Infections in Outpatient Surgery

Sheila S. Nazarian Mobin, MD, MMM[a],
Geoffrey R. Keyes, MD*[,b], Robert Singer, MD[c],
James Yates, MD[d,e,f,g,h], Dennis Thompson, MD, FACS[i]

KEYWORDS

• Outpatient surgery • Infections • Plastic surgery • Postoperative care

KEY POINTS

- In the plastic surgery patient population, outpatient surgery is cost effective and will continue to grow as the preferred arena for performing surgery in healthy patients.
- Although there is a widespread myth that outpatient surgery centers may suffer from increased infection rates due to lax infection control, the data presented from American Association for Accreditation of Ambulatory Surgery Facilities (AAAASF)–accredited facilities prove the contrary.
- There is a lack of data investigating infection prevention in the perioperative period in plastic surgery patients.
- As data collection becomes more refined, tracking the postoperative care environment should offer additional opportunities to lower the incidence of postoperative infections.

INTRODUCTION

Over the last decade, surgical care in the United States has shifted to an ambulatory surgical setting, where enormous growth has been seen. Ambulatory surgical centers are defined by the Centers for Medicare & Medicaid Services as facilities that operate exclusively to provide surgical services to patients who do not require hospitalization or stays in a surgical facility longer than 24 hours.[1] Between 2001 and 2008, there was a greater than 50% increase in the number of Medicare-certified ambulatory surgical centers in the United States.[2,3] In 2007, these facilities performed more than 6 million procedures.[2] According to Reuters,[4] as of 2011, more than 57 million outpatient surgeries took place in the United States in more than 5000 surgery centers nationwide. With efforts to boost cost-savings, three-quarters of surgeries are done on an outpatient basis.[5]

With growth in this sector, there have been articles written that express concern about the level of infection control in the outpatient surgery environment. These concerns have been fueled by some high-profile examples of lapses in prevention. Between 1998 and 2008, 448 people acquired hepatitis B or hepatitis C infection linked to outpatient care in 33 outbreaks.[5] In a 2010 *JAMA* article,[5] an audit of 68 centers in 3 states participating in a pilot inspection program found that approximately two-thirds (67.6%) had a lapse in at least 1 of 5 infection control categories. Although only a pilot study, these findings set off concerns about

[a] Resident Physician, Division of Plastic Surgery, Keck School of Medicine of USC, 1510 San Pablo Street, Suite 415, Los Angeles, CA 90033, USA; [b] Department of Plastic Surgery, Keck School of Medicine, University of Southern California, Los Angeles, CA, USA; [c] American Society of Plastic Surgeons, La Jolla, CA, USA; [d] Plastic and Cosmetic Surgery Center, Camp Hill, Pennsylvania, USA; [e] Grandview Surgery and Laser Center, Camp Hill, Pennsylvania, USA; [f] Holy Spirit Hospital, Camp Hill, Pennsylvania, USA; [g] Plastic Surgery Department, Pinnacle Health System, Harrisburg, Pennsylvania, USA; [h] AAAASF, Gurnee, Illinois, USA; [i] Department of Plastic Surgery, University of California, Los Angeles, CA, USA
* Corresponding author.
E-mail address: geoffreykeyes@sbcglobal.net

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Table 1
The total number of untoward operative sequelae

Total cases all AAAASF specialties	5,416,071		
Total procedures all AAAASF specialties	7,629,686	1.41	Procedures per case
Plastic surgery cases	3,922,202		
Plastic surgery procedures	5,525,255	1.41	Procedures per case

potentially serious lapses in infection control in several states.

The Centers for Disease Control and Prevention assess 5 categories of infection control: hand hygiene and personal protective equipment, injection safety and medication handling, equipment reprocessing (eg, sterilization and high-level disinfection), environmental cleaning, and handling of blood glucose monitoring equipment. The Centers for Disease Control and Prevention have found errors in basic infection control practices in the outpatient setting and, as a result, the reputation of outpatient surgery centers has suffered. More recent findings, however, in an extensive review of the data collection from the AAAASF, suggest that outpatient surgeries performed in accredited centers have low infection rates.[6]

DATA ON INFECTION RATES IN OUTPATIENT SURGERY FROM AAAASF

Data collected from AAAASF-certified surgery centers from 2001 to 2012 (**Table 1**) analyzed outcomes from 5,416,071 operations, where 7,629,686 procedures were performed (1.41 procedures per case). Plastic surgery cases comprised 3,922,202 of these operations and 5,525,255 of the procedures (also, 1.41 procedures per case).

The total number of untoward operative sequelae from these 3,922,202 plastic surgery cases was 21,944 (0.4052%); that is, 1 in 247 plastic surgery cases or 1 in 348 plastic surgery procedures had a complication (**Table 2**). Of these complications, 3063 were infections (0.0781%). Infections developed in 1 in 1281 plastic surgery cases and 1 in 1804 plastic surgery procedures. The infection rate as a percentage of all untoward sequelae was 13.96%.

In this data set, infection was most commonly reported, in order from highest to lowest, in the following procedures: breast augmentation, abdominoplasty, breast lift/reduction, liposuction, and facelift (**Table 3**). Although more infections were reported with breast augmentation surgery, there were more breast augmentations performed and the rate of infection was lower than in patients undergoing abdominoplasty. Therefore, the rate of infection per procedure, from highest to lowest, was as follows: abdominoplasty, breast lift/reduction, breast augmentation, liposuction, and facelift.

A total 462,588 abdominoplasties were performed and 757 cases of infection reported. This is a 0.16% infection rate (1 in 611 patients) from abdominoplasty. Also, 1,125,274 breast augmentation procedures were evaluated and 921 infections reported, resulting in a 0.08% incidence of infection or 1 in 1222 patients; 515,252 patients underwent breast lift/reduction with 582 reported infections, which is a 0.11% infection rate, or 1 in 885 breast lift/reduction patients; 517 of 688,241 liposuction patients had reported infection—0.08% or 1 in 1331 liposuction patients; and 346 of 499,477 facelift patients developed infection—0.07% or 1 in 1444 facelift patients (see **Table 3**). The most commonly cultured organism was Staphylococcus (**Table 4**). No organisms were found or

Table 2
Incidence of infection[a]

		Incidence Percentage by Case	1 in # Case	Incidence Percentage by Procedure	1 in # Procedure
Total plastic surgery sequelae	21,944	0.41%	247	0.29%	348
Total plastic surgery infections	3063	0.08%	1281	0.06%	1804
Infections as percentage of sequelae	13.96%				

[a] Incidence of infection by case and procedure. Infection as a percentage of all plastic surgery sequelae.

Table 3
Five procedures most commonly associated with infection

Procedure	Number of Infections	Number of Cases	Rate of Infection (%)	1 in
Breast augmentation	921	1,125,274	0.08	1222
Abdominoplasty	757	462,588	0.16	611
Breast lift/reduction	582	515,252	0.11	885
Liposuction	517	688,241	0.08	1331
Facelift and related procedures	346	499,477	0.07	1444

no culture was taken in 420 cases. Methicillin-resistant *Staphylococcus aureus* (MRSA) was cultured in 86 cases.

A total 225 plastic surgery patients had to be hospitalized due to postoperative infection. Most commonly, these patients requiring hospitalization had undergone, in order of most common to least common: abdominoplasty, breast augmentation, liposuction, breast lift/reduction, and facelift (**Table 5**). The specific incidences of infection requiring hospitalization from each plastic surgery procedure are as follows: 1 in 5782 abdominoplasty patients; 1 in 32,151 breast augmentation patients; 1 in 36,804 breast lift/reduction patients; 1 in 45,883 liposuction patients; and 1 in 49,948 facelift patients (see **Table 5**). The most commonly found organism in these patients was also Staphylococcus (**Table 6**). Cultures were not performed in 20 cases and cultures were negative in 12. MRSA was present in 9 patients requiring hospitalization because of infection.

Among these patients who acquired infections after plastic surgical procedures, only 1 succumbed. This patient had undergone liposuction and developed a MRSA infection. Thus, the incidence of mortality from all plastic surgery infections performed in an outpatient setting is 0.03%, or 1 death in 3063 infections. The death rate from infection among all plastic surgery cases performed in an outpatient setting is 0.00003%, or 1 death in 3,922,202 cases.

Table 4
Most common organisms

Organism	Number of Cases
Staphylococcus	376
Culture not done	240
No growth	180
MRSA	86

COMPARING INFECTION RATES BETWEEN INPATIENT AND OUTPATIENT SURGERIES

Comparing infection rates in hospital-based operations to outpatient facilities may seem an exercise in futility. Operations performed in hospitals may be performed on patients with higher levels of comorbidity and anesthetic risk than performed on an outpatient basis. Comparing specific procedures in similar patients, however, in the 2 settings is useful.

Speigleman and colleagues[7] performed a retrospective study on 69 consecutive abdominoplasties: 37 inpatients and 32 outpatients. Although the inpatients were on average older and had higher body mass indices, these differences did not reach statistical significance. The weight of the pannus removed from inpatients was significantly higher and this can be explained by the higher body mass indices in this group. The operations took longer in the inpatient group, although not significantly. The investigators defined wound infection as any patient who started on cloxacillin due to erythema or cellulitis near the surgical wound. Only 1 of 32 outpatients had a postoperative infection (3.1%), whereas 4 of 37 inpatients had postoperative infections (10.8%). On average, inpatients incurred an extra $1500 for the first night of hospital stay and $1000 for the second night. The outpatient group avoided these costs. The investigators strongly endorsed the safety and efficacy of abdominoplasties performed in an outpatient setting with a clear cost benefit.

In another study, by Buenaventura and colleagues,[8] breast reductions performed in either setting were examined over a 3-year period. Of the patients examined, 286 were outpatients and 52 were inpatients. The inpatients were, on average, 8 years older and 8 kg heavier and had approximately 400 g more breast tissue resected than the outpatients undergoing reduction mammoplasty. There were no significant differences in the incidence of minor complications, including infections, and the investigators concluded that

Table 5
Hospitalizations from infection

Procedure	Number of Hospitalizations	Number of Cases	Rate of Infection	1 in
Abdominoplasty	80	462,588	0.0173%	5782
Breast augmentation	35	1,125,274	0.0031%	32,151
Liposuction	15	688,241	0.0022%	45,883
Breast lift/reduction	14	515,252	0.0027%	36,804
Facelift and related procedures	10	499,477	0.0020%	49,948
Total	225			

reduction mammoplasty could be performed safely in an outpatient setting, with an average cost savings of between $1500 and $2500 compared with an overnight stay.

A retrospective study performed by Byrd and colleagues[9] reviewed 5316 consecutive cases performed in an outpatient setting between 1995 and 2000. Most cases were aesthetic in nature. Complications requiring a return to an operating room were analyzed, as were infection rates. They found that during this 6-year-period, 35 complications and no deaths were reported; 77% of complications were hematomas. There were only 6 infections reported. Infections requiring a return to an operating room accounted for only 0.11% of patients. Furthermore, 10.2% of cases performed consisted of a combination of multiple plastic surgery procedures. No greater risk of infection or increased adverse outcome was attributed to performing more than 1 procedure during a case in this study.

PATIENT SELECTION TO REDUCE INFECTION RATES

With the clear cost savings in avoiding inpatient stays, there is incentive to performing safe outpatient surgeries to keep this option viable. There are evidence-based precautions to take to keep outpatient infection rates low. Careful patient selection is the first step. Smoking, alcohol abuse, poor blood sugar control, obesity (greater than 20% of ideal body weight), steroid use, and malnutrition can all lead to poor wound healing and infection of open wounds.

Table 6
Most common organisms in hospitalized patients

Bacteria	Number of Cases
Staphylococcus	35
Culture not done	20
No growth	12
MRSA	9

Smoking

In an effort to clarify how smoking and nicotine affect wound healing, Sorensen[10] performed a review in 2012 and ultimately included 177 articles. He found that smoking decreases tissue oxygenation and attenuates the inflammatory healing process by way of cell chemotactic responsiveness, migratory function, and oxidative bactericidal mechanisms. The proliferative response is impaired by a reduced fibroblast migration and proliferations and decreased collagen synthesis and deposition. Smoking cessation restores tissue oxygenation and metabolism rapidly. Inflammatory cell response is reversed, in part, within 4 weeks, whereas the proliferative response remains impaired. Nicotine does not affect tissue microenvironment but seems to impair inflammation and stimulate proliferation. Cotinine or nicotine may be ordered as a blood or urine test to evaluate compliance.

Alcohol Use

Tonnensen and Kehlet[11] performed a meta-analysis to identify articles published from 1967 to 1998 looking at postoperative morbidity in alcohol abusers (more than 5 drinks of 60-g ethanol per day for several months or years). Studies demonstrated a 2-fold to 3-fold increase in postoperative morbidity; the most frequent complications were infections, bleeding, and cardiopulmonary insufficiency. Wound complications contributed to half of the morbidity. This study reported that the risk of wound complications is probably due to a combination of suppressed immune function, impaired hemostasis, and reduced

wound healing. According to Jorgensen and colleagues[12,13] in 2 separate studies, there is a reduced amount of protein and collagen in wounds in alcohol users that improves with 8 weeks of abstinence.

Poor Blood Glucose Control

Maintaining normal blood glucose levels has also been shown to lower the risk of infection. Hyperglycemia is associated with impaired leukocyte function, including granulocyte adherence, impaired phagocytosis, delayed chemotaxis, and depressed bactericidal capacity.[14] These leukocyte deficiencies can lead to infection and improve with tight glycemic control; however, the optimal targeted blood glucose to reduce postoperative infections is not known.

Obesity

Wick and colleagues[15] performed a retrospective cohort study of 7020 colectomy patients using claims from insurance plans. Patients who had a total or segmental colectomy over 6 years were included. They compared 30-day surgical site infection (SSI) rates among obese and nonobese patients and statistical analysis was performed to identify risk factors for SSIs. They found that obese patients had an increased rate of SSIs compared with nonobese patients (14.5% vs 9.5%, respectively; $P<.001$). The mean total cost was $31,933 in patients with infection versus $14,608 in patients without infection ($P<.001$). Total length of stay was longer in patients with infection than in those without infection (mean, 9.5 vs 8.1 days, respectively; $P<.001$), as was the probability of hospital readmission (27.8% vs 6.8%, respectively; $P<.001$). They concluded that obesity increases the risk of an SSI after colectomy by 60%, and the presence of infection increases the colectomy cost by a mean of $17,324.

Steroid use

A study by Ismael and colleagues[16] looked at preoperative steroid use and its association with increased postoperative complications. They used the National Surgical Quality Improvement Program public use files from 2005 to 2008 and found that of 635,265 patients identified, 20,434 (3.2%) used steroids preoperatively. Superficial SSIs increased from 2.9% to 5% of those patients using steroids (odds ratio [OR] 1.724). Deep SSIs increased from 0.8% to 1.8% (OR 2.353). Organ/space SSIs and dehiscence increased 2-fold to 3-fold with steroid use (ORs 2.469 and 3.338, respectively). Mortality increased almost 4-fold (1.6%–6.0%; OR 3.920). All results were significant ($P<.001$). The investigators concluded that concerns related to surgical risks in patients on chronic steroid regimens seem valid.

Malnutrition

It is generally thought that severe protein malnutrition may lead to poor wound healing and, therefore, a higher risk of SSIs. In a study by Markel and colleagues,[17] pediatric patients with ulcerative colitis were included in a 10-year retrospective review. A total of 51 children were identified and 20 infectious complications were identified in 18 patients. Preoperative steroid use was associated with a greater postoperative wound infection rate. Preoperative hemoglobin less than 10 g/dL ($P<.05$) and albumin less than 3 g/dL ($P = .1$) were associated with greater rates of postoperative infection.

To evaluate the impact of nutritional support on clinical outcomes in patients at nutritional risk defined by the nutritional risk screening 2002, Jie and colleagues[18] performed a prospective cohort study of hospitalized patients from 3 departments at The Johns Hopkins Hospital in Baltimore and 2 teaching hospitals in Beijing, from March 2007 to May 2008. Data were collected on the nutritional risk screening, application for parenteral nutrition and enteral nutrition, surgery, complications, and length of stay. The investigators recruited 1831 patients, with 45.2% of them at nutritional risk. Among the at-risk patients, the complication rate was significantly lower in the nutritional-support group than in the no-support group (20.3% vs 28.1%, $P = .009$), mainly because of the lower rate of infectious complications (10.5% vs 18.9%, $P<.001$). Subgroup analysis showed the complication rate was significantly lower in the enteral nutrition group ($P<.001$) but not the parenteral nutrition group ($P = .29$) compared with the no-support group. Among the patients without nutritional risk, the complication rate was not different between the nutritional-support group and the no-support group ($P = .10$). Statistical analysis showed nutritional support was a protective factor for complications in at-risk patients when adjusted for confounders ($P<.001$). No difference in length of stay was found.

Preoperative and Perioperative Methods to Reduce Surgical Site Infections

Perioperative antibiotics

The Centers for Medicare & Medicaid Services, in the form of the Surgical Care Improvement Project, have mandated prophylactic, preoperative, and perioperative antibiotic use. This evidence-based initiative targeted a 25% reduction in elective surgical complications, such as SSIs, by 2010.[19] A cornerstone of the Surgical Care Improvement Project guidelines focused on SSI

prevention is not only the provision of prophylactic antibiotics but also the administration of the appropriate prophylactic antibiotic within 1 hour before elective surgical incisions and cessation of the antibiotic within 24 hours of surgery.[20]

Although there have been recommendations to limit the use of perioperative prophylactic antibiotics, there are not many studies reported for plastic surgery patients. A study by Clayton and colleagues,[21] instituted antibiotic prescribing guidelines based on the Surgical Care Improvement Project. An increased rate of SSIs, similar to AAAASF data, was noted in breast reconstruction patients. The investigators sought to determine whether the change in antibiotic prophylaxis regimen affected rates of SSIs. They performed a retrospective study comparing patients undergoing breast reconstruction who received preoperative and postoperative prophylactic antibiotics with a group who received only a single dose of preoperative antibiotic. The type of reconstruction and known risk factors for implant infection were noted and 250 patients were included: 116 in the presurgical care improvement project group received preoperative and postoperative prophylactic antibiotics, and 134 in the surgical care improvement project group received a single dose of preoperative antibiotic. The overall rate of SSIs increased from 18.1% to 34.3% ($P = .004$) in those receiving the single dose of preoperative antibiotic. Infections requiring reoperation increased from 4.3% to 16.4% ($P = .002$). Multivariate logistic regression demonstrated that patients in the surgical care improvement group were 4.74 times more likely to develop an SSI requiring reoperation (95% CI, 1.69–13.80). Obesity, history of radiation therapy, and reconstruction with tissue expanders were associated with increased rates of SSI requiring reoperation. The investigators concluded that withholding postoperative prophylactic antibiotics in prosthetic breast reconstruction is associated with an increased risk of SSI, reoperation, and thus reconstructive failure. They suggested further studies to delineate the optimal amount of time to continue postoperative antibiotics.

Antibiotic saline irrigation

A study by Pfeiffer and colleagues[22] included 436 women who underwent breast augmentation at 2 different times by a single surgeon. The first group underwent surgery with cephalothin added to the saline irrigation; the second group was irrigated with saline alone—99.8% of patients underwent subpectoral placement with periareolar incisions. The frequency of infection in the cephalothin group was much less (6.7% vs 12.8% in the normal saline-only group, $P = .044$). The frequency of seroma was also less in the cephalothin group (7.6% vs 2.9%, $P = .036$). There was no significant difference in the development of capsular contraction between the 2 groups.

Intranasal mupirocin

A 2008 study by van Rijen and colleagues[23] showed that the prophylactic use of intranasal mupirocin significantly reduced the rate of postoperative *Staphylococcus aureus* infections among carriers. It has been shown that a large proportion of *S aureus* infections originate from patients' own flora.[24–26] Approximately 30% of the population carries nasal *S aureus* and present a risk factor for subsequent infection in patients undergoing surgery.[27–29] A literature search was performed and 686 surgical patients treated with 2% mupirocin calcium ointment, a broad-spectrum topical antibiotic, were reviewed. There were fewer *S aureus* infections found with treatment, 25 (3.6%) compared with 46 (6.7%) in the controls. This was a significant decrease in the incidence of *S aureus* nosocomial infection among surgical patients. Cases of mupirocin resistant *S aureus* have been reported in some patients with repeated use.[30]

Normothermia

Keeping the temperature of the patient above 35°C has also been shown to have an effect on decreasing SSIs. In a study by Seamon and colleagues,[31] 524 trauma laparotomies were analyzed from 2003 to 2008. The mean operative nadir temperature of the study population was 35.2 ± 1.1°C and 30.5% had at least 1 temperature measurement less than 35°C. Patients who developed SSIs (36.1%) had a lower mean intraoperative temperature nadir ($P = .009$) and had a greater number of intraoperative temperature measurements less than 35°C ($P<.001$) than those who did not. Statistical analysis showed that an intraoperative temperature of 35°C as the nadir temperature most predictive of SSI development. Multivariate analysis determined that a single intraoperative temperature measurement less than 35°C independently increased the site infection risk 221% per degree below 35°C ($P = .007$).

Preoperative hair removal

Although preparation of people for surgery has traditionally included removal of hair from the incision site, some studies claim that preoperative hair removal is harmful and causes SSIs and should be avoided. Tanner and colleagues[32] performed a Cochrane Database review to determine if routine preoperative hair removal (compared with no removal) and if the timing or method of hair

removal influenced rates of SSIs. Fourteen trials (17 comparisons) were included in the review; 3 trials involved multiple comparisons. Six trials, 2 of which had 3 comparison arms (972 participants), compared hair removal (shaving, clipping, or depilatory cream) with no hair removal and found no statistically significant difference in SSI rates; however, the comparison was underpowered. Three trials (1343 participants) that compared shaving with clipping showed significantly more SSIs associated with shaving (relative risk [RR] 2.09; 95% CI, 1.15–3.80). Seven trials (1213 participants) found no significant difference in SSI rates when hair removal by shaving was compared with depilatory cream (RR 1.53; 95% CI, 0.73–3.21); however, this comparison was also underpowered. One trial compared 2 groups that shaved or clipped hair on the day of surgery compared with the day before surgery. There was no statistically significant difference in the number of SSIs between groups; however, this comparison was also underpowered. The study investigators identified no trials that compared clipping with depilatory cream, investigated application of depilatory cream at different preoperative time points, or investigated hair removal in different settings (eg, ward or preoperative holding area). They concluded that when it is necessary to remove hair, the existing evidence suggests that clippers are associated with fewer SSIs than razors. There was no significant difference in SSI rates between depilatory creams and shaving or between shaving or clipping the day before surgery or on the day of surgery; however, studies were small and more research is needed.

Chlorhexadine shower

Chlorhexidine showering is frequently recommended as an important preoperative measure to prevent SSIs. The efficacy of this approach was evaluated by Chlebicki and colleagues.[33] They performed a search of electronic databases to identify prospective controlled trials evaluating whole-body preoperative bathing with chlorhexidine versus placebo or no bath for prevention of SSIs. Sixteen trials met inclusion criteria with a total of 17,932 patients: 7952 patients received a chlorhexidine bath, and 9980 patients were allocated to comparator groups. Overall, 6.8% of patients developed SSIs in the chlorhexidine group compared with 7.2% of patients in the comparator groups. Chlorhexidine bathing did not significantly reduce overall incidence of SSIs when compared with soap, placebo, or no shower or bath (RR 0.90; 95% CI, 0.77–1.05; $P = .19$). The investigators concluded that the available clinical trials suggest no appreciable benefit of preoperative whole-body chlorhexidine bathing for prevention of SSIs.

SUMMARY

In the plastic surgery patient population, outpatient surgery is cost effective and will continue to grow as the preferred arena for performing surgery in healthy patients. Although there is a widespread myth that outpatient surgery centers may suffer from increased infection rates due to lax infection control, the data presented from AAAASF accredited facilities prove the contrary.

There is a lack of data investigating infection prevention in the perioperative period in plastic surgery patients. Therefore, much of the data discussed in this article is extrapolated from literature in other surgical specialties, such as colorectal, trauma, orthopedic, and cardiothoracic surgery. As data collection becomes more refined, tracking the postoperative care environment should offer additional opportunities to lower the incidence of postoperative infections.

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