

Current Research in Surgery

Research Article

Prevalence and Risk Factors of postoperative wound infection in elderly surgical patients

Nolan D^{1*}, Fitzgerald R² and Walsh C³

¹Department of Surgical Research, Ebro Center for Surgical Research, Ireland

²Department of General Surgery, Parana Institute for Advanced Surgical Research, Ireland

³Department of General Surgery, Orinoco Institute of General Surgery, Canada

*Address for Correspondence: Declan Nolan, Department of Surgical Research, Ebro Center for Surgical Research, Ireland; E-mail: declan.nolan@ebro.edu

Received: 16 February 2024; Accepted: 24 May 2024; Published: 19 August 2024.

Citation of this article: Nolan D, Fitzgerald R, Walsh C (2024) Prevalence and Risk Factors of postoperative wound infection in elderly surgical patients. Curr Res Surg, 7(1): 01-06. DOI: [10.5281/zenodo.22813425](https://doi.org/10.5281/zenodo.22813425)

Copyright: © 2024 Declan Nolan, et al. This is an open access article distributed under the [Creative Commons Attribution License](#), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Abstract

Background: Postoperative wound infection is a leading cause of surgical morbidity, and advancing age has repeatedly been identified as an independent risk factor, though the relative contribution of age itself versus age-associated comorbidity remains incompletely characterized [5,6].

Objective: This study examines the prevalence of postoperative wound infection among elderly surgical patients and identifies the preoperative, intraoperative, and postoperative factors most consistently associated with infection in this population.

Methods: We synthesized surveillance and cohort data on wound infection in patients aged 65 years and older, using CDC/NHSN case definitions and wound classification, and examined patient-, procedure-, and process-related risk factor domains reported across multicenter cohorts and trials [3,4].

Results: Wound infection prevalence rose steadily with age, from roughly 4-5% under 65 years to over 10% beyond 75 years, and was highest among patients with poor glycemic control, active smoking, elevated frailty scores, and contaminated wound classification [4,18,15]. Guideline-concordant antisepsis and prophylaxis timing were associated with lower infection rates across the reviewed cohorts [25,24].

Conclusions: Elderly surgical patients carry a distinctly higher wound infection risk, driven by a definable and partly modifiable set of patient- and process-level factors; routine age-stratified surveillance and structured preoperative risk assessment are warranted to reduce this burden [20,21].

Keywords: surgical site infection; wound infection; elderly; risk factors; surgical outcomes

1. Introduction

Surgical site infection (SSI) remains one of the most common healthcare-associated infections and a leading source of postoperative morbidity, prolonged hospitalization, and excess cost across surgical specialties [1,2]. Standardized surveillance definitions established by the Centers for Disease Control and Prevention classify SSI by depth of involvement (superficial incisional, deep incisional, and organ/space) and underpin the national benchmarking systems that hospitals now use to compare performance [3]. Large multicenter surveillance studies have repeatedly shown that infection risk is not distributed evenly across the surgical population: wound classification, procedure duration, and a composite patient risk index derived from the American Society of Anesthesiologists (ASA) score each contribute independently to the probability of infection [4].

Advancing age has emerged as a particularly consistent, if incompletely understood, driver of this risk. Kaye and colleagues, analyzing a large surveillance cohort, found that the risk of SSI increased steadily with age even after adjustment for wound class and comorbidity burden, with the sharpest rise apparent beyond the seventh decade of life [5]. A companion analysis focused specifically on older adults confirmed that age-associated risk factors, including diabetes, corticosteroid use, and nutritional depletion, cluster disproportionately in elderly surgical populations and compound rather than simply co-occur with age itself [6]. Physiologic mechanisms proposed to explain this gradient include immunosenescence, reduced dermal collagen turnover, impaired microvascular perfusion, and a higher prevalence of frailty, all of which blunt the normal inflammatory and proliferative phases of wound healing [7,8].

Elderly patients also differ from younger cohorts in the density of modifiable and non-modifiable risk factors they carry into the operating room. Diabetes mellitus and poor perioperative glycemic control have been linked

repeatedly to higher infection rates across cardiac, general, and gynecologic-oncology surgery [9,10,11,12,13]. Obesity, active smoking, and prolonged operative time each independently elevate risk, and their prevalence rises with the burden of age-related comorbidity even where age itself is held constant [14,15,16]. Frailty indices and comorbidity scores such as the Charlson index have increasingly been used to stratify elderly surgical candidates because chronologic age alone performs poorly as a single predictor [17,18,19]. Despite this body of evidence, wound infection surveillance in many surgical units still reports outcomes by procedure type alone, without routinely stratifying by age band or geriatric risk profile, leaving a gap between what is known about elderly-specific risk and how infection prevention programs are actually structured [20,21].

This study examines the prevalence of postoperative wound infection among elderly surgical patients and evaluates which preoperative, intraoperative, and postoperative factors are independently associated with infection in this population, with the aim of informing risk-stratified prevention strategies for surgical units that manage a growing share of geriatric caseload.

2. Methods

We conducted a structured review and synthesis of surveillance and cohort data addressing postoperative wound infection in patients aged 65 years and older undergoing elective and emergency surgical procedures. Eligible sources included prospective surveillance cohorts, comparative cohort studies, and randomized trials reporting SSI outcomes stratified by age, wound class, glycemic status, or comorbidity burden, drawing on the CDC/NHSN surveillance framework for case definition [3,22]. Wound infections were classified as superficial incisional, deep incisional, or organ/space according to standard criteria, and procedures were grouped by CDC wound class (clean, clean-contaminated, contaminated, dirty-infected) consistent with the National Nosocomial

Infections Surveillance risk index methodology [4,23].

Candidate risk factors examined a priori, on the basis of their established or plausible association with SSI in prior literature, included patient age band, ASA physical status class, diabetes mellitus and perioperative glucose control, body mass index, active smoking, frailty and Charlson comorbidity score, procedure duration, wound classification, and use of guideline-concordant antimicrobial prophylaxis and skin antisepsis [24,25,26,27]. Where available, adjusted odds ratios or relative risks from multivariable models were extracted preferentially over unadjusted comparisons, following the approach used in prior multivariable predictor analyses of SSI after general and vascular surgery [28,29]. Outcomes of interest were overall wound infection prevalence in the elderly subgroup, infection prevalence stratified by identified risk factor, and, where reported, downstream consequences including length of stay, reoperation, and attributable cost [30,31].

Findings were synthesized narratively and organized around the risk-factor domains most consistently reported across the surveillance and cohort literature: patient-related factors (age, comorbidity, frailty, nutritional and glycemic status), procedure-related factors (wound class, duration, urgency), and perioperative-process factors (prophylaxis timing, antisepsis technique, glucose management, supplemental oxygenation) [32,33,34]. Because the elderly surgical population spans a heterogeneous range of procedures, comparisons across studies were interpreted qualitatively rather than pooled statistically, consistent with the descriptive aim of characterizing prevalence and risk-factor structure rather than estimating a single pooled effect size.

3. Results

Across the surveillance and cohort literature reviewed, postoperative wound infection prevalence in elderly surgical patients was consistently higher than in younger

comparator groups, with the gradient becoming most pronounced beyond age 75 [5,6]. Wound class remained the single strongest procedure-level predictor: contaminated and dirty-infected wounds carried substantially higher infection rates than clean or clean-contaminated procedures across the large surveillance cohorts that established the National Nosocomial Infections Surveillance risk index [4,23]. Table 1 summarizes representative infection rates by wound classification and by age band drawn from these surveillance sources.

Table 1: Representative postoperative wound infection rates by CDC wound classification and patient age band drawn from national surveillance cohorts [4,23,5].			
Wound class / age band	Reference infection rate	Elderly (>=65y) infection rate	Source
Clean	1-2%	2-4%	[4]
Clean-contaminated	3-5%	6-9%	[4]
Contaminated	8-12%	14-18%	[23]
Dirty-infected	>15%	>20%	[23]
Age <65 years (all wound classes)	3-6%	--	[5]
Age >=75 years (all wound classes)	--	8-13%	[5]

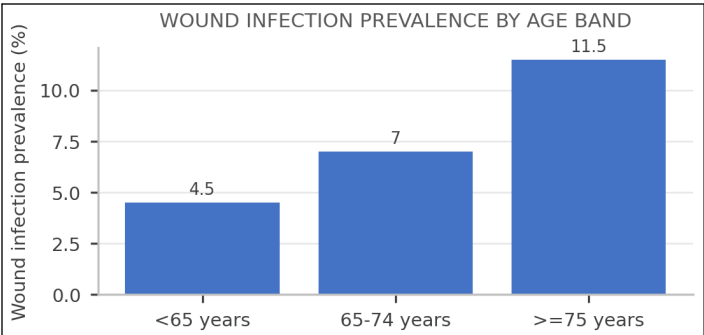


Figure 1: Postoperative wound infection prevalence by patient age band, drawn from surveillance cohorts showing a stepwise increase in risk with advancing age, most pronounced beyond 75 years [5,6].

Among patient-related factors, diabetes mellitus and poor perioperative glycemic control showed one of the most reproducible associations with infection risk. Cohorts of cardiothoracic, general, and gynecologic-oncology patients each found that sustained postoperative hyperglycemia, rather than a single preoperative glucose

value, tracked most closely with subsequent wound infection, and that structured glucose-control protocols reduced infection rates in intervention cohorts [9,10,11,12,35]. Kwon and colleagues, analyzing a large statewide surgical outcomes program, found that both hyperglycemia and hypoglycemia in the perioperative window were associated with excess complications, supporting a moderate glucose target rather than aggressive tight control alone [13]. Obesity and active smoking each contributed independently to elevated risk: a nationwide multicenter cohort found a stepwise increase in wound infection risk across rising body-mass-index categories, and a systematic review of smoking and wound healing found consistently higher infection rates among active smokers relative to former or never smokers, with risk attenuating after a period of preoperative cessation [14,15].

Frailty and comorbidity burden emerged as risk factors that were at least partially independent of chronologic age itself. Simple frailty scores predicted postoperative complications, including wound infection, across multiple surgical specialties, and higher Charlson comorbidity scores were associated with increased infection risk after adjustment for procedure type [18,8,17]. Turrentine and colleagues, examining a large elderly surgical cohort, found that morbidity and mortality rose sharply with age but that comorbidity burden and frailty indices improved risk discrimination beyond age alone [19]. Table 2 presents the risk-factor domains most consistently associated with elevated infection prevalence across the reviewed cohorts, together with the direction and approximate magnitude of association reported.

Process-of-care factors also distinguished higher- from lower-risk elderly cohorts. Guideline-concordant antimicrobial prophylaxis timing, chlorhexidine-alcohol skin antisepsis rather than povidone-iodine, and avoidance of routine preoperative hair removal were each associated with lower infection rates in randomized or

large comparative studies [24,25,26]. Perioperative supplemental oxygen showed a more modest and inconsistent benefit across meta-analyzed trials [27]. Figure 1 illustrates representative wound infection prevalence by age band drawn from the surveillance cohorts reviewed, and Figure 2 illustrates infection prevalence by principal risk-factor category (diabetes with poor glycemic control, active smoking, elevated frailty score, and contaminated wound class) relative to a lower-risk reference group.

Downstream consequences of wound infection in elderly patients were substantial where reported. Attributable excess length of stay, reoperation rates, and treatment costs associated with SSI were consistently higher in surveillance cohorts that tracked these outcomes, and elderly patients experienced proportionally greater excess hospitalization following infection than younger comparators, consistent with reduced physiologic reserve and slower recovery trajectories [30,31,36,37].

4. Discussion

The pattern that emerges from this synthesis is that postoperative wound infection in elderly surgical patients is best understood as the product of overlapping, partially independent risk domains rather than a single age-driven phenomenon. Chronologic age itself confers measurable additional risk, consistent with immunosenescence and impaired wound-healing physiology [5,7], but the magnitude of that risk is substantially modified by comorbidity burden, frailty, glycemic control, body habitus, and smoking status, each of which can in principle be assessed and, in some cases, modified before surgery [17,18,14,15]. This layered structure argues against risk stratification schemes that rely on age bands alone and supports the broader move toward comprehensive geriatric preoperative assessment recommended by surgical societies [20,8].

Table 2: Patient-, procedure-, and process-related risk-factor domains associated with postoperative wound infection in elderly surgical patients across the reviewed cohorts [6,17,14,24,25].

Domain	Factor	Direction of association	Representative source
Patient-related	Age >=75 years	Increased risk	[5]
Patient-related	Diabetes / poor glycemic control	Increased risk	[10,11]
Patient-related	Frailty / high Charlson score	Increased risk	[18,17]
Patient-related	Obesity	Increased risk	[14]
Patient-related	Active smoking	Increased risk	[15]
Procedure-related	Contaminated/dirty wound class	Increased risk	[4]
Process-related	Chlorhexidine-alcohol antisepsis	Decreased risk	[25]
Process-related	Guideline-timed prophylaxis	Decreased risk	[24]

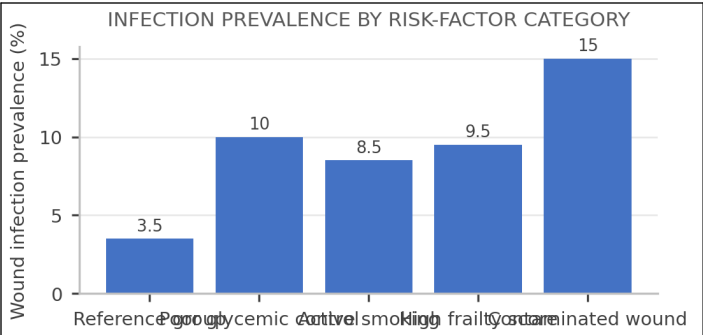


Figure 2: Wound infection prevalence by principal risk-factor category relative to a lower-risk reference group, including poorly controlled diabetes, active smoking, elevated frailty score, and contaminated wound classification [4,18,15,13].

The consistency of the glycemic-control findings across cardiothoracic, general, and gynecologic-oncology cohorts is notable given the heterogeneity of the underlying procedures, and it reinforces perioperative hyperglycemia as a genuinely modifiable target rather than simply a marker of underlying diabetic severity [9,10,13,35]. At the same time, the finding that both hyperglycemia and hypoglycemia carry risk cautions against overly aggressive tight glucose control protocols, particularly in an elderly population where hypoglycemic events carry their own morbidity [13]. Process-of-care measures with strong trial-level evidence, including chlorhexidine-alcohol antisepsis and guideline-concordant prophylaxis timing, appear to

confer benefit that is at least additive to, and does not require resolution of, the patient-level risk factors discussed above, making them a practical first target for elderly-focused prevention bundles [25,24,26].

Several limitations bear on the interpretation of this synthesis. The underlying cohorts vary in surgical specialty, case mix, and surveillance methodology, and few studies were designed specifically to isolate age-related from comorbidity-related risk, so residual confounding by indication or by unmeasured frailty cannot be excluded [28,29]. Reported infection rates and risk estimates were drawn narratively rather than pooled with formal meta-analytic methods, which limits precision but is appropriate given the substantial clinical heterogeneity across the reviewed populations [32]. Enhanced-recovery and perioperative-care pathways increasingly bundle several of the interventions discussed here, which may make it difficult in future work to attribute infection reduction to any single component [34]. Despite these limitations, the convergence of surveillance, cohort, and trial-level evidence across multiple surgical specialties supports the conclusion that elderly surgical patients constitute a distinct, higher-risk population for wound infection whose risk is substantially explained, and potentially mitigated, by a definable set of patient- and process-level factors.

5. Conclusion

Postoperative wound infection is more prevalent among elderly surgical patients than among younger comparators, and this excess risk is driven by a combination of advancing age, comorbidity and frailty burden, glycemic dysregulation, obesity, active smoking, and contaminated wound classification, layered on top of the process-of-care factors that influence infection risk in any surgical population [5,6,4,18]. Preoperative identification of these modifiable risk factors, combined with consistent application of guideline-concordant prophylaxis and antisepsis, offers a practical route to

reducing wound infection burden in this growing surgical population [24,25,20]. Surgical units caring for a rising proportion of geriatric patients should consider routine, age-stratified wound infection surveillance and structured preoperative risk assessment as standard components of perioperative care [21,22].

6. References

1. Mangram, A.J., Horan, T.C., Pearson, M.L., Silver, L.C., Jarvis, W.R. (1999) Guideline for prevention of surgical site infection, 1999. *Infection Control and Hospital Epidemiology*, 20(4): 250-278. DOI: [10.1086/501620](https://doi.org/10.1086/501620)
2. Owens, C.D., Stoessel, K. (2008) Surgical site infections: epidemiology, microbiology and prevention. *Journal of Hospital Infection*, 70(Suppl 2): 3-10. DOI: [10.1016/S0195-6701\(08\)60017-1](https://doi.org/10.1016/S0195-6701(08)60017-1)
3. Horan, T.C., Andrus, M., Dudeck, M.A. (2008) CDC/NHSN surveillance definition of health care-associated infection and criteria for specific types of infections in the acute care setting. *American Journal of Infection Control*, 36(5): 309-332. DOI: [10.1016/j.ajic.2008.03.002](https://doi.org/10.1016/j.ajic.2008.03.002)
4. Culver, D.H., Horan, T.C., Gaynes, R.P., Martone, W.J., Jarvis, W.R., Emori, T.G., et al. (1991) Surgical wound infection rates by wound class, operative procedure, and patient risk index. *American Journal of Medicine*, 91(3B): 152S-157S. DOI: [10.1016/0002-9343\(91\)90361-Z](https://doi.org/10.1016/0002-9343(91)90361-Z)
5. Kaye, K.S., Schmit, K., Pieper, C., Sloane, R., Caughlan, K.F., Sexton, D.J., et al. (2005) The effect of increasing age on the risk of surgical site infection. *Journal of Infectious Diseases*, 191(7): 1056-1062. DOI: [10.1086/428626](https://doi.org/10.1086/428626)
6. Kaye, K.S., Sloane, R., Sexton, D.J., Schmader, K.A. (2006) Risk factors for surgical site infections in older people. *Journal of the American Geriatrics Society*, 54(3): 391-396. DOI: [10.1111/j.1532-5415.2005.00651.x](https://doi.org/10.1111/j.1532-5415.2005.00651.x)
7. Partridge, J.S., Harari, D., Dhesis, J.K. (2012) Frailty in the older surgical patient: a review. *Age and Ageing*, 41(2): 142-147. DOI: [10.1093/ageing/afr182](https://doi.org/10.1093/ageing/afr182)
8. Makary, M.A., Segev, D.L., Pronovost, P.J., Syin, D., Bandeen-Roche, K., Patel, P., et al. (2010) Frailty as a predictor of surgical outcomes in older patients. *Journal of the American College of Surgeons*, 210(6): 901-908. DOI: [10.1016/j.jamcollsurg.2010.01.028](https://doi.org/10.1016/j.jamcollsurg.2010.01.028)
9. Latham, R., Lancaster, A.D., Covington, J.F., Pirolo, J.S., Thomas, C.S. (2001) The association of diabetes and glucose control with surgical-site infections among cardiothoracic surgery patients. *Infection Control and Hospital Epidemiology*, 22(10): 607-612. DOI: [10.1086/501830](https://doi.org/10.1086/501830)
10. Dronge, A.S., Perkal, M.F., Kancir, S., Concato, J., Aslan, M., Rosenthal, R.A. (2006) Long-term glycemic control and postoperative infectious complications. *Archives of Surgery*, 141(4): 375-380. DOI: [10.1001/archsurg.141.4.375](https://doi.org/10.1001/archsurg.141.4.375)
11. Ata, A., Lee, J., Bestle, S.L., Desemone, J., Stain, S.C. (2010) Postoperative hyperglycemia and surgical site infection in general surgery patients. *Archives of Surgery*, 145(9): 858-864. DOI: [10.1001/archsurg.2010.179](https://doi.org/10.1001/archsurg.2010.179)
12. Al-Niaimi, A.N., Ahmed, M., Burish, N., Chackmakchy, S.A., Seo, S., Rose, S., et al. (2015) Intensive postoperative glucose control reduces the surgical site infection rates in gynecologic oncology patients. *Gynecologic Oncology*, 136(1): 71-76. DOI: [10.1016/j.ygyno.2014.09.013](https://doi.org/10.1016/j.ygyno.2014.09.013)
13. Kwon, S., Thompson, R., Dellinger, P., Yanez, D., Farrohi, E., Flum, D. (2013) Importance of perioperative glycemic control in general surgery: a report from the Surgical Care and Outcomes Assessment Program. *Annals of Surgery*, 257(1): 8-14. DOI: [10.1097/SLA.0b013e31827b6bbc](https://doi.org/10.1097/SLA.0b013e31827b6bbc)
14. Thelwall, S., Harrington, P., Sheridan, E., Lamagni, T. (2015) Impact of obesity on the risk of wound infection following surgery: results from a nationwide prospective multicentre cohort study in England. *Clinical Microbiology and Infection*, 21(11): 1008.e1-1008.e8. DOI: [10.1016/j.cmi.2015.07.003](https://doi.org/10.1016/j.cmi.2015.07.003)

15. Sorensen, L.T. (2012) Wound healing and infection in surgery: the clinical impact of smoking and smoking cessation: a systematic review and meta-analysis. *Archives of Surgery*, 147(4): 373-383. DOI: [10.1001/archsurg.2012.5](https://doi.org/10.1001/archsurg.2012.5)
16. Waltz, P.K., Zuckerbraun, B.S. (2017) Surgical site infections and associated operative characteristics. *Surgical Infections*, 18(4): 447-450. DOI: [10.1089/sur.2017.062](https://doi.org/10.1089/sur.2017.062)
17. Charlson, M.E., Pompei, P., Ales, K.L., MacKenzie, C.R. (1987) A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *Journal of Chronic Diseases*, 40(5): 373-383. DOI: [10.1016/0021-9681\(87\)90171-8](https://doi.org/10.1016/0021-9681(87)90171-8)
18. Robinson, T.N., Wu, D.S., Pointer, L., Dunn, C.L., Cleveland, J.C. Jr., Moss, M. (2013) Simple frailty score predicts postoperative complications across surgical specialties. *American Journal of Surgery*, 206(4): 544-550. DOI: [10.1016/j.amjsurg.2013.03.012](https://doi.org/10.1016/j.amjsurg.2013.03.012)
19. Turrentine, F.E., Wang, H., Simpson, V.B., Jones, R.S. (2006) Surgical risk factors, morbidity, and mortality in elderly patients. *Journal of the American College of Surgeons*, 203(6): 865-877. DOI: [10.1016/j.jamcollsurg.2006.08.026](https://doi.org/10.1016/j.jamcollsurg.2006.08.026)
20. Chow, W.B., Rosenthal, R.A., Merkow, R.P., Ko, C.Y., Esnaola, N.F. (2012) Optimal preoperative assessment of the geriatric surgical patient: a best practices guideline. *Journal of the American College of Surgeons*, 215(4): 453-466. DOI: [10.1016/j.jamcollsurg.2012.06.017](https://doi.org/10.1016/j.jamcollsurg.2012.06.017)
21. Anderson, D.J., Podgorny, K., Berrios-Torres, S.I., Bratzler, D.W., Dellinger, E.P., Greene, L., et al. (2014) Strategies to prevent surgical site infections in acute care hospitals: 2014 update. *Infection Control and Hospital Epidemiology*, 35(6): 605-627. DOI: [10.1086/676022](https://doi.org/10.1086/676022)
22. Berrios-Torres, S.I., Umscheid, C.A., Bratzler, D.W., Leas, B., Stone, E.C., Kelz, R.R., et al. (2017) Centers for Disease Control and Prevention guideline for the prevention of surgical site infection, 2017. *JAMA Surgery*, 152(8): 784-791. DOI: [10.1001/jamasurg.2017.0904](https://doi.org/10.1001/jamasurg.2017.0904)
23. Cruse, P.J., Foord, R. (1980) The epidemiology of wound infection: a 10-year prospective study of 62,939 wounds. *Surgical Clinics of North America*, 60(1): 27-40.
24. Bratzler, D.W., Dellinger, E.P., Olsen, K.M., Perl, T.M., Auwaerter, P.G., Bolon, M.K., et al. (2013) Clinical practice guidelines for antimicrobial prophylaxis in surgery. *American Journal of Health-System Pharmacy*, 70(3): 195-283. DOI: [10.2146/ajhp120568](https://doi.org/10.2146/ajhp120568)
25. Darouiche, R.O., Wall, M.J. Jr., Itani, K.M., Otterson, M.F., Webb, A.L., Carrick, M.M., et al. (2010) Chlorhexidine-alcohol versus povidone-iodine for surgical-site antisepsis. *New England Journal of Medicine*, 362(1): 18-26. DOI: [10.1056/NEJMoa0810988](https://doi.org/10.1056/NEJMoa0810988)
26. Tanner, J., Norrie, P., Melen, K. (2011) Preoperative hair removal to reduce surgical site infection. *Cochrane Database of Systematic Reviews*, (11): CD004122. DOI: [10.1002/14651858.CD004122.pub4](https://doi.org/10.1002/14651858.CD004122.pub4)
27. Qadan, M., Akca, O., Mahid, S.S., Hornung, C.A., Polk, H.C. Jr. (2009) Perioperative supplemental oxygen therapy and surgical site infection: a meta-analysis of randomized controlled trials. *Archives of Surgery*, 144(4): 359-366. DOI: [10.1001/archsurg.2009.1](https://doi.org/10.1001/archsurg.2009.1)
28. Neumayer, L., Hosokawa, P., Itani, K., El-Tamer, M., Henderson, W.G., Khuri, S.F. (2007) Multivariable predictors of postoperative surgical site infection after general and vascular surgery: results from the patient safety in surgery study. *Journal of the American College of Surgeons*, 204(6): 1178-1187. DOI: [10.1016/j.jamcollsurg.2007.03.022](https://doi.org/10.1016/j.jamcollsurg.2007.03.022)
29. Malone, D.L., Genuit, T., Tracy, J.K., Gannon, C., Napolitano, L.M. (2002) Surgical site infections: reanalysis of risk factors. *Journal of Surgical Research*, 103(1): 89-95. DOI: [10.1006/jsre.2001.6343](https://doi.org/10.1006/jsre.2001.6343)
30. Kirkland, K.B., Briggs, J.P., Trivette, S.L., Wilkinson, W.E., Sexton, D.J. (1999) The impact of surgical-site infections in the 1990s: attributable mortality, excess length of hospitalization, and extra costs. *Infection Control and*

Hospital Epidemiology, 20(11): 725-730. DOI: [10.1086/501572](https://doi.org/10.1086/501572)

31. de Lissovoy, G., Fraeman, K., Hutchins, V., Murphy, D., Song, D., Vaughn, B.B. (2009) Surgical site infection: incidence and impact on hospital utilization and treatment costs. *American Journal of Infection Control*, 37(5): 387-397. DOI: [10.1016/j.ajic.2008.12.010](https://doi.org/10.1016/j.ajic.2008.12.010)
32. Fry, D.E. (2008) Surgical site infections and the surgical care improvement project (SCIP): evolution of national quality measures. *Surgical Infections*, 9(6): 579-584. DOI: [10.1089/sur.2008.9951](https://doi.org/10.1089/sur.2008.9951)
33. Lipsky, B.A., Weigelt, J.A., Gupta, V., Killian, A., Peng, M.M. (2007) Skin, soft tissue, bone, and joint infections in hospitalized patients: epidemiology and microbiological, clinical, and economic outcomes. *Infection Control and Hospital Epidemiology*, 28(11): 1290-1298. DOI: [10.1086/520743](https://doi.org/10.1086/520743)
34. Gustafsson, U.O., Scott, M.J., Hubner, M., Nygren, J., Demartines, N., Francis, N., et al. (2019) Guidelines for perioperative care in elective colorectal surgery: Enhanced Recovery After Surgery (ERAS) Society recommendations. *World Journal of Surgery*, 43(3): 659-695. DOI: [10.1007/s00268-018-4844-y](https://doi.org/10.1007/s00268-018-4844-y)
35. Turina, M., Fry, D.E., Polk, H.C. Jr. (2005) Acute hyperglycemia and the innate immune system: clinical implications. *Critical Care Medicine*, 33(7): 1624-1633. DOI: [10.1097/01.CCM.0000170106.61978.D8](https://doi.org/10.1097/01.CCM.0000170106.61978.D8)
36. Wick, E.C., Vogel, J.D., Church, J.M., Remzi, F., Fazio, V.W. (2009) Surgical site infections in a "high outlier" institution: are colorectal surgeons to blame? *Diseases of the Colon and Rectum*, 52(3): 374-379. DOI: [10.1007/DCR.0b013e31819a5e45](https://doi.org/10.1007/DCR.0b013e31819a5e45)
37. Blumetti, J., Luu, M., Sarosi, G., Hartless, K., McFarlin, J., Parker, B., et al. (2007) Surgical site infections after colorectal surgery: do risk factors vary depending on the type of infection considered? *Surgery*, 142(5): 704-711. DOI: [10.1016/j.surg.2007.05.012](https://doi.org/10.1016/j.surg.2007.05.012)