

Guidelines for the Prevention of Surgical Site Infection: The Surgical Infection Society of Thailand Recommendations (Executive Summary)

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Surgical site infection (SSI) is a common and potentially preventable complication after surgery. Recently there have been several guidelines for preventing SSI published by a variety of organizations. To promote the prevention of incisional SSI, the Surgical Infection Society of Thailand (SIST) systematically reviewed current evidence on this subject from the most recent studies available, together with expert opinions on appropriate and suitable interventions in Thailand. The SIST Recommendations cover four phases for a total of 28 items. They include pre-admission with three items, pre-operation with six items, intra-operation with 15 items, and post-operation with four items. Of these recommendations, 10 items are Level 1 evidence or high level of evidence and are grouped into "Thailand's SSI Prevention Bundle". This care bundle includes smoking cessation, weight-based antibiotic prophylaxis, appropriate hair removal, skin preparation with alcohol-based solution, wound protectors for abdominal surgery, antimicrobial-coated sutures for clean operation in high-risk patients and elective digestive surgery, perioperative glucose control, intra-operative normothermia, peri-operative maintenance of oxygen saturation at least 92% or preferably at least 95%, and changing contaminated gloves and surgical instruments before wound closure. Intravenous antibiotic prophylaxis suitable for common operations in Thailand and their recommended dosing are noted in the SIST guidelines for the prevention of SSI.

Keywords: Surgical site infection, Prevention, Guideline, Thailand, Antibiotic prophylaxis, Wound, Surgery, Operation, Bundle, Recommendation

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Surgical site infection (SSI) is a common and potentially preventable complication after surgery affecting up to one in six patients^(1,2). In general, SSI is classified into three categories: superficial

incisional SSI (infection involves only skin and subcutaneous tissue of incision), deep incisional SSI (infection involves deep fascia or muscle of incision) and organ or space SSI (infection involves any part of the anatomy other than the incision that is opened and manipulated during an operation)⁽³⁾. Although many clinicians have thought that the sequelae of incisional SSI are trivial, incisional SSI has significant adverse effects on patient's outcomes including prolonged hospitalization, increased rate of readmission, higher costs of healthcare, greater physical limitations, and

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Table 1. Summary of guidelines for the prevention of surgical site infection: the Society of Surgical Infection of Thailand (SIST) recommendations

Phase	Recommendations
Preadmission	<ol style="list-style-type: none"> 1. Stop smoking at least 2 weeks before surgery* 2. Provide nutrition therapy in malnourished patients scheduled for major operation 3. Screen and decolonize methicillin-resistant <i>Staphylococcus aureus</i> in relevant health professionals and patients
Preoperation	<ol style="list-style-type: none"> 1. Consider discontinuing immunosuppressive agents affecting cell-mediated immunity 2. Treat or control active infections remote to the surgical site 3. Shower or bathe before surgery 4. Consider using preoperative oral antibiotics and mechanical bowel preparation in elective colorectal surgery 5. If necessary, remove hair with a clipper shortly before entering a theater* 6. Give intravenous antimicrobial prophylaxis within 60 minutes before making an incision in prosthetic-associated procedures and clean-contaminated procedures*
Intraoperation	<ol style="list-style-type: none"> 1. Remove hand jewelry and artificial nails from staff's hand 2. Prepare staff's hand with antiseptic solutions before donning gloves 3. Consider using double gloving with powder-free gloves 4. Prepare patient's skin with alcohol-based antiseptic solutions unless contraindicated* 5. Do not routinely use of adhesive incision drapes 6. Wear sterile gowns and use proper drapes 7. Use wound-protector device in clean-contaminated, contaminated and dirty abdominal operation* 8. Maintain oxygen saturation $\geq 92\%$ (or preferably $\geq 95\%$)* 9. Maintain normothermia* 10. Control perioperative blood sugar - not higher than 200 mg/dL* 11. Avoid salt and fluid overload 12. Irrigate wound with warm saline solution before wound closure 13. Use antimicrobial-impregnated sutures in high-risk patients undergoing clean operation and patients undergoing elective digestive surgery* 14. Change contaminated gloves and instruments before wound closure* 15. Do not use prophylactic negative-pressure wound therapy on primarily closed incision
Postoperation	<ol style="list-style-type: none"> 1. Maintain normothermia 2. Maintain oxygen saturation $\geq 92\%$ (or preferably $\geq 95\%$) 3. Discontinue intravenous antimicrobial prophylaxis within 24 hours after an operation 4. Do not use advanced wound dressing on primarily closed wound

* indicates recommendations supported by level 1 or high level of evidence

poorer health-related quality of life⁽⁴⁾. A survey of SSI following 330 major colorectal operations in Thailand found that the length of hospitalization in patients with incisional SSI was 7.6 days longer than that of those without⁽¹⁾.

To promote the prevention of incisional SSI, the Surgical Infection Society of Thailand (SIST) systematically reviewed current evidence on the prevention of SSI from the most recent studies available, together with expert opinions on appropriate and suitable interventions in Thailand. Accordingly, these guidelines are taken from the members of SIST and several Thai experts on surgical infection, with the modification of five recent guidelines for

the prevention of SSI, namely the World Health Organization (WHO) in 2016^(5,6), the American College of Surgeons/Surgical Infection Society (ACS-SIS) in 2016^(7,8), the Centers for Disease Control and Prevention (CDC) in 2017⁽⁹⁾, the United Kingdom's National Institute for Health and Care Excellence (NICE) in 2019⁽¹⁰⁾, and the Asia Pacific Society of Infection Control (APSIC) in 2019⁽¹¹⁾.

The Guidelines for the prevention of SSI and SIST Recommendations are divided into four phases for a total of 28 items, as shown in Table 1. They are the pre-admission that includes three items, pre-operation that are six items, intra-operation that are 15 items, and post-operation that are four items. Of

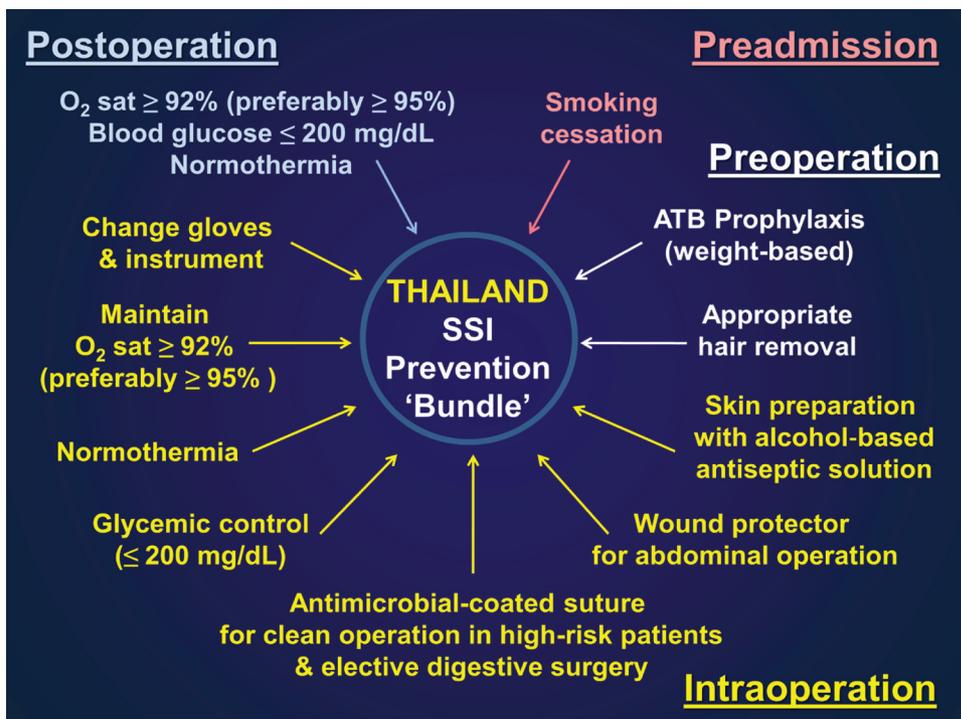


Figure 1. The Surgical Infection Society of Thailand (SIST) recommendations for preventing incisional surgical site infection (SSI) - supported by level 1 or high level of evidence. Notably, these 10 recommendations are grouped into “Thailand’s SSI Prevention Bundle”.

these recommendations, 10 items are Level 1 evidence or high level of evidence and are summarized in Figure 1⁽¹²⁻²⁰⁾.

Pre-admission

1. All patients should be strongly advised to stop smoking at least two weeks before surgery.
2. Pre-operative nutritional therapy with a preferential use of enteral nutrition should be given in malnourished patients scheduled for major operation.
3. Regarding methicillin-resistant *Staphylococcus aureus* (MRSA) screening and decolonization, surgical units, especially orthopedic surgery and cardiothoracic surgery, may evaluate their incidence of MRSA-related SSI. If the incidence is significant, screening nasal swabs for detecting MRSA carriage in surgical-related health professionals and patients may be performed and treated pre-operatively with 2% nasal mupirocin twice daily for five days.

Pre-operation

1. Discontinuation of immunosuppressive agents affecting cell-mediated immunity (e.g., high-dose prednisolone and cyclosporine) may be beneficial in reducing SSI. However, physicians should

balance between patient’s disease flare-up from drug withdrawal and risk or sequelae of SSI.

2. Active infections remote to the surgical site should be treated or well controlled before an elective operation.

3. Patients should take a shower or a bed bath with either normal soap or antiseptic soap before an operation. Clean clothes should be worn afterward. Time interval between body cleansing and operation should be as short as possible. This recommendation may apply to both inpatient and outpatient surgeries.

4. In elective colorectal surgery, pre-operative oral antibiotics in combination of mechanical bowel preparation may decrease the rate of SSI. However, mechanical bowel preparation alone is not associated with a reduction in SSI rate.

5. Hair removal should not be routinely performed. If necessary, hair should be removed with a clipper shortly before patients enter an operating room.

6. Pre-operative intravenous antimicrobial prophylaxis is indicated in prosthetic-associated procedures and clean-contaminated procedures. A clean-contaminated operation is defined as a procedure entering into a luminal organ with

Table 2. Intravenous antimicrobial prophylaxis suitable for surgical practices in Thailand

Type of surgery	Recommended antimicrobial agents	Alternatives
Breast ^a	Cefazolin	Clindamycin, vancomycin (if MRSA suspected) ^b
Burn ^c	Cefazolin	Clindamycin, vancomycin (if MRSA suspected) ^b
Cardiac	Cefazolin	Cefuroxime, clindamycin, vancomycin (if MRSA suspected) ^b
Head & neck ^d		
Clean with prosthesis placement (exclude tympanostomy tube) and Clean-contaminated including cancer (exclude tonsillectomy and functional endoscopic sinus procedure)	Cefazolin or cefuroxime + metronidazole, ampicillin-sulbactam, amoxicillin-clavulanic acid	Clindamycin
Hepatobiliary & pancreas	Cefazolin, cefoxitin ^e	Ampicillin-sulbactam, amoxicillin-clavulanic acid, ciprofloxacin ± metronidazole
Hernia (abdomen/groin)	Cefazolin	Clindamycin, vancomycin (if MRSA suspected) ^b
GI tract: esophagus, stomach & duodenum	Cefazolin, ampicillin-sulbactam, amoxicillin-clavulanic acid	Clindamycin + aminoglycoside or fluoroquinolone
GI tract: jejunum & ileum	Cefazolin	Clindamycin + aminoglycoside or fluoroquinolone, ampicillin-sulbactam, amoxicillin-clavulanic acid
GI tract: obstructed small bowel	Cefazolin or cefuroxime + metronidazole, cefoxitin ^e	Ampicillin-sulbactam, amoxicillin-clavulanic acid, metronidazole + aminoglycoside or fluoroquinolone
GI tract: colon, rectum & anus	Cefazolin or cefuroxime + metronidazole, cefoxitin ^e , ampicillin-sulbactam, amoxicillin-clavulanic acid	Metronidazole or clindamycin + aminoglycoside or fluoroquinolone
Maxillofacial	Cefazolin	Ampicillin-sulbactam, amoxicillin-clavulanic acid, clindamycin
Neurosurgery	Cefazolin	Clindamycin, vancomycin (if MRSA suspected) ^b
Obstetrics ^f & gynecology	Cefazolin	Cefoxitine, ampicillin-sulbactam, amoxicillin-clavulanic acid, metronidazole or clindamycin + aminoglycoside or fluoroquinolone
Orthopedic	Cefazolin	Clindamycin, vancomycin (if MRSA suspected) ^b
Thoracic	Cefazolin	Ampicillin-sulbactam, amoxicillin-clavulanic acid, clindamycin, vancomycin (if MRSA suspected) ^b
Urologic ^g (without urinary tract entry)	Cefazolin	Levofloxacin or ciprofloxacin (if isolate sensitive)
Urologic ^g (with urinary tract entry)	Cefazolin + aminoglycoside, ampicillin-sulbactam, amoxicillin-clavulanic acid	If third-generation cephalosporin-resistant gram-negative bacilli is identified prior to surgery, consider using an agent that the bacteria are sensitive to - but must avoid prolonged use
Vascular	Cefazolin	Clindamycin, vancomycin (if MRSA suspected) ^b

GI=gastrointestinal

Specific notes:

^a Antimicrobial prophylaxis may be considered in non-reconstructive breast cancer procedures only, providing that at this moment there is no significant protection against surgical site infection in augmentation mammoplasty using periareolar submuscular technique, reduction mammoplasty and lumpectomy.

^b Methicillin-resistant *Staphylococcus aureus* (MRSA) may be suspected in patients known to be colonized or infected with MRSA, or on broad spectrum antimicrobial agents e.g., fluoroquinolones, third-generation cephalosporins prior to surgery.

^c Available evidence does not support the role of systemic antibiotic prophylaxis in managing most of burn patients. However, it may be useful in patients with severe burns who require mechanical ventilation, and in selected split-thickness skin grafting procedures.

^d Antimicrobial prophylaxis is not recommended in clean head & neck surgery unless there are conditions stated above.

^e Cefminox is an alternative to cefoxitin because both drugs are in Cephamycin group and have comparable spectrums.

^f In cesarean section, antibiotic should be given prior to incision as in other surgery. Administration of prophylactic agent after clamping the umbilical cord as has been traditionally performed is abandoned because it is associated with a higher incidence of postoperative infection including endometritis. There is no evidence of harm to the newborn in giving antibiotic before clamping the umbilical cord.

^g International guidelines have recommended fluoroquinolones and trimethoprim-sulfamethoxazole. However, uropathogens in Thailand are frequently resistant to these two agents. Further studies using domestic data are warranted so that more appropriate recommendations can be made. In patients undergoing urologic instrumentation involving urinary tract, antimicrobial prophylaxis is not necessary if urine culture shows no growth prior to the surgical procedure.

General notes:

- Antimicrobial agents recommended for surgical prophylaxis are based on availability and susceptibility pattern in Thailand 2018 and 2019 (National Antimicrobial Resistance Surveillance Center of Thailand: NARST).

- Cefazolin and clindamycin are recommended based on susceptibility data - which demonstrated that more than 90% of methicillin-susceptible *Staphylococcus aureus* (MSSA) are sensitive to cefazolin and clindamycin (NARST 2019).

- Cefoxitin, amoxicillin-clavulanic acid, ampicillin-sulbactam, levofloxacin and ciprofloxacin are recommended based on 2019 susceptibility data in Thailand - which demonstrated that *Escherichia coli* is susceptible to these 5 agents in the following order of 89.9%, 68.1%, 59.9%, 47.8% and 39.5%, respectively (NARST 2019).

- Ceftriaxone is not recommended because it should be limited for therapeutic rather than prophylactic use e.g., patients with acute cholecystitis which may not be determined prior to incision (not patients undergoing cholecystectomy for non-infected biliary conditions).

- Vancomycin, clindamycin, levofloxacin, and ciprofloxacin may be an alternative for patients with beta-lactam allergy.

Table 3. Recommended dosing and administration of specific agents for surgical antimicrobial prophylaxis

Antimicrobial agents	Adult	Pediatric	Redosing interval (hours)*
Ampicillin-sulbactam	3 g (ampicillin 2 g/sulbactam 1 g)	50 mg/kg of ampicillin component	2
Ampicillin	2 g	50 mg/kg	2
Amoxicillin-clavulanic acid	2.4 g (amoxicillin 2 g/clavulanic acid 0.4 g)	25 mg/kg of amoxicillin component	2
Cefazolin	1 to 3 g (2 g is generally recommended)	30 mg/kg	4
Cefuroxime	1.5 g	50 mg/kg	4
Cefoxitin	2 g	40 mg/kg	2
Cefminox	2 g	40 mg/kg	6
Ceftriaxone	2 g	50 to 75 mg/kg	n/a
Ciprofloxacin	400 mg	10 mg/kg	n/a
Clindamycin	900 mg	10 mg/kg	6
Gentamicin	5 mg/kg based on dosing weight (single dose)	2.5 mg/kg based on dosing weight	n/a
Levofloxacin	500 mg	10 mg/kg	n/a
Metronidazole	500 mg	15 mg/kg	n/a
Vancomycin	30 g/kg	15 g/kg	n/a

n/a=not available

Notes:

- The optimal time for administration of preoperative doses is within 60 minutes before surgical incision - except vancomycin and fluoroquinolones which should be given at 60 to 120 minutes before an incision due to their prolonged time to adequate tissue distribution.
- Given efficacy of postoperative antimicrobial administration has been unproven for most procedures. A single dose or continuation for less than 24 hours is recommended to shorten postoperative course and to minimize postoperative antimicrobial resistance.
- If an agent with a short half-life is used such as cefazolin and cefoxitin, it should be re-administered for procedures with duration exceeding the recommended redosing interval (from the time of initiating pre-incisional dose). Redosing may also be warranted if prolonged or excessive bleeding occurs or if there are other factors that may shorten the half-life of the prophylactic agent e.g., extensive burns. Redosing may not be warranted in patients in whom the half-life of the agent may be prolonged e.g., patients with renal insufficiency.

colonizing flora. Choice of intravenous antimicrobial prophylaxis depends on the coverage of possible pathogens at the incision site, host's comorbidity and other patient-specific risk factors. In general, intravenous antimicrobial prophylaxis should be given within 60 minutes before a surgical incision, except vancomycin and fluoroquinolones, which should be given at 60 to 120 minutes before an incision due to their prolonged time to adequate tissue distribution. Intravenous antimicrobial prophylaxis should be re-dosed intraoperatively if the operation time is longer than two half-lives of the drug or the blood loss is greater than 1,500 mL. Based on the National Antimicrobial Resistance Surveillance Center of Thailand (NARST), the recommendation of intravenous antimicrobial prophylaxis suitable for common surgical practices in Thailand is shown in Table 2. Dosing of specific antimicrobial agents is shown in Table 3.

Intra-operation

1. Staff's hand preparation includes the removal of hand jewelry and artificial nails.
2. Staff's hand preparation should be done by

antiseptic solutions using either scrubbing or rubbing before donning gloves. In case of visible soiling, hand scrubbing is preferential.

3. Double gloving with powder-free gloves is recommended.

4. Either disposable non-woven or reusable woven drapes and surgical gowns can be used, together with other appropriate personal protective equipment. Notably, wearing theater attire out of an operation room is discouraged.

5. Patient's skin preparation with alcohol-based antiseptic solutions should be used unless contraindicated. A traditional scrub-and-paint technique is recommended especially in the presence of visible soiling.

6. There is no strong evidence suggesting that the use of adhesive incision drapes can reduce the incidence of incisional SSI. Therefore, its routine use is discouraged.

7. Wound-protector devices may be used in clean-contaminated, contaminated and dirty abdominal operation.

8. During an operation, patient's oxygen saturation should always be at least 92% or preferably

at least 95%.

9. Core temperature should be measured during major operation. Maintaining normothermia (body temperature of 36°C or more) throughout an operation is advised. Pre-operative active warming could be a maneuver to maintain normothermia.

10. The target intra-operative and post-operative blood sugar should not be higher than 200 mg/dL, especially in diabetic patients.

11. Avoidance of salt and fluid overload is recommended. Intra-operative goal-directed fluid therapy may be used in high-risk operations or high-risk patients.

12. Wound irrigation with warm saline solution may be performed prior to wound closure. Notably, wound irrigation with antibiotics should not be done.

13. During wound closure, antimicrobial-impregnated or triclosan-coated sutures may be used to minimize the risk of incisional SSI in high-risk patients undergoing clean operation and patients undergoing elective digestive surgery.

14. Changing contaminated gloves and surgical instruments including sutures before wound closure is recommended, especially in colorectal surgery.

15. There is no strong evidence suggesting that prophylactic negative-pressure wound therapy on primarily closed incision can reduce the incidence of wound infection. Therefore, the use of this equipment is discouraged.

Post-operation

1. Normothermia should be maintained in the early post-operative period.

2. In the early post-operative period, patient's oxygen saturation should be maintained at least 92% (or preferably at least 95%).

3. Intravenous antimicrobial prophylaxis should be discontinued within 24 hours after an operation, even in the presence of drain.

4. There is no role of advanced wound dressing on primarily closed wound.

What is already known on this topic?

There are several international guidelines for the prevention of SSI but not all recommendations are suitable or feasible to be applied into surgical practices in Thailand. It would be of great importance to develop a national guideline for preventing SSI in Thailand.

What this study adds?

The Surgical Infection Society of Thailand

proposes a guideline for the prevention of SSI focusing on superficial and deep incisional SSI. The guideline consists of 28 recommendations, 10 of which are supported by high level of evidence and therefore, are grouped into "Thailand's SSI Prevention Bundle".

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Disclaimer

The guidelines for the prevention of surgical site infection recommended by the Surgical Infection Society of Thailand are systematically developed to assist clinicians and other relevant health professionals about appropriate measures for preventing surgical site infection, which is focusing only on superficial and deep incisional surgical site infection, based on evidence from a comprehensive literature review of the most recent studies available and expert opinions.

These guidelines are targeted at clinicians and other relevant health professionals only. They do not constitute a textbook and therefore, deliberately, provide no or little explanation or background to each recommendation or measurement. They also do not necessarily represent the views of all clinicians at the Surgical Infection Society of Thailand, the Royal College of Surgeons of Thailand or other health organizations. The recommendations contained in these guidelines do not indicate an exclusive course of action or standard of care. It is not mandatory to apply

the recommendations. They do not replace the need for application of clinical judgment to each individual presentation, nor variations based on locality and facility type. Ultimately, health professionals must make their own decisions about care on a case-by-case basis and based on the availability of resources provided at their clinic or hospital.

The Surgical Infection Society of Thailand has made considerable efforts to ensure the information upon these guidelines is accurate and up to date, but it might not be so. Accordingly, users of these guidelines are strongly advised to confirm that the information contained within them is correct by way of independent sources. The Surgical Infection Society of Thailand and authors accept no responsibility for any inaccuracies, information perceived as misleading, or the success or failure of any recommendation detailed in the guideline.

Conflict of interest

The authors declare no conflict of interest.

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