



Surgical technique

Intraoperative povidone-iodine irrigation for infection prevention

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ABSTRACT

Although prevention of infection following arthroplasty requires a multifaceted approach, the use of intraoperative irrigation is an important component of any protocol. Recent clinical practice guidelines from the Centers for Disease Control, World Health Organization, and International Consensus Meeting on Musculoskeletal Infection advocate the use of a dilute povidone-iodine solution prior to wound closure. Our experience suggests that this practice is safe, inexpensive, and easily implemented. The present article describes our institutional irrigation protocol and reviews the current literature regarding povidone-iodine solutions.

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Introduction

Many perioperative, wound, and host factors have been associated with an increased risk of surgical site infection (SSI) and periprosthetic joint infection (PJI). Therefore, a range of preventive measures have been proposed [1,2]. One of these measures is prophylactic intraoperative wound irrigation, which removes and dilutes body fluids, microbes, and cellular debris and may have a direct antimicrobial effect when additive antiseptic agents are used.

Although there is agreement that perioperative irrigation in some form should be performed, the optimal irrigation solution remains an issue of debate. However, there is emerging evidence that favors the use of povidone-iodine. Two recent clinical practice guidelines issued by the World Health Organization (WHO) and Centers for Disease Control (CDC) recommend the use of prophylactic incisional wound irrigation with an aqueous povidone-iodine solution for prevention of SSI [2–4]. Furthermore, experts at the second International Consensus Meeting on Musculoskeletal Infection voted with a “super majority, strong consensus” in favor of

“dilute povidone-iodine use for the irrigation of wounds during surgical procedures.”

Because of the growing body of literature, pertaining to both antimicrobial efficacy and safety to host tissues, the use of a dilute povidone-iodine rinse is gaining acceptance as a means of mitigating infection risk. This article describes our institutional protocol for dilute povidone-iodine irrigation during elective joint arthroplasty, as part of the perioperative armamentarium against infection. Pertinent literature and guidelines are also summarized.

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The WHO, CDC, and International Consensus Meeting Clinical Practice Guidelines advocate for the use of a dilute povidone-iodine rinse for wound irrigation during surgical procedures [2,3,5]. Our experience suggests that an intraoperative soak of 0.3% povidone-iodine solution for up to 3 minutes (Table 1) is an efficacious and cost-effective tool for reduction of SSI and PJI.

Discussion

Modern infection prevention protocols include several advances in patient, wound, and environmental strategies. Irrigation during clean orthopaedic procedures is one important aspect in the armamentarium of interventions to reduce SSIs. Although various irrigation solutions are available for clinical use, with debatable antimicrobial efficacy and clinical safety, there is a growing support

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Table 1
Practical stepwise protocol for sterile povidone-iodine irrigation.

Rothenman protocol for sterile povidone-iodine intraoperative rinse
1. Mix 30 mL of sterile 10% povidone-iodine (from sterile catheter pack; manufactured by Aplicare, Meriden, CT) with 1 L of 0.9% saline in a sterile splash basin
2. Prior to fascial closure, pour in the diluted 0.3% povidone-iodine solution described above into the wound
3. Leave to soak for up to 3 min
4. Suction away any remaining povidone-iodine solution
5. Rinse with 1 L normal saline

for the use of povidone-iodine for intraoperative surgical prophylaxis [2,3].

Povidone-iodine is a chemical complex of polyvinylpyrrolidone and elemental iodine. Free iodine is gradually released from this complex and is chemically toxic to microorganisms [6]. This antiseptic provides broad-spectrum bactericidal activity at a low cost and with minimal toxicity [7–14]. In antimicrobial testing, povidone-iodine has been shown to kill methicillin-resistant *Staphylococcus aureus* and other antibiotic-resistant strains within 20–30 seconds of exposure [13,15]. Cichos et al [16] also highlighted the in vitro polymicrobial efficacy of povidone-iodine against *Staphylococcus epidermidis*, *Haemophilus influenzae*, *Pseudomonas aeruginosa*, *Burkholderia cepacia*, and *Escherichia coli*.

The clinical use of povidone-iodine irrigation initially garnered support from work in the specialties of general surgery, urology, cardiac and spinal surgery (Table 2) [17–25]. SSI prevention guidance, released by the CDC in 2017, explicitly recommends intraoperative irrigation of deep or subcutaneous tissues with aqueous iodophor solution (grade 2; weak recommendation) [2]. Similarly, the WHO evidence-based guidelines for SSI prevention list 29 recommendations, among which is the suggestion to consider irrigation of incisional wounds of clean or clean-contaminated wounds using an aqueous povidone-iodine solution before closure. Their guidelines committee assessed available evidence from 7 randomized controlled trials (RCTs) in abdominal surgery and spinal surgery which demonstrated that irrigation with aqueous povidone-iodine solution is beneficial compared to saline solution alone [17–23]. Furthermore, a meta-analysis of these 7 RCTs demonstrated that irrigation with aqueous povidone-iodine confers benefit vs saline irrigation (odds ratio 0.31, 95% confidence interval 0.13–0.73, $P = .007$), with an effect equivalent to 50 fewer SSIs per 1000 procedures [26]. In a broader meta-analysis examining 15 level I and II studies across multiple surgical disciplines, 10 studies cited povidone-iodine irrigation as more efficacious at preventing SSI than control interventions of saline, water, or no irrigation [25].

Although well studied in the non-arthroplasty literature, the use of povidone-iodine irrigation in the context of joint arthroplasty is supported by a single retrospective cohort study, which demonstrated a significant reduction in SSI from 0.97% to 0.15% ($P = .04$) [27]. Recently, a study from our institutional database presented at the 2017 annual meeting of the American Association of Hip and Knee Surgeons demonstrated the effects of individual protocol changes including dilute povidone-iodine lavage, subcuticular skin closure, and occlusive dressing application on SSI [28]. The multivariate logistic regression analysis showed that dilute povidone-iodine played the greatest role in reducing SSI (odds ratio 0.28, $P = .04$). A well-designed RCT examining povidone-iodine efficacy for infection prevention after arthroplasty is currently underway, and will soon provide a higher level evidence in this setting [29].

Given the current era of healthcare cost scrutiny, Kerbel et al examined the cost-effectiveness of povidone-iodine irrigation using break-even equation modeling. They noted that dilute povidone-iodine lavage prior to wound closure represents a highly cost-effective means of reducing infection after TJA at typical hospital supply costs (\$0.50–\$40), with a maximum absolute risk reduction of between 0.01% and 0.16% required to break-even [30]. Of note, this is well below the absolute risk reduction of PJI using dilute povidone-iodine reported in the prior arthroplasty literature at 0.82% [27].

Sceptics of povidone-iodine cite potential negative effects that have been sporadically reported in the literature. First, some in vitro studies have reported an adverse effect of povidone-iodine on tissue regeneration, cultured chondrocytes, and embryonic chick osteoblasts [14,31,32]. Second, historical case studies describe systemic serum iodine toxicity as a result of irrigation [33,34]. However, none of these aforementioned adverse effects have ever been substantiated in clinical trials [18–23]. Finally, Schmidt et al recently suggested that while povidone-iodine was effective at in vitro *S epidermidis* eradication, higher concentrations or longer exposure times may be required for biofilm penetration (10% for 1 minute or 3.5% for 10 minutes), which may be important when treating SSIs [35].

We would like to note an issue concerning the sterility of povidone-iodine used for irrigation as many solutions are not formally labeled as “sterile.” It is generally considered not acceptable to use formulations intended solely for skin preparation or multi-use antiseptic containers that are serially opened for disparate episodes of care—due to the risk of intrinsic or extrinsic contamination, respectively [36]. The Food and Drug Administration recently raised awareness of the potential for microbial stowaways in certain topical antiseptic products, and accordingly requested label changes to “non-sterile” preparations that were not formally treated during their manufacturing to eliminate microbes

Table 2
Summary of orthopaedic literature comparing the efficacy of irrigation solutions containing povidone-iodine with respect to prevention of SSI.

Author	Category	N	Intervention	Comparison	Analysis	Outcome measure	Incidence of SSI	P-value
Cheng et al 2005 [22]	Spinal	414 (206 controls/208 interventions)	Povidone-iodine	RCT	Multivariate	SI and DI	0% vs 3.40%	.01
Chang et al 2006 [21]	Spinal	244 (124 controls/120 interventions)	Povidone-iodine	RCT	Univariate	SI and DI	0% vs 4.83%	.03
Kokavec and Frístáková 2008 [23]	Ortho	162 (73 controls/89 interventions)	Povidone-iodine	RCT	N/A	SI	0% vs 2.74%	N/A
Brown et al 2012 [27]	TJA	2550 (1862 pre/688 post)	Povidone-iodine	Retrospective;	Univariate	DI	0.15% vs 0.97%	.04
Austin et al 2017 [28]	TKA	10,076 (8530 pre/1546 post)	Povidone-iodine	Retrospective;	Multivariate	SI	0.13% vs 0.60%	.04

DI, deep infection; N/A, not applicable; SI, superficial infection; TJA, total joint arthroplasty; TKA, total knee arthroplasty. Adapted and modified from Blom et al [5] (RightsLink License Number 4555280188381).

[37]. This issue has yet to be resolved given the dearth of commercially available povidone-iodine solutions formally labeled as “sterile.” We advise surgeons to educate themselves as to their options and carefully weigh the risks and benefits of using the povidone-iodine solutions available to them for irrigation of the surgical site.

Summary

The prophylactic addition of sterile povidone-iodine irrigation into the perioperative armamentarium confers a significant reduction in SSI risk, with relatively limited toxicity to musculo-skeletal tissues and modest cost. Although there are multiple irrigation solutions available that claim to achieve these goals, the aforementioned protocol (Table 1) has been found to be safe, simple, and extremely effective in our experience.

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