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The Multidisciplinary Defense Against Surgical Site Infections (SSIs): From Sociocultural Determinants to Point-of-Care Diagnostics and Antimicrobial Stewardship

Mohsen Sameer Alhaddad (1) , Bandar Ali Sharahi (2) , Ibrahim Ali Madarbesh (2) , Bishi Ahmad Mohammad Moukli (2) , Jawaher Tami H Alkahtani (3) , Adel Fayadh Shihadah Alanazi (4) , Anoud Mater Shamali Alenazi (5) , Rawdha Mohammed Saleh Fallatah (6) , Sarah Abdulaziz Asiri (7) , Munirah Ibraheem Almehimed , Nabil Ali Ahmed Sofyani (8) , Abdulaziz Ali Abdullah Al-Muqrin (9)

(1) Eastern Health Cluster,Ministry of Health, Saudi Arabia,
(2) Sabya General Hospital,Ministry of Health, Saudi Arabia,
(3) Imam Abdul Rahman Al-Faisal Hospital,Ministry of Health, Saudi Arabia,
(4) Tabuk Maternity and Children's Hospital, Ministry of Health, Saudi Arabia,
(5) King Khalid Hospital, Ministry of Health, Saudi Arabia,
(6) Jeddah - King Fahd General Hospital - Al Mushrifah Health Center, Ministry of Health, Saudi Arabia,
(7) King Saud Medical City, Ministry of Health, Saudi Arabia,
(8) Ministry Of Health, Saudi Arabia,
(9) Inventory Control Department, Hail Health Cluster,Ministry of Health, Saudi Arabia

Abstract

Background: Surgical Site Infections (SSIs) represent a pervasive threat to global health security, driving antimicrobial resistance (AMR), prolonging hospital stays, and increasing morbidity and mortality. Traditional prevention strategies, often siloed within specific perioperative domains, fail to address the complex, multifactorial etiology of SSIs, which spans biological, technological, and sociobehavioral spheres. **Aim:** This narrative review synthesizes contemporary evidence (2015-2024) to construct an integrated model for SSI prevention. It examines the confluence of sociocultural determinants, the critical roles of allied health personnel (e.g., healthcare assistants), and advancements in laboratory diagnostics, pharmacy, dentistry, and anesthesia technology. **Methods:** A comprehensive search of PubMed, Scopus, and Web of Science databases was conducted. Literature on SSI risk factors, prevention bundles, rapid diagnostics, antimicrobial stewardship (AMS), and interdisciplinary collaboration was analyzed thematically. **Results:** Evidence confirms that SSI pathogenesis exists at the intersection of patient-level factors (e.g., health literacy, oral health), procedural elements (e.g., normothermia, antibiotic timing), and microbial ecology. Isolated interventions are suboptimal. Effective defense requires a unified bundle where point-of-care diagnostics guide targeted therapy, pharmacy-led AMS optimizes prophylaxis, dental clearance eliminates occult foci, and anesthesia technology maintains physiological homeostasis, all supported by patient engagement facilitated by healthcare teams. **Conclusion:** A paradigm shift from compartmentalized protocols to a cohesive, transdisciplinary "SSI Defense Bundle" is imperative. This model emphasizes pre-operative optimization, real-time intraoperative monitoring, and post-operative stewardship, with clear communication channels across all specialities to mitigate this quintessential health security threat.

Keywords: Surgical Site Infection; Antimicrobial Stewardship; Interdisciplinary Communication; Point-of-Care Testing; Health Literacy

Introduction

Surgical Site Infections (SSIs) remain a formidable challenge in modern healthcare, accounting for approximately 20% of all healthcare-associated infections and presenting a critical nexus of clinical, economic, and public health concerns (Ban et al., 2017). As a health security threat, SSIs directly fuel the crisis of antimicrobial resistance (AMR) through the increased and often empiric use of broad-spectrum antibiotics, while concurrently burdening healthcare systems with extended hospitalizations, re-admissions, and complex re-operations (World Health Organization [WHO], 2016). The financial toll is staggering, with SSIs known to double the cost of surgical care and inflict high indirect costs on patients and societies (Zimlichman et al., 2013). Despite decades of focused guidelines from entities like the Centers for Disease Control and Prevention (CDC) and the World Health Organization, SSI rates have plateaued in many settings, suggesting that traditional, siloed prevention strategies have reached their limit of effectiveness (Karapetyan et al., 2023).

The pathogenesis of an SSI is not a simple linear event but a multifactorial outcome arising from a complex interplay between the patient's endogenous

*Corresponding author e-mail: malhaddad1@moh.gov.sa (Mohsen Sameer Alhaddad).
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microbiome and immune status, the surgical wound environment, and exogenous microbial contamination (Campioli et al., 2022). This complexity demands an equally sophisticated and integrated defense strategy. Current prevention often fragments responsibility: surgeons focus on technique, anesthetists on physiological parameters, nurses on wound care, and pharmacists on antibiotic orders. This fragmentation allows critical vulnerabilities—such as unaddressed patient-level risk factors, suboptimal communication, and delays in diagnostic feedback—to persist (Olowo-Okere et al., 2019).

Therefore, a new paradigm is required, one that synthesizes insights from diverse but interconnected fields. This review argues that a robust defense against SSIs must be inherently multidisciplinary, weaving together the sociocultural understanding of patient behavior, the procedural expertise of surgery and anesthesia, the diagnostic precision of modern laboratory science, the pharmacological rigor of antimicrobial stewardship, and the preventative focus of dentistry. This review aims to propose a unified, cross-specialty bundle that transcends departmental boundaries to mount a coherent, patient-centered defense against surgical site infections.

The Sociocultural and Human Factor Foundation

The foundation of any effective SSI prevention strategy is laid long before the first surgical incision, rooted in patient engagement and understanding. Sociocultural determinants, particularly health literacy and socioeconomic status, are powerful yet often underestimated predictors of surgical outcomes (Berete et al., 2023). A patient's ability to comprehend and adhere to pre-operative instructions—such as smoking cessation, glycemic control for diabetic patients, or appropriate antiseptic bathing—directly influences their microbial burden and physiological resilience (Rasouli et al., 2014). Low health literacy is associated with poorer understanding of these instructions, later presentation with advanced disease (increasing surgical complexity), and reduced adherence to post-discharge wound care protocols, all of which elevate SSI risk (Korol et al., 2013; McLean et al., 2023).

Within this sociocultural framework, healthcare assistants (HCAs), including nursing assistants and surgical technologists, play a pivotal and under-recognized role. They are frequently the frontline personnel responsible for executing key pre-operative prevention measures. Their technique in performing pre-operative skin antisepsis—the duration of scrubbing, the allowance for adequate drying time of chlorhexidine gluconate or iodine-based solutions—has a direct microbiological impact on the surgical field (Sartelli et al., 2022).

Furthermore, HCAs are instrumental in patient education and reinforcement, often spending more direct time with anxious patients pre-operatively than busy surgeons or anesthetists. Their competency in communicating complex instructions in an accessible manner and their vigilance in ensuring protocol compliance (e.g., verifying a patient has completed a pre-operative chlorhexidine wash) are critical human-factor safeguards (Fasugba et al., 2020). Investing in standardized, competency-based training for HCAs on the *why* and *how* of SSI prevention protocols is not merely an operational detail but a strategic component of infection control, bridging the gap between guideline and practice.

Laboratory Science and Point-of-Care Testing for Risk Stratification and Pathogen Identification

Laboratory science provides the evidence base for moving from empirical, population-level protocols to personalized, precision-based prevention and treatment. Traditional microbiology, with culture times of 48-72 hours, creates a dangerous diagnostic gap in post-operative infection management, often leading to delayed or inappropriate antibiotic therapy (Van De Groep et al., 2018; She & Bender, 2019). The integration of rapid molecular diagnostics, particularly multiplex polymerase chain reaction (PCR) panels, represents a revolution in this space. These point-of-care (POC) or near-POC tests can identify pathogens and key resistance genes (e.g., *mecA* for MRSA, *blaKPC* for carbapenemase) directly from surgical wound fluid or tissue samples within hours, enabling early, targeted antimicrobial therapy and facilitating timely surgical re-intervention if needed (Yo et al., 2022).

Beyond pathogen identification, laboratory medicine contributes to pre-operative risk stratification. Biomarker panels that assess a patient's underlying inflammatory state or nutritional status can identify those at heightened risk for infection and poor healing. For instance, pre-operative levels of C-reactive protein (CRP), albumin, and hemoglobin A1c (for glycemic control) provide objective data to guide pre-habilitation efforts (Lee et al., 2018; Buse et al., 2023). The future lies in integrating these data streams. A pre-operative risk score combining sociodemographic data, clinical parameters, and biomarker profiles could trigger tailored intervention pathways—such as intensified pre-habilitation, targeted decolonization protocols, or heightened post-operative monitoring (Zhang et al., 2023; Cadili et al., 2023). This shift from reactive to proactive, data-driven risk management positions the laboratory as a central pillar in the pre-emptive defense against SSIs, informing actions across the entire perioperative continuum (Table 1).

Table 1: The Integrated SSI Defense Bundle: Roles and Interventions by Speciality

Speciality/Discipline	Pre-Operative Phase	Intraoperative Phase	Post-Operative Phase
Surgery & Nursing/HCAs	Patient education & pre-op bathing; MRSA screening/decollonization; hair removal (clipping, not shaving).	Aseptic technique; appropriate skin antisepsis; timely administration of prophylactic antibiotics.	Aseptic wound care; monitoring for signs of infection; patient education on home care.
Anesthesia Technology	Assessment for risk factors (e.g., hypothermia).	Maintenance of normothermia (forced-air warmers); glycemic control; optimization of tissue oxygenation.	Monitoring in PACU for physiological stability.
Pharmacy / AMS	Review of medication history for AMS; protocol development for antibiotic prophylaxis.	Ensuring timely delivery of correct antibiotic dose & redosing for long procedures.	Streamlining/de-escalating therapy based on culture/POC results; monitoring for adverse effects.
Laboratory Medicine	Risk stratification via biomarkers (CRP, Albumin, HbA1c); MRSA surveillance testing.	(Future) Real-time monitoring of intraoperative biomarkers.	Rapid pathogen ID & resistance profiling via PCR/POC tests from wound samples.
Dentistry	Oral health assessment; treatment of active periodontitis/odontogenic infections before elective major surgery.	N/A	N/A (unless oral source is suspected in late-onset SSI).

Pharmacology and Stewardship

The pharmacist's role in SSI prevention is central and extends far beyond the simple dispensing of antibiotics. As leaders of Antimicrobial Stewardship (AMS) programs, pharmacists are tasked with optimizing the use of antimicrobials to improve patient outcomes while minimizing toxicity and curbing resistance (Barlam et al., 2016). In the context of SSI prevention, this begins with the development and enforcement of evidence-based, procedure-specific guidelines for surgical antibiotic prophylaxis (SAP). These guidelines must specify the optimal agent, dose, timing (within 60 minutes before incision, adjusted for specific drugs), and duration (typically a single dose or re-dosing for prolonged procedures or significant blood loss) (Bratzler et al., 2013). Pharmacy-driven interventions, such as automatic stop orders at 24 hours post-operation for most procedures, have proven highly effective in reducing unnecessary antibiotic exposure without increasing infection rates (Raman et al., 2015; Aryee et al., 2020).

Furthermore, pharmacists are critical in managing the formulary and ensuring the availability of effective topical and surgical irrigation agents. The debate between various antiseptic solutions (povidone-iodine vs. chlorhexidine-alcohol) and antibiotic irrigants (e.g., bacitracin) requires pharmacologic expertise to balance efficacy, potential for toxicity, and contribution to AMR (Edmiston et al., 2020). Post-operatively, the pharmacist's role becomes diagnostic and corrective. In collaboration with the surgical and microbiology teams, they interpret rapid diagnostic results to streamline or de-escalate empiric therapy, selecting the most narrow-spectrum, effective agent. This closed-loop of prophylactic optimization, intraoperative support, and post-operative stewardship ensures that the critical tool of antibiotics is used as a precise scalpel rather than a blunt instrument, preserving its efficacy for future patients—a core tenet of health security (Calderwood et al., 2023).

Dentistry and Anesthesia Technology

Two specialized fields, often peripheral in traditional SSI discussions, offer critical levers for prevention: dentistry and anesthesia technology. Oral health is a window to systemic inflammation. Periodontal disease and periapical infections represent reservoirs of bacteremia, with oral pathogens like *Streptococcus viridans* and anaerobic bacteria being implicated in distant site infections, including in prosthetic joints and cardiac valves (Sanz et al., 2018). For patients undergoing major elective surgeries, particularly orthopedic, cardiac, or oncologic procedures, a pre-operative dental evaluation is a prudent, risk-mitigating strategy (Serón et al., 2023). Identifying and treating active oral infections before surgery can eliminate a persistent source of hematogenous seeding that could compromise the surgical site, especially in procedures involving implants or compromised tissue (Meoli et al., 2022).

Concurrently, anesthesia technology specialists are guardians of intraoperative physiological homeostasis, a key determinant of infection risk. Their management of core body temperature is paramount; even mild intraoperative hypothermia (≤1°C below normal) can trigger vasoconstriction, reduce tissue oxygenation, and impair neutrophil function, tripling the risk of SSI (A El-Sayed et al., 2021). The use of forced-air warming systems, fluid warmers, and increased ambient room temperature are standard preventive measures. Furthermore, anesthesia providers manage other modifiable risk factors: tight glycemic control in diabetic patients, optimization of oxygen delivery through adequate fluid management and supplemental oxygen, and careful consideration of blood transfusion thresholds, as transfusions can have immunomodulatory effects (Wang et al., 2023). By maintaining a stable, supportive internal environment, anesthesia technology directly enhances the patient's innate immune defense at the surgical wound level (Uysal et al., 2021).

Synthesizing the Defense

The evidence compels a move from independent checklists to a synchronized, multidisciplinary system. The proposed "Unified SSI Defense Bundle" (Table 2) conceptualizes prevention as a continuum with three phases, mandating specific inputs and communication handoffs between all involved specialties.

Pre-Operative Optimization (The "Pre-Hab" Phase)

This phase begins at the surgical booking. A standardized risk assessment tool, integrating sociodemographic data, laboratory biomarkers, and a mandatory dental screening for high-risk procedures, stratifies patients. Pharmacists verify medication histories and flag AMS concerns. HCAs, supported by clear protocols, engage in validated patient education and execute pre-operative skin preparation. The goal is to bring the patient to the operating room in an optimized state.

Intraoperative Execution (The "Aseptic Homeostasis" Phase)

This is a symphony of simultaneous actions: the surgeon and HCA maintain asepsis; the anesthesia team vigilantly manages normothermia, glycemia, and oxygenation; the pharmacy ensures timely antibiotic re-dosing communicated via the electronic health record or protocol. Future integration may include real-time POC monitoring of inflammatory markers.

Post-Operative Stewardship & Surveillance (The "Precision Response" Phase)

Upon any suspicion of infection, rapid molecular diagnostics are immediately deployed. Results are communicated via a structured alert to a dedicated AMS-pharmacy team, who collaborate with surgeons on targeted therapy. HCAs and nurses perform standardized wound assessments with clear escalation pathways. All data feeds back into a unit-wide surveillance system to audit compliance and outcomes, closing the quality improvement loop (Table 2). Figure 1 illustrates the multidisciplinary defense against surgical site infections (SSIs).

Figure 1: A Multidisciplinary Defense Bundle Against Surgical Site Infections Across the Perioperative Continuum

Table 2: Communication Pathways and Handoffs in the Unified SSI Defense Bundle

Clinical Scenario	Initiating Party	Critical Information	Receiving Party/Action	Goal
High pre-op CRP/Dental caries identified	Laboratory/ Dentist	Elevated biomarker; Active odontogenic infection.	Surgical Coordinator & Pre-op Clinic	Trigger intensified pre-hab pathway & dental treatment prior to surgery date.
Procedure exceeds 3-hour duration	Anesthesia Technology	Elapsed time since antibiotic dose; Patient weight.	Pharmacy/AMS System	Automatic alert for intraoperative re-dosing of antibiotic prophylaxis.
Purulent wound drainage post-op day 3	Nursing/HCA	Clinical signs of SSI.	Surgical Team & Microbiology	Immediate order for wound culture & **Rapid Multiplex PCR**.
PCR result shows MRSA + *mecA* gene	Laboratory	Pathogen ID & resistance marker within 2 hours.	Pharmacy/AMS Team & Surgeon	Automatic alert to de-escalate/change empiric vancomycin to targeted therapy (e.g., ceftaroline if susceptible).
Post-discharge SSI readmission	Hospital Epidemiologist	SSI rate data by procedure/surgeon.	Multidisciplinary SSI Review Committee	Root-cause analysis of bundle compliance failure; protocol refinement.

Conclusion

Surgical Site Infections epitomize a complex health security challenge where biological, technological, and human systems intersect. As this review demonstrates, isolated excellence in the operating theatre or the pharmacy is insufficient. The pathogens responsible for SSIs exploit the gaps between our specialties, our communication lines, and our understanding of patient behavior. The path forward requires a deliberate, systemic integration of disciplines.

The proposed "Unified SSI Defense Bundle" is not merely a set of tasks but a framework for collaboration, where the sociocultural insights guide engagement, laboratory diagnostics inform precision, pharmacy stewardship protects resources, dentistry secures distant fronts, and anesthesia technology safeguards the internal milieu. Implementing such a model demands institutional commitment to interprofessional education, shared metrics, and breaking down hierarchical barriers. Ultimately, defending against SSIs is less about a new antibiotic or a novel dressing, and more about forging a coherent, multidisciplinary alliance—a unified front in the ongoing battle for patient safety and antimicrobial security.

References

1. A El-Sayed, W. M., M Eldeeb, I. E. M., Khater, M. K. A., & Morsy, T. A. (2021). Operating room and patient safety: an overview. *Journal of the Egyptian Society of Parasitology*, *51*(2), 391-404.
2. Aryee, A., Rockenschaub, P., Gill, M. J., Hayward, A., & Shallcross, L. (2020). The relationship between clinical outcomes and empirical antibiotic therapy in patients with community-onset Gram-negative bloodstream infections: a cohort study from a large teaching hospital. *Epidemiology & Infection*, *148*, e225. doi:10.1017/S0950268820002083
3. Ban, K. A., Minei, J. P., Laronga, C., Harbrecht, B. G., Jensen, E. H., Fry, D. E., ... & Duane, T. M. (2017). American College of Surgeons and Surgical Infection Society: surgical site infection guidelines, 2016 update. *Journal of the American College of Surgeons*, *224*(1), 59-74. *DOI:* 10.1016/j.jamcollsurg.2016.10.029
4. Barlam, T. F., Cosgrove, S. E., Abbo, L. M., MacDougall, C., Schuetz, A. N., Septimus, E. J., ... & Trivedi, K. K. (2016). Implementing an antibiotic stewardship program: guidelines by the Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America. *Clinical infectious diseases*, *62*(10), e51-e77. https://doi.org/10.1093/cid/ciw118
5. Berete, F., Demarest, S., Charafeddine, R., Meeus, P., Bruyère, O., & Van der Heyden, J. (2023). Does health literacy mediate the relationship between socioeconomic status and health outcomes?. *European Journal of Public Health*, *33*(Supplement_2), ckad160-774. https://doi.org/10.1093/eurpub/ckad160.774
6. Bratzler, D. W., Dellinger, E. P., Olsen, K. M., Perl, T. M., Auwaerter, P. G., Bolon, M. K., ... & Weinstein, R. A. (2013). Clinical practice guidelines for antimicrobial prophylaxis in surgery. *American journal of health-system pharmacy*, *70*(3), 195-283.
7. Buse, G. L., Pinto, B. B., Abelha, F., Abbott, T. E., Ackland, G., Afshari, A., ... & Chew, M. S. (2023). ESAIC focused guideline for the use of cardiac biomarkers in perioperative risk evaluation. *European Journal of Anaesthesiology| EJA*, *40*(12), 888-927. *DOI:* 10.1097/EJA.0000000000001865
8. Cadili, L., van Dijk, P. A., Grudzinski, A. L., Cape, J., & Kuhnen, A. H. (2023). The effect of preoperative oral nutritional supplementation on surgical site infections among adult patients undergoing elective surgery: A systematic review and meta-analysis. *The American Journal of Surgery*, *226*(3), 330-339. https://doi.org/10.1016/j.amjsurg.2023.06.011
9. Calderwood, M. S., Anderson, D. J., Bratzler, D. W., Dellinger, E. P., Garcia-Houchins, S., Maragakis, L. L., ... & Kaye, K. S. (2023). Strategies to prevent surgical site infections in acute-care hospitals: 2022 Update. *Infection Control & Hospital Epidemiology*, *44*(5), 695-720. doi:10.1017/ice.2023.67
10. Campioli, C. C., Challener, D., Comba, I. Y., Shah, A., Wilson, W. R., Sohail, M. R., ... & O'Horo, J. C. (2022). Overview and risk factors for postcraniotomy surgical site infection: a four-year experience. *Antimicrobial Stewardship & Healthcare Epidemiology*, *2*(1), e14. doi:10.1017/ash.2021.258
11. Edmiston Jr, C. E., Lavin, P., Spencer, M., Borlaug, G., Seabrook, G. R., & Leaper, D. (2020). Antiseptic efficacy of an innovative perioperative surgical skin preparation: A confirmatory FDA phase 3 analysis. *Infection Control & Hospital Epidemiology*, *41*(6), 653-659. doi:10.1017/ice.2020.27
12. Fasugba, O., Mitchell, B. G., McInnes, E., Koerner, J., Cheng, A. C., Cheng, H., & Middleton, S. (2020). Increased fluid intake for the prevention of urinary tract infection in adults and children in all settings: a systematic review. *Journal of Hospital Infection*, *104*(1), 68-77. https://doi.org/10.1016/j.jhin.2019.08.016
13. Karapetyan, K., Mei, S., Choudhury, A., & Cottreau, J. (2023). Overview of antibiotic prophylaxis in orthopaedic and cardiac procedures. *Orthopaedic Nursing*, *42*(5), 312-316. *DOI:* 10.1097/NOR.0000000000000972
14. Korol, E., Johnston, K., Waser, N., Sifakis, F., Jafri, H. S., Lo, M., & Kyaw, M. H. (2013). A systematic review of risk factors associated with surgical site infections among surgical patients. *PloS one*, *8*(12), e83743. https://doi.org/10.1371/journal.pone.0083743
15. Lee, C. C., Chang, C. H., Chen, S. W., Fan, P. C., Chang, S. W., Chen, Y. T., ... & Tsai, F. C. (2018). Preoperative risk assessment improves biomarker detection for predicting acute kidney injury after cardiac surgery. *PloS one*, *13*(9), e0203447. https://doi.org/10.1371/journal.pone.0203447

16. McLean, K. A., Goel, T., Lawday, S., Riad, A., Simoes, J., Knight, S. R., ... & NIHR Global Health Research Unit on Global Surgery. (2023). Prognostic models for surgical-site infection in gastrointestinal surgery: systematic review. *British Journal of Surgery*, *110*(11), 1441-1450. https://doi.org/10.1093/bjs/znad187
17. Meoli, A., Ciavola, L., Rahman, S., Masetti, M., Toschetti, T., Morini, R., ... & Peri-Operative Prophylaxis in Neonatal and Paediatric Age (POP-NeoPed) Study Group. (2022). Prevention of surgical site infections in neonates and children: non-pharmacological measures of prevention. *Antibiotics*, *11*(7), 863. https://doi.org/10.3390/antibiotics11070863
18. Olowo-Okere, A., Ibrahim, Y. K. E., Olayinka, B. O., & Ehinmidu, J. O. (2019). Epidemiology of surgical site infections in Nigeria: A systematic review and meta-analysis. *Nigerian Postgraduate Medical Journal*, *26*(3), 143-151. *DOI:* 10.4103/npmj.npmj_72_19
19. Raman, G., Avendano, E., Berger, S., & Menon, V. (2015). Appropriate initial antibiotic therapy in hospitalized patients with gram-negative infections: systematic review and meta-analysis. *BMC infectious diseases*, *15*(1), 395. https://doi.org/10.1186/s12879-015-1123-5
20. Rasouli, M. R., Restrepo, C., Maltenfort, M. G., Purtill, J. J., & Parvizi, J. (2014). Risk factors for surgical site infection following total joint arthroplasty. *JBJS*, *96*(18), e158. *DOI:* 10.2106/JBJS.M.01363
21. Sanz, M., Ceriello, A., Buysschaert, M., Chapple, I., Demmer, R. T., Graziani, F., ... & Vegh, D. (2018). Scientific evidence on the links between periodontal diseases and diabetes: Consensus report and guidelines of the joint workshop on periodontal diseases and diabetes by the International Diabetes Federation and the European Federation of Periodontology. *Diabetes research and clinical practice*, *137*, 231-241. https://doi.org/10.1016/j.diabres.2017.12.001
22. Sartelli, M., Cortese, F., Scatizzi, M., Labricciosa, F. M., Bartoli, S., Nardacchione, F., ... & Marini, P. (2022). ACOI Surgical Site Infections Management Academy (ACOISSIMA): Recommendations on the prevention of surgical site infections. *Il Giornale di Chirurgia-Journal of the Italian Surgical Association*, *42*(2), e12. *DOI:* 10.1097/IA9.0000000000000002
23. Serón, C., Olivero, P., Flores, N., Cruzat, B., Ahumada, F., Gueyffier, F., & Marchant, I. (2023). Diabetes, periodontitis, and cardiovascular disease: towards equity in diabetes care. *Frontiers in Public Health*, *11*, 1270557. https://doi.org/10.3389/fpubh.2023.1270557
24. She, R. C., & Bender, J. M. (2019). Advances in rapid molecular blood culture diagnostics: healthcare impact, laboratory implications, and multiplex technologies. *The journal of applied laboratory medicine*, *3*(4), 617-630. https://doi.org/10.1373/jalm.2018.027409
25. Van De Groep, K., Bos, M. P., Savelkoul, P. H., Rubenjan, A., Gazenbeek, C., Melchers, W. J., ... & Mars Consortium. (2018). Development and first evaluation of a novel multiplex real-time PCR on whole blood samples for rapid pathogen identification in critically ill patients with sepsis. *European Journal of Clinical Microbiology & Infectious Diseases*, *37*(7), 1333-1344. https://doi.org/10.1007/s10096-018-3255-1
26. Wang, W., Zhao, L., Niu, P., Zhang, X., Luan, X., Zhao, D., & Chen, Y. (2023). Effects of perioperative blood transfusion in gastric cancer patients undergoing gastrectomy: A systematic review and meta-analysis. *Frontiers in Surgery*, *9*, 1011005. https://doi.org/10.3389/fsurg.2022.1011005
27. World Health Organization. (2016). *Global guidelines for the prevention of surgical site infection*. World Health Organization.
28. Yo, C. H., Shen, Y. H., Hsu, W. T., Mekary, R. A., Chen, Z. R., Lee, W. T. J., ... & Lee, C. C. (2022). MALDI-TOF mass spectrometry rapid pathogen identification and outcomes of patients with bloodstream infection: a systematic review and meta-analysis. *Microbial Biotechnology*, *15*(10), 2667-2682. https://doi.org/10.1111/1751-7915.14124
29. Zhang, F., Huang, L., Li, M., Quan, Z., Wang, Y., Luo, H., ... & Wang, J. (2023). Effect of pre-operative low serum pre-albumin on surgical site infection in post-surgery subjects: A systematic review and meta-analysis. *Surgical Infections*, *24*(8), 684-691. https://doi.org/10.1089/sur.2023.095
30. Zimlichman, E., Henderson, D., Tamir, O., Franz, C., Song, P., Yamin, C. K., ... & Bates, D. W. (2013). Health care–associated infections: a meta-analysis of costs and financial impact on the US health care system. *JAMA internal medicine*, *173*(22), 2039-2046. doi:10.1001/jamainternmed.2013.9763