the SSI prevention measures during the preparatory phase using a perioperative staff safety assessment tool, which is designed to help surgical teams to assess the gaps that most frequently cause SSI in their local context. The prevention measures identified through this process included preoperative patient bathing, avoiding hair removal or doing it with clippers, appropriate surgical hand preparation, appropriate patient skin preparation, optimal antibiotic prophylaxis, and improving operating room discipline. All sites consistently implemented or strengthened these measures based on the use of evidence-based protocols or standard operating procedures. Information about the implementation activities is given in figure 1. A more detailed description, process indicators used, and available implementation support documents are provided in the appendix. Local teams were encouraged to adapt these activities and to develop additional actions according to the local needs and culture (figure 1). An important feature of the intervention was the local production of the WHO-recommended product for surgical skin preparation (ie, a chlorhexidine alcohol-based product) and an alcohol-based hand rub to be used as an alternative to antimicrobial soap for surgical hand preparation (WHO formulations were modified according to Suchomel and colleagues; appendix). External quality control testing of the alcohol-based hand rub was done at Geneva University Hospitals (Geneva, Switzerland). The Comprehensive Unit-based Safety Programme approach aimed at the creation or improvement of the local safety climate, and the motivation of local teams to comply with SSI prevention measures implemented through the intervention. In brief, the Comprehensive Unit-based Safety Programme is a five-step iterative process that includes the education of staff on the science of improving patient safety, identification of defects (defined as anything clinically or operationally that should not recur) by the teams, engagement of local leadership, promotion of accountability of front-line staff and senior leaders, identification of how to learn from defects, and implementation of tools to help to improve teamwork and communication. Implementation of the Surgical Unit-based Safety Programme intervention was done entirely by local teams. Staff from WHO and Johns Hopkins Armstrong Institute for Patient Safety and Quality formed a central coordinating team that provided technical expertise and mentorship on project management and data collection.</td>
<td></td>
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</tbody>
</table>

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The four periods to follow the preparatory period were: baseline (6 months), including the start of SSI surveillance and monitoring of a range of perioperative indicators related to planned SSI prevention measures and final preparations for the formal rollout of the intervention; intervention (on a defined date), consisting of the rollout of the intervention through local launch activities; follow-up (between 7 and 12 months), representing the first evaluation period of the effect of the intervention (end date of the intervention was fixed for all sites); and sustainability (between 4 and 6 months), representing the long-term follow-up when the intervention had become part of the regular process of care.
This central coordination was delivered at a distance through monthly webinars, e-mails, and telephone discussions, until the end of follow-up. During the study, each site received one support visit from the WHO team, and participated in three inter-site meetings. Between-site exchange of information was encouraged throughout the study. A small budget was provided to each hospital to be used only for costs incurred from data collection extending beyond normal clinical services. Funds were not used for the procurement of equipment or products related to the project or for the remuneration of pre-existing staff.

Outcomes

The primary study outcome was the first occurrence of SSIs diagnosed according to the first study protocol and the outcome measure was the cumulative incidence of SSI per 100 surgical operations within 30 days of the procedure. The secondary outcome was mortality within 30 days. SSI surveillance was done according to a protocol developed specifically for this project and based on methods described by the US Centers for Disease Control and Prevention National Health Care Safety Network.\(^{11,12}\) This approach involved a 30-day follow-up after all operative procedures, regardless of the use of implanted materials, and used inpatient chart reviews, outpatient clinic attendance, and telephone calls for contact with patients. We aimed to have at least three separate postoperative interactions (of any type) with each patient during the 30-day period. All major elective and emergency operations were eligible for inclusion and there were no other inclusion or exclusion criteria. Sites enrolled an intake reflective of their overall surgical case load. We aimed to include at least 50 operations per month per site into SSI surveillance.

Data collection for surveillance was done by staff in operating theatres for perioperative data, and by trained infection control staff postoperatively. One additional member of nursing staff in each hospital was employed to lead surveillance activities.

As process indicators, we collected data on adherence to the six perioperative SSI prevention measures according to the study protocols (appendix). Data were collected on paper forms and entered into an Epi-Info database (version 3.1.4), with a monthly external review of data quality.

### Statistical analyses

With an estimated pre-intervention risk of 12%, based on a WHO meta-analysis related to countries of low and middle income,\(^1\) we anticipated that the SSI incidence would be reduced by one-third between the before and after intervention periods. Assuming a 90% statistical power at a 5% level of significance, an expectation of a 1.2 size ratio between time periods, and a 10% drop-out, we aimed to include 3000 operations in surveillance across all study sites. This sample size calculation was done for the total number of operations and with no expectation to assess the effect of the intervention within each individual site. Descriptive data were analysed by study period in a combined dataset and then stratified by articles.
site. Comparisons of mean values were done using Student’s t-tests and χ² tests for categorical variables. We estimated the 95% CI for proportions with the Clopper-Pearson exact method.

As data were clustered at site level, we used a logistic regression model with mixed-effects to assess the effect of the intervention on outcomes. In the first model, SSI was the dependent variable, the site was the random factor, and the intervention phase was the main independent variable. Random effects were introduced on the intercept and the regression coefficient for the intervention phase to take into consideration variability of effects between sites. We applied this model combining all operations across all four sites to estimate the effect during follow-up compared with baseline. One site was unable to provide sufficient data in the sustainability period. Therefore, to estimate the effect during both follow-up and sustainability period, we applied the same model only to data generated by the other three sites. For the purposes of the analysis, we considered only the single anatomically deepest form of SSI (organ or space, followed by deep, and then superficial) in patients with more than one SSI diagnosed during the surveillance period. In this model, we adjusted for key confounders (ie, patient age in categories, <27, 27–36, 37–51, and >51 years) and the US Centers for Disease Control and Prevention National Nosocomial Infection Surveillance (NNIS) Risk Index. The NNIS Risk Index is an internationally accepted method for surgical risk stratification, whereby data related to the Surgical Wound Class, the American Society of Anesthesiologists (ASA) score, and the operation duration are used to assign a score of between 0 and 3. We used the NNIS Risk Index score as follows: the reference category (zero) was assigned if any one variable was above the cutoff value, a score of 2 if two variables were above the values, and a score of 3 if all variables were above the values. The NNIS Risk Index variable was included in the multivariable models because it is a potential confounder in the relationship between intervention and outcomes.

We used the same statistical approach in the second model to assess the likelihood of death within 30 days of surgery (dependent variable). We also did post-hoc analyses by site to explore the trends of cumulative SSI incidence per 100 surgical operations on a monthly basis, in two separate comparisons: baseline and follow-up; and between follow-up and sustainability period. For this purpose, we used a linear regression model. Simple autoregressive models, such as AR(1), were used if autocorrelation was suspected. We did statistical analyses using Stata (version IC 14), and interrupted time series analysis using R (version 3.3.3, package nlme). We adhered to ORION guidelines for the reporting of results.34

<table>
<thead>
<tr>
<th>Total (n=4322)</th>
<th>Baseline (n=1604)</th>
<th>Follow-up (n=1827)</th>
<th>p value</th>
<th>Sustainability period (n=891)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Continued from previous page)</td>
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<td></td>
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<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Urgency of operation</th>
<th>Elective (n=4313)</th>
<th>Semi-elective</th>
<th>Urgent</th>
<th>Emergency</th>
<th>Grade of lead surgeon</th>
<th>Senior</th>
<th>Middle</th>
<th>Junior</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2266 (52.6%)</td>
<td>757 (17.3%)</td>
<td>672 (15.3%)</td>
<td>272 (6.3%)</td>
<td>2384 (55.7%)</td>
<td>970 (41.4%)</td>
<td>407 (25.6%)</td>
<td>207 (13.0%)</td>
</tr>
<tr>
<td></td>
<td>830 (51.9%)</td>
<td>207 (12.9%)</td>
<td>112 (7.0%)</td>
<td>451 (28.2%)</td>
<td>976 (61.4%)</td>
<td>983 (54.7%)</td>
<td>424 (23.6%)</td>
<td>390 (21.7%)</td>
</tr>
<tr>
<td></td>
<td>949 (52.1%)</td>
<td>214 (11.8%)</td>
<td>180 (9.9%)</td>
<td>479 (28.3%)</td>
<td>−</td>
<td>425 (47.8%)</td>
<td>406 (46.5%)</td>
<td>59 (6.6%)</td>
</tr>
<tr>
<td></td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>&lt;0.0001</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
</tbody>
</table>

Data are mean (SD) or n (%). Some percentages do not add up to 100% because of rounding. ASA=American Society of Anesthesiologists. NNIS=National Nosocomial Infection Surveillance System. AAA=abdominal aortic aneurysm. *All statistical tests were performed between baseline and follow-up. 1ASA classes: (1) normal healthy, (2) mild systemic disease, (3) severe systemic disease, (4) incapacitating systemic disease, (5) moribund.

Table 1: Patient and operation characteristics across the four study sites

<table>
<thead>
<tr>
<th>Process indicators for SSI prevention intervention measures across study periods in four (baseline and follow-up) and three (sustainability period) hospitals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preoperative patient bathing (n=4321, 0.02%)</td>
</tr>
<tr>
<td>Appropriate hair removal (n=4310, 0.3%)</td>
</tr>
<tr>
<td>Appropriate skin preparation (n=4307, 0.3%)</td>
</tr>
<tr>
<td>Quality of surgical hand preparation (n=4277, 2.3%)</td>
</tr>
<tr>
<td>Appropriate use of antibiotic prophylaxis (n=4322, 0.0%)</td>
</tr>
<tr>
<td>Theatre discipline</td>
</tr>
<tr>
<td>Number of individuals present at the start of the operation (n=4313, 0.2%)</td>
</tr>
<tr>
<td>Number of entries during the operation (n=4236, 0.0%)</td>
</tr>
</tbody>
</table>

Data are mean (SD). Data per variable and percentage missing data are also given. SSI=surgical site infection.

Table 2: Process indicators for SSI prevention intervention measures across study periods in four (baseline and follow-up) and three (sustainability period) hospitals

**Role of the funding source**

This study was funded by the US Agency for Healthcare Research and Quality and the WHO Service Delivery and Safety Department. The study was designed by academic investigators from Johns Hopkins Armstrong Institute for Patient Safety and Quality and WHO technical staff. Data were analysed by a statistical team appointed by the study sponsors. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

**Results**

Four study sites collected data according to the study protocol, and implemented the intervention during the
planned timeframe. Due to unforeseen local difficulties, including long-lasting health-care workers’ strikes, one site (Zimbabwe) was unable to recruit adequate numbers of patients and was not included in the analysis. 4322 operations were followed up in surveillance between Jan 1, 2014, and Dec 31, 2015. These included 1604 operations at baseline, 1827 at follow-up, and 891 during the sustainability period. Sustainability data from three sites were included in the final analysis, because one site failed to collect sufficient data, and those data that were collected were of poor quality. During the study, 94% (3976/4322) of patients had two or more follow-up interactions (ie, inpatient reviews, outpatient clinic, or telephone interviews) and 80% (3458/4322) had three or more interactions during their 30-day surveillance period. Patient and surgical procedure characteristics across the four study sites are summarised in table 1. Of 4322 operations, the most common procedures were caesarean section (1087; 25·8%), herniorrhaphy (335; 7·9%), and open reduction of fracture (404; 9·6%). According to the surgical wound class, procedures were mainly clean or clean-contaminated wounds (1897 [44.0%] and 2091 [48.5%]). The proportion of clean-contaminated wounds increased significantly over the study periods (p<0.0001; table 1). Overall, most patients were healthy individuals according to the ASA score (ASA 1; 55·1%), or affected only by mild systemic disease (ASA 2; 35·0%). The proportion of patients with ASA scores of 2 and 3 increased significantly over the study (p<0.0001; table 1).

All indicators of compliance with the SSI prevention measures improved significantly between baseline and follow-up (table 1). This effect was also confirmed in the sustainability period in three sites (table 2). The unadjusted cumulative incidence of SSI decreased significantly during a 30-day postoperative period between baseline (8·0%, 95% CI 6·8–9·5) and follow-up (3·9%, 3·0–4·8; p<0.0001; figure 2; table 3). In the sustainability period, the overall pooled SSI incidence was 3·9% (2·7–5·4). Superficial SSI decreased significantly (p<0.0001), as did overall unadjusted SSI cumulative incidence in clean-contaminated, contaminated, and dirty or infected wounds between baseline and follow-up (p<0.0001; table 3).

When all operations across all four sites were combined and adjusted for the NNIS Risk Index and age categories in our multivariable model, the likelihood of SSI during follow-up was significantly lower than before implementation of the intervention (odds ratio [OR] 0·40, 95% CI 0·27–0·61; p<0.0001; table 4). The NNIS Risk Index was independently associated with the likelihood of SSI, and showed a dose–response relationship. For each increase of the Risk Index, the likelihood of SSI was higher than the previous (table 4). When the same model was applied to data generated by the three sites that provided data for the sustainability period, the likelihood of SSI was even smaller during follow-up than before implementation of the intervention (0·35, 0·25–0·49; p<0.0001). This result was confirmed when the sustainability period and baseline were compared (0·32, 0·22–0·49; p<0·0001), but we did not find any difference in the likelihood of SSI when the sustainability and follow-up periods were compared (0·92, 0·59–1·43; p=0·71).

Month-by-month cumulative incidence of SSI per 100 surgical operations over the study periods in the

![Figure 2: Unadjusted SSI cumulative incidence overall and by site at baseline and follow-up in four sites](https://www.thelancet.com/neurology Vol 17 May 2018)

<table>
<thead>
<tr>
<th>Site</th>
<th>Before intervention</th>
<th>After intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>129</td>
<td>1604</td>
</tr>
<tr>
<td>2</td>
<td>70</td>
<td>1827</td>
</tr>
<tr>
<td>3</td>
<td>38</td>
<td>891</td>
</tr>
<tr>
<td>4</td>
<td>11</td>
<td>39</td>
</tr>
</tbody>
</table>

SSI=surgical site infection. *All four sites included in the analysis. †Only three sites included in the analysis.

Table 3: Description of the incidence of SSI within 30 days post surgery across study periods and according to wound class
individual sites are shown in the appendix. During follow-up, a significant monthly decrease of 2.0% (1.2–2.9; p=0.001) of the cumulative incidence of SSI in site three was observed (appendix). During the sustainability period, the monthly cumulative incidence trend of SSI in any of the three sites was not significant (appendix). For the 30-day mortality following surgery, we observed a reduction between the baseline (33 [2.1%] of 1604 patients) and the follow-up (29 [1.6%] of 1818 patients). However, this difference was not statistically significant (OR 0.73, 95% CI 0.43–1.22; p=0.22) even after adjustment for the NNIS risk group and age group (0.72, 0.42–1.24; p=0.24).

**Discussion**

We showed that the implementation of a multimodal SSI prevention strategy is feasible in low-resource settings and can improve preventive measures and reduce the SSI risk. To our knowledge, this is the first report on SSI prevention based on multisite SSI surveillance at hospitals in sub-Saharan African countries. This study is also highly innovative in its description of the adaptation and local co-development of a complex intervention and related tools conceived for use in a high-income country into low-income settings. Participating hospitals were representative of both public and private (faith-based) facilities providing surgical services in east and southern Africa (see figure 1). The intervention combined SSI technical prevention measures identified as a priority for improvement by local leads, together with tools adapted to facilitate the adoption of these measures and the promotion of a wider patient safety culture. SSI surveillance, monitoring of perioperative indicators and the implementation of the intervention were done by trained hospital staff using consistent methods across all sites. We collected detailed process and outcome data on a predefined number of operations in facilities that faced typical challenges for delivering surgical services in this region.

Using an adapted protocol that referred to internationally accepted SSI definitions, we showed that multisite SSI surveillance is feasible in African settings, typically with a single member of the nursing staff able to collect high quality data for around 50 operations per month. In particular, and similar to others, by complementing outpatient clinic consultations with telephone calls (including requests to send images to monitor wound status), our 30-day post-surgery patient follow-up involved a high number of patient interactions. However, by limiting surveillance to the 30-day postoperative period, we were unable to detect implant infections, which can occur up to 12 months postoperatively. To limit loss to follow-up, some participating hospitals put in place systems to trace patients included in surveillance, such as inserting coloured signs in their records and links to other clinics in the area. One hospital faced unexpected institutional difficulties that prevented a good-quality collection of a sufficient number of cases in the sustainability period. These difficulties were related to variability in available human resources and increased workload, which reflects the challenges of implementation research in public hospitals in countries of low and middle income. Although local teams considered the overall strategy (particularly the collection of SSI and process indicators) resulted in an increased workload, they also considered that the availability of these data for regular feedback was a crucial lever for changing practices. In our experience, if evaluation and feedback are perceived as crucial for the motivation of improvement and are supported by appropriate training and commitment by the hospital leadership and national public health bodies, this format of surveillance would be practicable and sufficiently low cost for countries of low and middle income to implement into cycles of improvement within routine practice.

The overall risk of SSI in the hospitals before the introduction of the intervention was high (baseline overall SSI cumulative incidence of 8.0%), similar to other reports in sub-Saharan African countries. However, the baseline SSI risk varied markedly between individual institutions, which could be explained, in part, by the different surgical procedures and compliance with some of the key measures for the prevention of SSI. To take this variability into consideration, we used a multivariable model adjusting for different risks in surgery, and variations between sites at baseline and follow-up. Overall, we found an approximate 60% reduction in SSI risk across all sites, as a result of the intervention. Furthermore, in this model, all three components of the NNIS Risk Index were associated with an increase in SSI risk. An appropriate risk stratification approach is essential for any reliable SSI surveillance system, and our study provides some evidence that the NNIS Risk Index could be suitable for

<table>
<thead>
<tr>
<th>Follow-up*</th>
<th>Odds ratio</th>
<th>95% CI</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>NNIS Risk Index†</td>
<td>-</td>
<td>-</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>1</td>
<td>1.73</td>
<td>1.14–2.63</td>
<td>0.0094</td>
</tr>
<tr>
<td>2</td>
<td>5.00</td>
<td>2.98–8.38</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>3</td>
<td>7.72</td>
<td>3.81–15.64</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Age, years‡</td>
<td>-</td>
<td>-</td>
<td>0.3927</td>
</tr>
<tr>
<td>27–36</td>
<td>1.26</td>
<td>0.79–2.00</td>
<td>0.3275</td>
</tr>
<tr>
<td>37–51</td>
<td>0.89</td>
<td>0.56–1.42</td>
<td>0.6332</td>
</tr>
<tr>
<td>&gt;51</td>
<td>1.17</td>
<td>0.75–1.81</td>
<td>0.4863</td>
</tr>
</tbody>
</table>

N=3237 (of 3426) observations. SD of the random effect estimate on the intercept was 0.61 (95% CI 0.26–1.44) and the on the intervention period was 0.12 (0.00–1.18), meaning that the baseline odds of SSI differed between sites. The result of the likelihood ratio test (comparing the mixed-effects logistic regression with the fixed-effects logistic regression model) was 18.69 (p<0.0001). SSI=surgical site infection. NNIS=National Nosocomial Infection Surveillance System. *Reference: baseline. †Reference: American Society of Anesthesiologists score of 2 or less, surgical wound class clean-contaminated, and operation duration of less than 60 min. ‡Reference: younger than 27 years.

Table 4: Assessment of the intervention effectiveness on SSI rates: comparison of the baseline to follow-up in four sites.
multisite SSI surveillance programmes in countries of low and middle income; however, previous single institution studies in African hospitals have not supported this finding.\(^7\) Although data collection in the sustainability period was only done in three sites, the SSI risk remained significantly reduced when compared with baseline, and without a significant difference when compared with follow-up.

Baseline data showed significant gaps in several key SSI preventive measures before the intervention. As reported in other studies of SSI occurrence done in countries of low and middle income, compliance with appropriate surgical antibiotic prophylaxis and surgical site skin preparation were particularly poor, including the inadequate use of an appropriate skin disinfection product and inappropriate methods of hair removal.\(^5\)\(^,\)\(^7\)\(^,\)\(^9\)\(^,\)\(^10\) SSI risk reduction following the intervention was mirrored by a significant performance improvement in all indicators. Importantly, our findings linking sustained compliance with prevention measures with SSI risk reduction indicated that the intervention had progressively become part of routine patient care, because hospitals continued to collect data independent of study conditions. Additionally, the local production or procurement of specific products has now become part of the regular hospital budget.

We believe that the success in the improvement of clinical practice and outcomes was mainly attributable to the motivation of site staff to improve their practices, and the status of local project leaders as influential members of their respective departments. Infection prevention and control best practices are most successfully implemented when embedded within a culture of safety and teamwork that is facilitated by an adaptive approach. Although the study was coordinated by a WHO central team with experience in SSI surveillance and infection control interventions, we believe that the level of support was modest, and the intervention could be reproduced in other settings by a small local team with a short period of appropriate training.

Our study has limitations. First, our study had an observational design and we were unable to include control wards due to local decisions. These decisions were linked to feasibility and a risk of contamination between intervention and control wards, given that the intervention had an institutional climate change component. We could not exclude some regression to the mean effect or contamination by external strategies, although we verified that no national or local campaigns that could have interfered with our intervention were implemented in the same period. A stepped-wedge, cluster-randomised controlled trial could be a superior study design to confirm our findings. Second, although, to our knowledge, this study represents the largest report of multisite SSI surveillance in sub-Saharan African countries, it is still small when compared with SSI surveillance datasets in high-income settings, where nationwide or even international activities are well established. Third, our study was not powered to detect the effects of the intervention at individual sites. We observed some remarkable variations between sites, which probably reflect differences in pre-existing institutional infection control expertise coupled with an element of random fluctuations, especially as the numbers of surgical procedures under surveillance periods were relatively modest. Despite this limitation, we did a post-hoc analysis to further explore the effect of the intervention on a monthly basis in each site and found heterogeneous results, with only one site showing a monthly decrease of the cumulative incidence of SSI during follow-up. We cannot be certain to what extent the reduction in SSI risk we observed could be reproduced in other hospitals in the region. Finally, we were unable to collect information that could quantify changes in the organisational safety culture in these hospitals.

Our findings show that the implementation of a multimodal SSI prevention intervention successfully tested in high-income countries is feasible in low-resource settings. The intervention was associated with an improvement in infection prevention and control practices in participating hospitals, particularly when fully embedded in routine hospital practice. Our multimodal strategy was also associated with a significant reduction of SSI risk following the implementation of the programme, but this finding needs to be confirmed by large-scale experimental studies (ideally, pragmatic clinical trials with randomised stepped-wedge design). Efforts will be needed to improve and measure the long-term sustainability and effect of such complex programmes.

Contributors

BA and SMB designed the study and supervised study implementation. BA and AMA led the writing of the paper and contributed to data interpretation. BA, AMA, and NZK coordinated study implementation. AG-A led the data analysis and contributed to the writing of the paper. PN, JB, GO, RM, AE, JJ, MM, and JM led local project implementation and data collection. All authors contributed to the interpretation of data and subsequent writing, reviewing, and revision of the manuscript.

Declaration of interests

SB has a contract agreement with the Agency for Healthcare Research and Quality. All other authors declare no competing interests.

Acknowledgments

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the authors and do not reflect the official position of the US Agency for Healthcare Research and Quality or the US Department of Health and Human Services. WHO takes no responsibility for the information provided or the views expressed in this Article.

References


Advanced Infection Prevention and Control Training

Group work 6. Understand your current situation

Take a few moments to think about and discuss the following questions in small groups (3–4 people seated together).

1. What are the major factors determining SSI in your surgical services/facilities?

2. Do you know how to start your improvement journey, specifically in relation to SSI process measures (rather than surveillance)?

3. What tools are available to you in order that you can make improvements?

4. Do you have a tried and tested approach to improvement within your facility, reflecting the existing culture?
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Handout 16. SSI surveillance perioperative data collection form

The form is available to download from: http://www.who.int/infection-prevention/tools/surgical/evaluation_feedback/en/
### Surgical site infection surveillance peri-operative data collection form

<table>
<thead>
<tr>
<th>ID</th>
<th>Patient name</th>
<th>Age/ Date of birth</th>
<th>InPatient number</th>
<th>Date of admission</th>
<th>Primary diagnosis</th>
<th>Sex</th>
<th>F</th>
<th>M</th>
<th>Surveillance number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Surgical procedure

- Operating theater [ ]

#### Date of surgery

- Lead surgeon name

#### Grade

- ASA class
  1. Normal healthy person
  2. Mild systemic disease (e.g. hypertension, well controlled diabetes)
  3. Severe systemic disease not incapacitating (e.g. moderate COPD, diabetes, malignancy)
  4. Incapacitating systemic disease that is a constant threat to life (e.g. pre-eclampsia, heavy bleeding)
  5. Moribund patient, not expected to survive with or without operation (e.g. major trauma)

#### Surgical wound class

- Clean = Sterile tissue with no resident bacteria e.g. neurosurgery
- Clean-contaminated = CONTROLLED entry to tissue with resident bacteria e.g. hysterectomy
- Contaminated = UNCONTROLLED entry to tissue with bacteria e.g. acute gastrointestinal perforation
- Dirty / infected = Heavy contamination (e.g. soil in wound) or infection already established

#### Start time (knife to skin)

- [ : ] 24h clock

#### End time (skin closure)

- [ : ] 24h clock

#### Duration = hrs mins

#### Urgency of operation

- □ Emergency – must be done immediately to save life (e.g. major bleed)
- □ Urgent – must be done within 24-48h (e.g. repair of fracture)
- □ Semi-elective – must be done within days-weeks (e.g. tumour removal)
- □ Elective – no time constraints (e.g. cosmetic procedure)

### CDC – NNIS Risk Index Variables

- Weight kg
- Height cm

### PRE/PERI-OPERATIVE PROCESS MEASURES

#### Patient preparation

- Pre-op bath/shower (full body [ Y / N ] Date .........)
- Antimicrobial soap used [ Y / N ] Plain soap used [ Y / N ]
- Hair removal (HR): □ Razor □ Clippers □ None
- HR Date ....................
- □ Home □ Ward □ Theatre

#### Surgical antibiotic prophylaxis

- □ No prophylaxis required
- □ Required but not given due to: □ Unavailable □ Other ..................

#### Antibiotic given:

- □ Co-amoxiclav □ Cefazolin □ Cloxacillin □ Vancomycin
- □ Ciprofloxacin □ Gentamicin □ Metronidazole □ Penicillin
- □ Other antibiotic.......................... Dose........................ (mg)

- Time given [ : ] 24h clock
- Time re-dosed [ : ] 24h clock

#### Postoperative antibiotics

- Were antibiotics ceased at completion of surgery? [ Y / N ]
- If not, what antibiotics were prescribed?

#### Drug.......................... Dose........................ (mg)

#### Doses / day.......................... Duration (days)..........................

####Reason given

- □ Post-op prophylaxis □ Drain / implant inserted □ Treating suspected / known infection □ Other ..................

#### Other measure(s) – decided at local level

- □ Metal (Ortho) □ Skin graft □ Mesh □ Other

---

**Date form completed ........../........../..........

**Database entry [ Y / N ]

**Signature...........................................

---
Key explanations to complete the peri-operative form

Box 1

**Surgical procedure** - refers to an operation where at least one incision (including a laparoscopic approach) is made through the skin or mucous membrane, or reoperation via an incision that was left open during a prior operative procedure AND takes place in an operating theatre – select the exact surgical procedure from the list below.

- Abdominal aortic aneurysm repair
- Limb amputation
- Appendix surgery
- Shunt for dialysis
- Bile duct, liver or pancreas surgery
- Breast surgery
- Cardiac surgery
- Carotid endarterectomy
- Coronary artery bypass surgery – donor + graft sites
- Coronary artery bypass surgery – chest only
- Gallbladder surgery
- Colon surgery
- Craniotomy
- Caesarean section
- Spinal fusion
- Open reduction of fracture
- Gastric surgery
- Herniorrhaphy
- Hip prosthesis
- Heart transplant
- Abdominal hysterectomy
- Knee prosthesis
- Kidney transplant
- Laminectomy
- Liver transplant
- Neck surgery
- Kidney surgery
- Ovarian surgery
- Pacemaker surgery
- Prostate surgery
- Peripheral vascular bypass surgery
- Rectal surgery
- Refusion of spine
- Small bowel surgery
- Spleen surgery
- Thoracic surgery
- Thyroid and/or parathyroid surgery
- Vaginal hysterectomy
- Ventricular shunt
- Abdominal surgery

Grade of surgeon - senior (surgeon with more than 10 years of experience in total); junior (surgeon with less than 10 years of experience); trainee (junior doctor who is in training in the surgical specialty); ‘other grade’ of surgeon (as defined locally).

Box 3

**Surgical wound class** -

1. **Clean** refers to an uninfected operative wound in which no inflammation is encountered and the respiratory, alimentary, genital or uninfected urinary tracts are not entered. In addition, clean wounds are primarily closed and, if necessary, drained with closed drainage. Operative incisional wounds that follow non-penetrating (blunt) trauma should be included in this category if they meet the criteria.

2. **Clean-contaminated** refers to operative wounds in which the respiratory, alimentary, genital or urinary tracts are entered under controlled conditions and without unusual contamination. Specifically, operations involving the biliary tract, appendix, vagina and oropharynx are included in this category, provided no evidence of infection or major break in technique is encountered.

3. **Contaminated** refers to open, fresh, accidental wounds. In addition, operations with major breaks in sterile technique (for example, open cardiac massage) or gross spillage from the gastrointestinal tract, and incisions in which acute, non-purulent inflammation is encountered, including necrotic tissue without evidence of purulent drainage (for example, dry gangrene), are included in this category.

4. **Dirty or infected** includes old traumatic wounds with retained devitalized tissue and those that involve existing clinical infection or perforated viscera. This definition suggests that the organisms causing postoperative infection were present in the operative field before the operation.

Box 5

**Patient pre-operative bath/shower** – patient shower or bath should be performed with either antimicrobial soap or plan soap, ideally 1-2 hours before the operation or at least the night before.

**Appropriate surgical hand preparation (scrubbing)** - an antiseptic (antimicrobial soap and water) handwash or antiseptic handrub (alcohol-based handrub product classified as high quality), performed immediately preoperatively to eliminate transient flora and reduce resident skin flora (such antisepsics often have persistent antimicrobial activity). The technique should be the WHO recommended steps, including drying. Length of time is according to the manufacturers’ instructions, typically 2-5 minutes for soap and water; for alcohol–based handrub follow manufacturers’ instructions (http://www.who.int/gpsc/5may/hhsurgicalA3.pdf?ua=1).

**Appropriate surgical skin preparation (under sterile conditions)** - use of sterile gauze/sponge and instruments, with movements from clean to dirty areas, that is, from the centre of the incision site outwards, maintaining aseptic technique and covering a broad area of the patient’s skin, to be performed immediately before draping and incision. No areas touched that are not part of the preparation area. Allow to fully dry before incision.
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Handout 17. SSI surveillance postoperative data collection form

The form is available to download from: http://www.who.int/infection-prevention/tools/surgical/evaluation_feedback/en/
1. At each patient interaction, first check the patient's identification. Then assess or ask about the SSI symptoms:

   • Drainage of fluid from wound: pus versus clear (serous) / bloody / other
   • Pain / tenderness beyond normal for operation
   • Localized swelling or wound breakdown
   • Redness/heat of skin
   • Generally unwell, especially fever >38°C

If any SSI symptoms are noted in Box 2, proceed to Box 3 to determine the SSI case definition and consult with the operating surgeon.

All follow-up in the 30-day post-operative period should be recorded in Box 2. Each patient interaction should be recorded in the “Event” column from the day of surgery onwards, including: surgical procedure, wound dressing removed/changed, (each) inpatient (IP) review, discharge, outpatient (OP) review, telephone call, readmission, return to the operating theatre, surveillance discontinued (reason). At least three reviews are recommended in the 30-day follow-up period. For each “Event”, please record the date, tick the “Antibx” column if antibiotics are prescribed/being taken, complete health workers’ initials, and record any surgical site infection (SSI) symptoms or other important notes in the last column (see footnote 1).

**BOX 2 - Admission date to hospital for primary operation: …/…/……… Hospital discharge date: …/…/………**

<table>
<thead>
<tr>
<th>Day</th>
<th>Date</th>
<th>Event</th>
<th>Antibx</th>
<th>SSI symptoms and other notes¹</th>
<th>Health worker initials</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>Surgical procedure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-5</td>
<td></td>
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</tr>
<tr>
<td>6-7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8-10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11-14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15-17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22-25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26-29</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 30</td>
<td></td>
<td>End of SSI surveillance (standard)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. At each patient interaction, first check the patient’s identification. Then assess or ask about the SSI symptoms:

   • Drainage of fluid from wound: pus versus clear (serous) / bloody / other
   • Pain / tenderness beyond normal for operation
   • Localized swelling or wound breakdown
   • Redness/heat of skin
   • Generally unwell, especially fever >38°C

If any SSI symptoms are noted in Box 2, proceed to Box 3 to determine the SSI case definition and consult with the operating surgeon.

**BOX 3**

**Surgical Site Infection?** □ Yes □ No (Determine with case definition tick boxes below)

**Patient re-admitted for Surgical Site Infection?** □ Yes □ No (note reason) …………………………………………………………………………………………….

**Date of re-admission for Surgical Site Infection:** …/…/……… **Discharge date:** …/…/………

**□** Superficial SSI (skin/subcutaneous)

   e.g. cellulitis
   □ Purulent drainage (pus) from superficial incision

**OR** □ Organism identified (if culture done)*

**OR** □ Superficial incision deliberately re-opened

**AND** □ Infection symptoms¹

**□** Surgeon/attending physician diagnosis

**□** Deep SSI (fascia/muscle)

   e.g. deep abscess
   □ Purulent drainage (pus) from deep incision

**OR** □ Deep incision dehiscence or deliberately opened by surgeon

**AND** □ Organism identified (if culture done)*

**AND** □ Infection symptoms¹

**OR** □ Deep infection/abscess found on imaging/examination

**□** Organ/space SSI**

   Deeper than fascia/muscle
   e.g. endometritis (organ), peritonitis (space)
   □ Purulent drainage (pus) from sterile organ or space (from an inserted drain)

**OR** □ Organ or space infection/abscess found on imaging/examination

**OR** □ Organism identified from fluid/tissue from organ/ space*

**□** Non-infectious local wound complications including bleeding and abnormal skin reactions

**□** Patient death: Date …/…/……… Cause of death (as far as known) ……………………………………………………………………………………………

**Microbiology culture results**

<table>
<thead>
<tr>
<th>Specimen taken</th>
<th>Organism(s) identified</th>
<th>Antibiotic resistance/sensitivities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date: …/…/………</td>
<td>type: ……………………</td>
<td></td>
</tr>
</tbody>
</table>

*Note: most surgical wounds that have broken down rapidly become colonized with bacteria. Bacterial growth from a wound is only significant when a sample to identify organisms by microbiological culture is collected aseptically under sterile conditions with symptoms of infection also present.
Key explanations to complete the post-operative form

Whose phone number = patient (mobile or home), or family member, or neighbour, or friend

Checked = phone number called to check before patient leaves hospital

**List of specific organ/space infection sites**

<table>
<thead>
<tr>
<th>Code</th>
<th>Site</th>
<th>Code</th>
<th>Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>BONE</td>
<td>Osteomyelitis</td>
<td>MED</td>
<td>Mediastinitis</td>
</tr>
<tr>
<td>BRST</td>
<td>Breast abscess or mastitis</td>
<td>MEN</td>
<td>Meningitis or ventriculitis</td>
</tr>
<tr>
<td>CARD</td>
<td>Myocarditis or pericarditis</td>
<td>ORAL</td>
<td>Oral cavity (mouth, tongue, or gums)</td>
</tr>
<tr>
<td>DISC</td>
<td>Disc space</td>
<td>OREP</td>
<td>Other infections of the male or female reproductive tract</td>
</tr>
<tr>
<td>EAR</td>
<td>Ear, mastoid</td>
<td>PJI</td>
<td>Periprosthetic joint infection</td>
</tr>
<tr>
<td>EMET</td>
<td>Endometritis</td>
<td>SA</td>
<td>Spinal abscess without meningitis</td>
</tr>
<tr>
<td>ENDO</td>
<td>Endocarditis</td>
<td>SINU</td>
<td>Sinusitis</td>
</tr>
<tr>
<td>GIT</td>
<td>Gastrointestinal tract</td>
<td>UR</td>
<td>Upper respiratory tract</td>
</tr>
<tr>
<td>IAB</td>
<td>Intraabdominal, not specified</td>
<td>USI</td>
<td>Urinary System infection</td>
</tr>
<tr>
<td>IC</td>
<td>Intracranial, brain abscess or dura</td>
<td>VASC</td>
<td>Arterial or venous infection</td>
</tr>
<tr>
<td>JNT</td>
<td>Joint or Bursa</td>
<td>VCUF</td>
<td>Vaginal cuff</td>
</tr>
<tr>
<td>LUNG</td>
<td>Other infections of the lower respiratory tract</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To understand specific criteria for defining these infections please refer to CDC/NHSN Surveillance Definitions for Specific Types of Infections
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Handout 18. Modified WHO formulations for surgical hand preparation

**Formulation I**  
Final concentrations: ethanol 80% wt/wt, glycerol 0.725% vol/vol, hydrogen peroxide 0.125% vol/vol.  
**Ingredients:**  
1. ethanol (absolute), **800 g**  
2. H₂O₂ (3%), **4.17 ml**  
3. glycerol (98%), **7.25 ml** (or 7.25 x 1.26 = 9.135 g)  
4. top up to **1000 g** with distilled or boiled water

**Formulation II**  
Final concentrations: isopropanol 75% wt/wt, glycerol 0.725% vol/vol, hydrogen peroxide 0.125% vol/vol.  
**Ingredients:**  
1. isopropanol (absolute), **750 g**  
2. H₂O₂ (3%), **4.17 ml**  
3. glycerol (98%), **7.25 ml** (or 7.25 x 1.26 = 9.135 g)  
4. top up to **1000 g** with distilled water

**Sources:**  
Advanced Infection Prevention and Control Training

Handout 19. Summary of success factors

Here is a list of factors from a range of settings that made success in SSI improvement achievable (slide 121).

Summary of success factors

• Use of multimodal strategies (this does not mean checklists and bundles)
• Having a step-wise action plan
• Mapping recommendations according to the surgical patient journey
• Empowering teams and involving front-line staff
• Engaging leadership
• Letting teams take the lead on adaptation
• Catalysing collective and individual ownership
• Using data to create awareness
• Awarding teams and work demonstrating a safety culture spirit
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Group work 7. Preparing a multimodal strategy for SSI

Instructions

Work in groups of 6–8 for this exercise, using the blank tables below.

First, use surgical hand preparation as your example of a needed improvement. The scenario is: it has been noticed that not all surgeons undertake the recommended surgical hand preparation, and postoperative infections are occurring in patients.

Try to list under each component of the multimodal strategy in the table the requirements to ensure that all surgeons follow this recommendation.

Next, take another SSI recommendation that you think needs to be improved and do the same exercise.

Remember that earlier in this module we talked about the resources that might be needed when thinking about, for example, system change as part of a multimodal strategy to prevent SSI.

Key questions for each group

- Does the facility need to procure, produce, identify, allocate or prepare anything for the improvement to take place and for the system change to be sustainable in order to help staff to prevent SSI? Where should resources be deployed within the facility, including when improvement is slower than expected?
- Does the facility have staff competent in delivering targeted training and the right materials to deliver the training? Which staff need to be trained and how can the facility ensure staff can attend training sessions? It is also important to ask whether any system change has been made or is needed so that the training delivered is realistic to the setting – for example, if training takes place on use of a negative pressure device, the device needs to be available for use.
- Does the facility have staff competent in undertaking monitoring and feedback and the right resources to conduct monitoring? Which staff need to be trained to ensure effective monitoring and feedback? Are there forums in which feedback can be delivered, and is the organization prepared to receive feedback and act on it?
- Does the facility know which recommendations need communications to support reliable implementation, as well as which staff would benefit from reminders and where best to position these for impact? Are the right expertise and resources available to develop impactful communications?
## Advanced Infection Prevention and Control Training

<table>
<thead>
<tr>
<th>System change</th>
<th>Training and education</th>
<th>Monitoring and feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

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<table>
<thead>
<tr>
<th>Reminders and communications</th>
<th>Institutional safety climate – culture change</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
</tbody>
</table>
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Handout 20. Hand hygiene and the surgical journey infographic

The infographic is available to download from: http://www.who.int/infection-prevention/tools/surgical/reminders-advocacy/en/
About 1 in 3 SSIs are due to S. aureus, >40% of which is MRSA, making SSI prevention critical to the antimicrobial resistance (AMR) agenda.


Refer to WHO 5 Moments for Hand Hygiene material for further guidance
www.who.int/gpsc/5may

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*About 1 in 3 SSIs are due to S. aureus, >40% of which is MRSA, making SSI prevention critical to the antimicrobial resistance (AMR) agenda

*SAVE LIVES: Clean Your Hands. WHO 2016. www.who.int/gpsc/5may

Advanced Infection Prevention and Control Training
Handout 21. WHO surgical handrubbing poster

The poster is available to download from: http://www.who.int/infection-prevention/campaigns/clean-hands/EN_PSP_GPSC1_5May_2016/en/
Surgical Handrubbing Technique

- Handwash with soap and water on arrival to OR, after having donned theatre clothing (cap/hat/bonnet and mask).
- Use an alcohol-based handrub (ABHR) product for surgical hand preparation, by carefully following the technique illustrated in Images 1 to 17, before every surgical procedure.
- If any residual talc or biological fluids are present when gloves are removed following the operation, handwash with soap and water.

Images 3-7: Smear the handrub on the right forearm up to the elbow. Ensure that the whole skin area is covered by using circular movements around the forearm until the handrub has fully evaporated (10-15 seconds).

Images 8-10: Now repeat steps 1-7 for the left hand and forearm.

Images 11-17: Continue rubbing the remaining steps, repeating if necessary, ensuring that all areas of the hands and forearms are covered.

1. Put approximately 5ml (3 doses) of ABHR in the palm of your left hand, using the elbow of your other arm to operate the dispenser.
2. Dip the fingertips of your right hand in the handrub to decontaminate under the nails (5 seconds).
3. Images 3-7: Smear the handrub on the right forearm up to the elbow. Ensure that the whole skin area is covered by using circular movements around the forearm until the handrub has fully evaporated (10-15 seconds).
4. Images 8-10: Now repeat steps 1-7 for the left hand and forearm.
5. Rub the back of the left hand, including the wrist, moving the right palm back and forth, and vice-versa.
6. Rub palm against palm back and forth with fingers interlinked.
7. Rub the back of the fingers by holding them in the palm of the other hand with a sideways back and forth movement.
8. Rub the back of the right hand, including the wrist, moving the left palm back and forth, and vice-versa.
9. Rub palm against palm back and forth with fingers interlinked.
10. Rub the back of the fingers by holding them in the palm of the other hand with a sideways back and forth movement.
11. Put approximately 5ml (3 doses) of ABHR in the palm of your left hand as illustrated, to rub both hands at the same time up to the wrists, following all steps in images 12-17 (20-30 seconds).
12. Cover the whole surface of the hands up to the wrist with ABHR, rubbing palm against palm with a rotating movement.
13. When the hands are dry, sterile surgical clothing and gloves can be donned.

Repeat this sequence (average 60 sec) the number of times that adds up to the total duration recommended by the ABHR manufacturer’s instructions. This could be two or even three times.
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Handout 22. WHO hand hygiene observation form

## Observation Form

<table>
<thead>
<tr>
<th>Facility:</th>
<th>Period Number*:</th>
<th>Session Number*:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service:</td>
<td>Date: (dd/mm/yy)</td>
<td>Observer: (initials)</td>
</tr>
<tr>
<td>Ward:</td>
<td>Start/End time: (hh:mm)</td>
<td>Page N°:</td>
</tr>
<tr>
<td>Department:</td>
<td>Session duration: (mm)</td>
<td>City**:</td>
</tr>
</tbody>
</table>

**Country**: 

<table>
<thead>
<tr>
<th>Prof.cat Code</th>
<th>Prof.cat Code</th>
<th>Prof.cat Code</th>
<th>Prof.cat Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>N°</td>
<td>N°</td>
<td>N°</td>
<td>N°</td>
</tr>
</tbody>
</table>


|   | a-b-f.   | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     |
|   | HR       | HW         | missed     | gloves     | HR         | HW         | missed     | gloves     |
|   | a-b-f.   | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     |
|   | HR       | HW         | missed     | gloves     | HR         | HW         | missed     | gloves     |
|   | a-b-f.   | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     |
|   | HR       | HW         | missed     | gloves     | HR         | HW         | missed     | gloves     |
|   | a-b-f.   | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     |
|   | HR       | HW         | missed     | gloves     | HR         | HW         | missed     | gloves     |
|   | a-b-f.   | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     |
|   | HR       | HW         | missed     | gloves     | HR         | HW         | missed     | gloves     |
|   | a-b-f.   | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     |
|   | HR       | HW         | missed     | gloves     | HR         | HW         | missed     | gloves     |
|   | a-b-f.   | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     |
|   | HR       | HW         | missed     | gloves     | HR         | HW         | missed     | gloves     |
|   | a-b-f.   | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     | a-b-f.     |
|   | HR       | HW         | missed     | gloves     | HR         | HW         | missed     | gloves     |

**To be completed by the data manager.**

**Optional**, to be used if appropriate, according to the local needs and regulations.

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WHO acknowledges the Hôpitaux Universitaires de Genève (HUG), in particular the members of the Infection Control Programme, for their active participation in developing this material.

Revised August 2009
### General Recommendations
(refer to the Hand Hygiene Technical Reference Manual)

1. In the context of open and direct observations, the observer introduces him/herself to the health-care worker and to the patient when appropriate, explains his/her task and proposes immediate informal feedback.
2. The health-care worker, belonging to one of the main four following professional categories (see below), is observed during the delivery of health-care activities to patients.
3. Detected and observed data should be recorded with a pencil in order to be immediately corrected if needed.
4. The top of the form (header) is completed before starting data collection (excepted end time and session duration).
5. The session should last no more than 20 minutes (±10 minutes according to the observed activity); the end time and the session duration are to be completed at the end of the observation session.
6. The observer may observe up to three health-care workers simultaneously, if the density of hand hygiene opportunities permits.
7. Each column of the grid to record hand hygiene practices is intended to be dedicated to a specific professional category. Therefore numerous health-care workers may be sequentially included during one session in the column dedicated to their category. Alternatively each column may be dedicated to a single health-care worker only of whom the professional category should be indicated.
8. As soon as you detect an indication for hand hygiene, count an opportunity in the appropriate column and cross the square corresponding to the indication(s) you detected. Then complete all the indications that apply and the related hand hygiene actions observed or missed.
9. Each opportunity refers to one line in each column; each line is independent from one column to another.
10. Cross items in squares (several may apply for one opportunity) or circles (only a single item may apply at one moment).
11. When several indications fall in one opportunity, each one must be recorded by crossing the squares.
12. Performed or missed actions must always be registered within the context of an opportunity.
13. Glove use may be recorded only when the hand hygiene action is missed while the health-care worker is wearing gloves.

### Short description of items

| Facility: | to complete according to the local nomenclature |
| Service: | to complete according to the local nomenclature |
| Ward: | to complete according to the local nomenclature |
| Department: | to complete according to the following standardized nomenclature: |
| Medical, including dermatology, neurology, haematology, oncology, etc.: | surgery, including neurosurgery, urology, EENT, ophthalmology, etc. |
| Mixed (medical & surgical), including gynaecology: | obstetrics, including related surgery |
| Paediatrics, including related surgery: | intensive care & resuscitation |
| Emergency unit: | long term care & rehabilitation |
| Ambulatory care, including related surgery: | other (to specify) |
| Period N°: | 1) pre- / 2) post-intervention; and then according to the institutional counter. |
| Date: | day (dd) / month (mm) / year (yy) |
| Start/end time: | hour (hh) / minute (mm) |
| Session duration: | difference between start and end time, resulting in minutes of observation. |
| Session N°: | attributed at the moment of data entry for analysis. |
| Observer: | observer’s initials (the observer is responsible for the data collection and for checking their accuracy before submitting the form for analysis). |
| Page N°: | to write only when more than one form is used for one session. |

### Prof.cat:
accordance with the following classification:

1. Nurse / midwife 1.1 nurse, 1.2 midwife, 1.3 student.
2. Auxiliary
3. Medical doctor 3.1 in internal medicine, 3.2 surgeon, 3.3 anaesthetist / resuscitator / emergency physician, 3.4 paediatrician, 3.5 gynaecologist, 3.6 consultant, 3.7 medical student.
4. Other health-care worker 4.1 therapist (physiotherapist, occupational therapist, audiologist, speech therapist), 4.2 technician (radiologist, cardiology technician, operating room technician, laboratory technician, etc., 4.3 other (dietician, dentist, social worker and any other health-related professional involved in patient care), 4.4 student.

### Number:
number of observed health-care workers belonging to the same professional category (same code) as they enter the field of observation and you detect opportunities.

### Opp(ortunity):
declared by one indication at least.

### Indication:
reason(s) that motivate(s) hand hygiene action; all indications that apply at one moment must be recorded

| bef.pat: before touching a patient | aft.f: after body fluid exposure risk |
| bef.aept: before clean/aseptic procedure | aft.pat: after touching a patient |
| aft.p.surr: after touching patient surroundings |

### HH action:
response to the hand hygiene indication(s); it can be either a positive action by performing handrub or handwash, or a negative action by missing handrub or handwash

| HR: hand hygiene action by handrubbing with an alcohol-based formula | Missed: no hand hygiene action performed |
| HW: hand hygiene action by handwashing with soap and water |

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Advanced Infection Prevention and Control Training

Handout 23. Reference list including additional reading material


Advanced Infection Prevention and Control Training


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EPOC. What study designs can be considered for inclusion in an EPOC review and what should they be called? London: Cochrane Effective Practice and Organization of Care; 2017 (http://epoc.cochrane.org/resources/epoc-resources-review-authors, accessed 8 June 2018).


Advanced Infection Prevention and Control Training


Advanced Infection Prevention and Control Training


Kawamura H, Matsumoto K, Shigemi A, Orita M, Nakagawa A, Nozima S et al. A bundle that includes active surveillance, contact precaution for carriers, and cefazolin-based...
Advanced Infection Prevention and Control Training


McDonald LT, Clark AM, Landauer AK, Kuxhaus L. Winning the war on surgical site infection: evidence-based preoperative interventions for total joint arthroplasty. AORN J. 2015; 102(2):182.e1–e11.


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