A Comparative Analysis of Surgical Wound Infection Methods: Predictive Values of the CDC, ASEPSIS, and Southampton Scoring Systems in Evaluating Breast Reconstruction Surgical Site Infections

Insiyah Campwala, BS¹, Kayla Unsell, BS¹,
and Subhas Gupta, MD, CM, PhD, FRCSC, FACS¹

Plastic Surgery

2019, Vol. 27(2) 93-99

© 2019 The Author(s)

Article reuse guidelines:

sagepub.com/journals-permissions

DOI: 10.1177/2292550319826095

journals.sagepub.com/home/psg

Abstract

Infection is the most significant complication in breast reconstruction surgery. While the Center for Disease Control and Prevention (CDC) is the most prevalent tool for surgical site infection (SSI) diagnosis, ASEPSIS and Southampton scoring methods have been speculated to be more sensitive. The ASEPSIS scoring system previously demonstrated much better interrater reliability than the CDC. We sought to assess the predictive value of various wound scoring methods in breast reconstruction SSIs. A retrospective analysis of all single-institution breast reconstruction infections from January 2013 to June 2016 was performed. Patients' postoperative wound-related complications were collected. Southampton, CDC, and modified ASEPSIS scores—extended to 30 postoperative days—were calculated. Relative predictive values for implant-based reconstruction were evaluated. Among the 22 reviewed cases, ASEPSIS scores greater than 30 resulted in a more than 50% rate of implant-based breast reconstruction failure. There was a significant positive correlation between ASEPSIS score and failure rate ($P = .022$). A Southampton classification of B—minor complication (60% failure)—had a greater associative risk of reconstruction failure than a classification of C—major complication (23% failure)—or classification of D—major hematoma (0% failure). The CDC score had no predictive value of success versus failure of reconstruction. While the CDC criteria and Southampton scoring systems demonstrated little clinical use, the ASEPSIS scoring system shows substantial predictive value for breast reconstruction SSIs. New procedure protocols should be implemented to require detailed surgical notes including the proportion of the wounds affected by inflammatory responses to allow for easier wound score calculation by these alternate scoring systems.

Résumé

Une analyse comparative des méthodes d'infection des plaies chirurgicales : les valeurs prédictives des systèmes de score du CDC, de l'ASEPSIS et de Southampton pour évaluer les infections au siège de reconstruction mammaire : L'infection est la principale complication en cas de reconstruction mammaire. L'outil du *Center for Disease Control* (CDC) est le plus prévalent pour diagnostiquer l'infection au siège de l'opération, mais on spécule que les méthodes de score de l'ASEPSIS et de Southampton sont plus sensibles. L'ASEPSIS a déjà démontré une fiabilité interévaluateur bien meilleure que l'outil du CDC. Les chercheurs ont cherché à évaluer la valeur prédictive de diverses méthodes de score des plaies en cas d'infection au siège de la reconstruction mammaire. Les chercheurs ont effectué une analyse rétrospective de toutes les infections des reconstructions mammaires dans un seul établissement entre janvier 2013 et juin 2016. Ils ont colligé les complications liées aux plaies postopératoires des patients. Ils ont calculé les scores de Southampton, de CDC et de l'ASEPSIS modifiés, prolongées jusqu'à 30 jours après l'opération, et évalué les valeurs prédictives relatives des reconstructions mammaires par implant. Dans les

¹ Department of Plastic Surgery, Loma Linda University School of Medicine, Loma Linda, CA, USA

Corresponding Author:

Subhas Gupta, Department of Plastic Surgery, Loma Linda University School of Medicine, 11175 Campus Street, Suite 21126, Loma Linda, CA 92354, USA.
Email: sgupta@llu.edu

22 cas analysés, les scores de l'ASEPSIS supérieurs à 30 entraînaient un taux d'échec de reconstructions mammaires par implant supérieur à 50%. Il y avait une corrélation positive importante entre le score de l'ASEPSIS et le taux d'échec ($p=0,022$). Une classification de Southampton de B (complication mineure, échec de 60%) comportait un risque associatif plus important d'échec de la reconstruction qu'une classification de C (complication majeure, échec de 23%) ou de D (hématome majeur, échec de 0 %). Le score de CDC n'avait aucune valeur prédictive de succès par rapport à l'échec de reconstruction. Les critères de CDC et les systèmes de score de Southampton se sont révélés de peu d'intérêt clinique, mais le système de score de l'ASEPSIS a une valeur prédictive substantielle d'infection au siège de la reconstruction mammaire. Il faut adopter de nouveaux protocoles d'intervention pour exiger la prise de notes chirurgicales détaillées, y compris la proportion de plaies touchées par les réponses inflammatoires pour calculer plus facilement le score des plaies au moyen de ces autres systèmes de score.

Keywords

surgical site infection, wound scoring, wounds, infection, Center for Disease Control, ASEPSIS scoring system, Southampton Wound Assessment Scale, breast reconstruction

Significance of This Study

What Is Already Known About This Subject?

- Physicians' diagnosis of infection can have a major impact on surgical wound infection rates.
- Breast surgery has a higher infection rate (15%) than clean surgery (1.5%-3%).
- The Center for Disease Control and Prevention (CDC), ASEPSIS, and Southampton systems are 3 of the most common surgical site infection (SSI) scoring systems.

What Are the New Findings?

- The CDC criteria and Southampton scoring systems show little clinical use for predicting outcomes of breast reconstruction SSIs.
- There is a significant positive correlation between ASEPSIS score and implant failure rate.
- Standardized, objective assessments of SSIs necessitate a higher level of detail in surgical and postoperative notes.

How Might These Results Change the Focus of Research or Clinical Practice?

These data encourage a shift away from use of the CDC and Southampton definitions for SSI diagnosis and the adoption of a more objective and comprehensive scoring system for use in breast reconstructive surgery.

Introduction

We have seen many improvements in the management of post-surgical recovery and taken many precautions against infections and complications over the past 2 decades. Yet, surgical

site infections (SSIs) remain the most common and expensive hospital-acquired infections, accounting for 20% of such infections. The annual cost of SSI in the United States is estimated to be about US\$3.5 to US\$10 billion, stemming from the associated increased length of stay, emergency department visits, and readmissions.¹

Breast surgery, classified as "clean-contaminated," has infection rates ranging from 3% to 15%—much higher than the infection rates for clean surgery (1.5%-3%).² These higher rates of infection are thought to be associated with microbial contamination or poor healing due to insufficient blood supply of the breast epithelial ductal tissue, residual hematomas or seromas, or acute biofilm formation.³

Whereas pain, swelling, erythema, warmth, and impairment of function are consistently seen as signs of infection,⁴ the medical community has tried to standardize these diagnoses using strict definitions. Bruce et al, in a systematic review of prospective studies of surgical wound infection from 1993 to 1999, cataloged 41 distinct surgical wound infection definitions, 5 of which were deemed "standard" definitions by multidisciplinary groups. Of note, the presence of pus was the most common indicator of infection across all definitions. They found that the Center for Disease Control and Prevention (CDC) definition was the most widely implemented and the ASEPSIS wound scale—originally created to assess wounds resulting from cardiothoracic surgery—was most often used as a quantitative grading tool. The review overall demonstrated the wide range of SSI definitions being used in clinical practice and the need for validation of each and surveillance of a standardized system.⁵ It is imperative that we identify a single surveillance system of SSI, ideally one which has a meaningful definition of infections, consistent interpretation of classification criteria, applicability to both inpatient and outpatient procedures, ability to detect infection post discharge, sufficient precision to distinguish small differences, and reasonable cost.⁶

Amid the approximately 40 identified definitions of SSI, we aim to examine the 3 most prominent: the CDC, ASEPSIS, and Southampton scoring systems.

The CDC Definition of SSI

The CDC has issued an SSI criterion that distinguishes superficial incisional SSI, deep incisional SSI, and organ/space SSI.

Superficial incisional SSI is an infection that occurs within 30 days after the operation, and the infection involves only skin or subcutaneous tissue of the incision and at least one of the following:

- Purulent drainage, with or without laboratory confirmation, from the superficial incision.
- Organisms identified from an aseptically obtained specimen from the superficial incision.
- At least one of the following signs or symptoms of infection: pain or tenderness, localized swelling, redness, or heat AND superficial incision is deliberately opened by the surgeon, unless incision is culture negative.
- Diagnosis of superficial incisional SSI by the surgeon or attending physician.

Do not report the following conditions as SSI:

- Stitch abscess (minimal inflammation and discharge confined to the points of suture penetration).
- A localized stab wound or pin site infection—would be considered a skin or soft tissue infection, depending on its depth.
- Infected burn wound.
- Infected circumcision.
- Incisional SSI that extends into the fascial and muscle layers (see deep incisional SSI).

Deep incisional SSI occurs within 30 to 90 days and infection involves deep soft tissues (eg. fascial and muscle layers) of the incision and at least one of the following:

- Purulent drainage from the deep incision but not from the organ/space component of the surgical site.
- A deep incision spontaneously dehisces or is deliberately opened by a surgeon when the patient has at least one of the following signs or symptoms: fever ($>38^{\circ}\text{C}$), localized pain, or tenderness, unless site is culture negative.
- An abscess or other evidence of infection involving the deep incision is found on direct examination, during reoperation, or by histopathologic or radiologic examination.
- Diagnosis of a deep incision SSI by a surgeon or attending physician.

Note:

- Infection that involves both superficial and deep incision sites is reported as deep incisional SSI.
- An organ/space SSI that drains through the incision is reported as a deep incisional SSI.

Organ/space SSI occurs within 30 to 90 days and infection involves any part of the body deeper than the fascial/muscle layers, which is opened or manipulated during the operative procedure and at least one of the following:

- Purulent drainage from a drain that is placed into the organ/space.
- Organisms are identified from an aseptically obtained fluid or tissue in the organ/space by a culture or nonculture-based microbiologic testing method that is performed for purposes of clinical diagnosis or treatment.
- An abscess or other evidence of infection involving the organ/space that is detected on direct examination or by histopathologic or radiologic examination.
- Diagnosis of a deep incision SSI by a surgeon or attending physician.^{7,8}

ASEPSIS Score

The ASEPSIS wound scoring method was created by Wilson et al in 1986 and is an acronym for Additional treatment, Serous discharge, Erythema, Purulent exudate, Separation of deep tissues, Isolation of bacteria, and Stay as inpatient prolonged over 14 days. Its design was based on signs and symptoms of infected sternal surgical wounds post cardiac surgery. The score is calculated based on the percentage of the wound affected by serous exudate, erythema, purulent exudate, and separation of deep tissues. Additional points are awarded for antibiotic treatment, drainage of pus under local anesthesia, debridement of the wound under general anesthesia, isolation of bacteria, and stay as inpatient prolonged over 14 days. Scores are grouped into 4 categories: satisfactory healing (0-10), disturbance of healing (11-20), minor SSI (21-30), moderate SSI (31-40), and severe SSI (>40). The original ASEPSIS score is meant to evaluate the surgical site for infections from day 5 to 7 postoperatively.⁹

For example, if a patient presented with a surgical site that was approximately 20% erythematous, then that patient would receive 2 points. If this same patient was also given antibiotics and less than 20% of the wound presented with purulent exudate, 10 and 2 points should be added, respectively. Altogether, the patient would receive a wound score of 14. The presence of any other signs or symptoms should be added to this patient's score, placing the patient in one of the 4 categories. This patient would fall into the category of disturbance of healing if no other findings were discovered.

Southampton Score

The Southampton score was originally designed by Bailey et al in 1992 to assess hernia wounds.¹⁰ Wounds are graded according to any complications and their extent:

Figure 1. ASESIS score distribution versus outcomes.

- Grade 0—Normal healing
- Grade I—Normal healing with mild bruising or erythema
 - A—Some bruising
 - B—Considerable bruising
 - C—Mild erythema
- Grade II—Erythema plus other signs of inflammation
 - A—At 1 point
 - B—Around sutures
 - C—Along wound
 - D—Around wound
- Grade III—Clear or haemoserous discharge
 - At 1 point only (<2 cm)
 - Along wound (>2 cm)
 - Large volume
 - Prolonged (>3 days)
- Grade IV—Pus
 - A—At 1 point only (<2 cm)
 - B—Along wound (>2 cm)
- Grade V—Deep or severe wound infection with or without tissue breakdown; hematoma requiring aspiration.

The wounds are then split into 4 categories:

- A—Normal healing.
- B—Minor complication.
- C—Major complication, wound infection—wounds graded IV or V or wounds treated with antibiotics after discharge from hospital.
- D—Major hematoma—wound or scrotal hematoma requiring aspiration or evacuation.

While comparative evaluations have been generated in other subspecialties, an analysis of the utility of the CDC SSI criterion, ASESIS score, and the Southampton score has not yet been produced in plastic surgery. The abstract for this article was published in the *Journal of Investigative Medicine* in January 2017 and presented at the Western Medical Research Conference in January 2017.

Figure 2. ASESIS score distribution versus failure rate.

Figure 3. Southampton score distribution versus outcomes.

Materials and Methods

Under the auspices of a quality assurance review, a retrospective analysis of all intradepartmental breast reconstruction infections from January 2013 through June 2016 was performed. A total of 1662 cases were reviewed, and 22 wound infections were identified. Patients' postoperative wound-related complications were collected, as well as final reconstruction status (success or failure). The CDC and modified Southampton scores—eliminating prescribed antibiotics effect on scores, along with a modified ASESIS score—extended to 30 postoperative days—were calculated. Relative predictive values for implant-based reconstruction were evaluated using SPSS Statistics, version 23, for Mac (IBM, Armonk, New York).

Results

Twenty-two SSIs were evaluated using the CDC SSI criterion and the ASESIS and Southampton scoring systems. The final reconstruction status (successful or failed) for each of the cases

Figure 4. Southampton score distribution versus failure rate.

Table 1. Regression Analysis of ASEPSIS and Southampton Scoring Systems.

SSI Scoring Tool	R^2	P Value
ASEPSIS score	0.866	.022
Southampton score	0.792 ^a	.110

Abbreviation: SSI, surgical site infection.

^aSouthampton's R^2 value is inconclusive as there is a negative correlation between the severity of SSI score and the rate of failure of reconstruction.

was also noted. All 22 SSIs were categorized by the CDC as superficial incisional SSIs.

The ASEPSIS scoring method resulted in 0 cases with 0 to 10 points, indicating satisfactory healing; 7 cases with 11 to 20 points, indicating disturbance of healing (32%); 11 cases with 21 to 30 points, indicating minor SSI (50%); 2 cases with 31 to 40 points, indicating moderate SSI (9%); and 2 cases with >40 points, indicating severe SSI (9%). Within each score bin, the rate of failure of the reconstructions (implant loss/total cases) is as follows: 11 to 20 points—28.6% failure, 21 to 30 points—27.3% failure, 31 to 40 points—50% failure, and >40 points—50% failure (Figure 1). A linear regression analysis of the relationship between ASEPSIS scores and reconstruction failure rate showed that 86.6% of the variation in failure rate could be explained by the variation in ASEPSIS scores ($R^2 = 0.866$). Additionally, our P value of .022 indicated that there is a significant positive correlation between ASEPSIS score and failure rate (Figure 2).

With the Southampton scoring system, 2 cases scored an A—normal healing (9%), 5 cases scored B—minor complication (23%), 13 cases scored C—major complication (59%), and 2 cases scored D—major hematoma (9%). Within each score level, the rate of failure of the reconstructions (implant loss/total cases) is as follows: A—50% failure, B—60% failure, C—23% failure, and D—0% failure (Figure 3). A linear regression analysis of the relationship between Southampton scores

and reconstruction failure rate showed that 79.2% of the variation in failure rate could be explained by the variation in Southampton score ($R^2 = 0.792$). However, this statistic is inconclusive as the P value was .110, and the line of best fit shows a negative correlation between Southampton score and failure rate (Figure 4). Table 1 summarizes the analysis of the ASEPSIS and Southampton scoring systems and their relation to reconstruction failure rate.

Discussion

Physicians' diagnosis of infection can have a major impact on surgical wound infection rates; therefore, a precise, objective, and standardized definition of infection is essential to improving patient outcomes.^{11,12} The CDC definition for SSIs, used primarily by the American College of Surgeons National Surgical Quality Improvement Program,¹³ is the most widely used criterion in diagnosis—used in research, quality improvement, public reporting, and performance comparisons.¹ One of the primary concerns related to this definition is the subjective nature of the stipulation that the infection be diagnosed by an attending physician, which may lead to overdiagnosis, resulting in excessive length of stay, unnecessary therapy, elevated health-care costs, and risk of malpractice.^{7,14} As a result, Hedrick et al found that there is poor reliability between clinical reviewers in defining SSI on the basis of the CDC criteria, with an 82.16% overall agreement between reviewers and a κ value of 0.64.¹⁵

The ASEPSIS score is an objective wound evaluation tool that can provide a quantitative analysis of the severity of the SSI. However, the use of variables such as the prescription of antibiotics for treatment still allows for a degree of subjectivity in that there is a large range over which physicians prescribe antibiotics for SSIs. It has also been suggested that the length of incision be taken into account for more conclusive wound evaluation rather than just the percentage of the affected wound.⁷ Siah and Childs, via a systematic review of the ASEPSIS scoring system in non-cardiac-related surgery, found that its reliability level declined as the severity of infection worsened and therefore caution against its use outside of cardiac surgery.¹⁶ In a study of 1029 surgical patients, an ASEPSIS score greater than 10 points was associated with a significant delay in discharge from the hospital and a score greater than 20 was more sensitive and as specific as the presence of pus as an indicator of infection.¹⁷

Comparative analyses of wound scoring systems in other specialties have been done. A study of colorectal SSIs found that surgeons demonstrated a higher interrater agreement with ASEPSIS assessments than with the CDC criteria.⁷ Pus results in automatic infection diagnosis with the CDC and Southampton systems; however, a review of 5804 surgical wounds showed that only 39% of pus-filled wounds had ASEP-SIS scores greater than 20.¹⁸ A review of 559 surgical wounds found that the 7-day postoperative window set by the ASEPSIS score limited its capability for infection diagnosis.¹⁹ Seeing a deficiency, Hall and Hall developed a new wound scoring

system for use in breast surgery; this criterion has not been externally validated.²⁰

In this study, we sought to evaluate the predictive value of the CDC criterion, ASEPSIS score, and Southampton score in breast reconstruction infections. We found that the CDC criteria and Southampton scoring systems show little clinical use, while our 30-day modified ASEPSIS scoring system shows substantial predictive value of outcomes in the setting of breast reconstruction.

The CDC criteria categorized all 22 SSIs as superficial incisional SSIs, partially as a result of the superficial plane of the body in which breast reconstructions are performed. An additional problem with the CDC is its reliance on subjective physician diagnosis—allowing for varying rates of infection diagnosis. The CDC SSI definition has little, if any, predictive value in breast reconstruction.

The ASEPSIS scoring method showed more promise. We adjusted the ASEPSIS score to include the first 30 days postoperatively, rather than just the first week, to ensure more thorough infection diagnosis. Wound scores greater than 30 had a 50% failure rate, and we found that there was a significant positive correlation between ASEPSIS scores and failure rate ($P = .022$). Note that the ASEPSIS scoring system categorizes scores 21 to 30 as minor SSI, 31 to 40 as moderate SSI, and scores greater than 40 as severe SSI.

The Southampton scoring system classified 91% of the cases as having some form of complication (scores B, C, and D, $N = 20$). The rate of failure actually decreased from score B—minor complication (failure rate 60%)—to score C—major complication (failure rate 23%—and D—major hematoma (failure rate 0%). This trend showed a negative correlation between Southampton score and failure rate, although not significant ($P = 0.110$). Such a correlation is meaningless in proper wound assessment.

Both the ASEPSIS score and the Southampton score used prescription of antibiotics as an indicator for infection. Prescription of antibiotics led to a 10-point addition in the ASEPSIS score. The Southampton score automatically assigns all patients prescribed postoperative antibiotics with a score of C—major complication. Prescription of antibiotics is subjective and dependent on physician and department policy and preferences. Because breast reconstruction requires the implantation of a foreign object, each of our 22 cases was prescribed antibiotics.²¹ In order to better assess the validity of each of these scales in our patient population, we amended the scoring guidelines. We did not adjust the point values in the ASEPSIS score for the use of antibiotics. We also did not assign scores in the Southampton scoring system based on antibiotic prescription. This is because a score of 10 in the ASEPSIS method does not significantly alter the categorization of the wound; however, the Southampton score would automatically assign each of our cases a score of major complication. We would suggest that appropriately used prophylactic antibiotic prescription not be included in standardized wound assessments for more objective results.

Additionally, the ASEPSIS and Southampton scoring systems require a higher level of detail in surgical and postoperative notes. The ASEPSIS score factors the percentage of wound affected by serous exudate, erythema, purulent exudate, and separation of deep tissues into scoring. The Southampton scoring method calls for a distinction between erythema, discharge, and pus “at one point,” “around sutures,” “along wound,” and “around wound” based on the diameter of the affected area. Both of these systems require that such detail be recorded at every postoperative examination; such was often not the case with our current records—especially given that our study included a time frame from before the universal adoption of an electronic health record, causing confusion in wound classification. Standardized detailed notes on morbidity incorporating more quantitative descriptions ought to be implemented; this would allow for easier wound score calculation and would add power to the infection screening tools.

Limitations

Even though there is an overall low rate of SSI in the population studied, it highlights the importance of having a sensitive and specific tool to score wounds as opposed to a general tool such as the CDC scoring method. A prospective study analyzing the utility of the ASEPSIS scoring system in breast reconstruction is planned.

Authors' Note

Presented at Western Medical Research Conference of the American Federation for Medical Research, January 2017. I.C. contributed to the conception, design, data collection, data analysis and interpretation, and the writing of the article. K.U. contributed to the data collection. S.G. contributed to the conception, design, data analysis and interpretation, critical revision of the article, and the final approval of the article.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

References

1. Ban KA, Minei JP, Laronga C, et al. American College of Surgeons and Surgical Infection Society: surgical site infection guidelines, 2016 update. *J Am Coll Surg*. 2017;224(1):59-74. doi:10.1016/j.jamcollsurg.2016.10.029.
2. Kataria K, Bagdia A, Srivastava A. Are breast surgical operations clean or clean contaminated? *Indian J Surg*. 2015;77(suppl 3):1360-1362. doi:10.1007/s12262-015-1252-5.
3. Williams N, Sweetland H, Goyal S, Ivins N, Leaper DJ. Randomized trial of antimicrobial-coated sutures to prevent surgical site infection after breast cancer surgery. *Surg Infect*. 2011;12(6):469-474. doi:10.1089/sur.2011.045.

4. Peel AL, Taylor EW. Proposed definitions for the audit of post-operative infection: a discussion paper. Surgical Infection Study Group. *Ann R Coll Surg Engl*. 1991;73(6):385-388.
5. Bruce J, Russell EM, Mollison J, Krukowski ZH. The quality of measurement of surgical wound infection as the basis for monitoring: a systematic review. *J Hosp Infect*. 2001;49(2): 99-108
6. Petrica A, Brinzeu C, Brinzeu A, et al. Accuracy of surgical wound infection definitions—the first step towards surveillance of surgical site infections. *TMJ*. 2009;59(3-4):362-365.
7. Hedrick TL, Harrigan AM, Sawyer RG, et al. Defining surgical site infection in colorectal surgery: an objective analysis using serial photographic documentation. *Dis Colon Rectum*. 2015; 58(11):1070-1077.
8. Surgical site infection (SSI) event. *cdc.gov*. 2017. Web.
9. Wilson AP, Treasure T, Sturridge MF, Grüneberg RN. A scoring method (ASEPSIS) for postoperative wound infections for use in clinical trials of antibiotic prophylaxis. *Lancet*. 1986;1(8476): 311-313.
10. Bailey IS, Karran SE, Toyn K, et al. Community surveillance of complications after hernia surgery. *BMJ*. 1992;304(6825): 469-471.
11. Greenwald PW, Shaible DD, Ruzich JV, Prince SJ, Birnbaum AJ, Bijur PE. Is single observer identification of wound infection a reliable endpoint? *J Emerg Med*. 2002;23(4):333-335
12. Taylor G, McKenzie M, Kirkland T, Wiens R. Effect of surgeon's diagnosis on surgical wound infection rates. *Am J Infect Control*. 1990;18(5):295-299.
13. Johnson C, Campwala I, Gupta S. Examining the validity of the ACS-NSQIP calculator in plastic surgery: lack of input specificity, outcome variability and imprecise risk calculations. *J Investig Med*. 2017;65(3):722-725.
14. Ehrenkranz NJ, Richter EI, Phillips PM, et al. An apparent excess of operative site infections: analyses to evaluate false-positive diagnoses. *Infect Control Hosp Epidemiol*. 1995;16(12):712-716.
15. Hedrick TL, Sawyer RG, Hennessy SA, et al. Can we define surgical site infection accurately in colorectal surgery? *Surg Infect (Larchmt)*. 2014;15(4):372-376.
16. Siah CJ, Childs C. A systematic review of the ASEPSIS scoring system used in non-cardiac-related surgery. *J Wound Care*. 2012; 21(3):124, 126-130.
17. Wilson AP, Weavill C, BurrIDGE J, Kelsey MC. The use of the wound scoring method ASEPSIS in postoperative wound surveillance. *J Hosp Infect*. 1990;16(4):297-309.
18. Wilson APR, Gibbons C, Bruce J. Surgical wound infection as a performance indicator: agreement of common definitions of wound infection in 4773 patients. *BMJ*. 2004;329(7468):720-723.
19. Wilson AP, Helder N, Themini-mulle SK, et al. Comparison of wound scoring methods for use in audit. *J Hosp Infect*. 1998; 39(2):119-126.
20. Hall JC, Hall JL. The measurement of wound infection after breast surgery. *Breast J*. 2004;10(5):412-415.
21. Biskup N, Workman AD, Kutzner E, Adetayo OA, Gupta SC. Perioperative safety in plastic surgery: is the World Health Organization Checklist useful in a broad practice? *Ann Plast Surg*. 2016;76(5):550-555.