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A comparative study on surgical outcomes between preoperative hand disinfection by surgical hand rubbing and traditional surgical hand scrubbing

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Abstract: *Background:* Surgical wound infection (Syn. Surgical site infection SSI) remains major chunk of hospital acquired infection despite robust advancements of science and technology in asepsis research. *Objective:* This Prospective, observational longitudinal study was designed to assess whether aqueous alcohol-based surgical hand rubbing (SHR) can effectively replace traditional surgical hand scrubbing (SHS) without increasing incidence of SSIs amid additional benefits of enhanced compliance and saving of real time, and saving water in the operation rooms. *Methods:* The study was conducted to assess outcomes of gastrointestinal (GI) surgeries from 1st January 2025 to 1st March 2025 on 83 patients with comparable demographic and procedural profiles scheduled for elective open and laparoscopic uncomplicated cases. Two groups of surgeons with comparable skills in two units were primed into two arms by randomly assigning to carry out either surgical hand scrubbing (SHS n=37) and surgical hand rubbing (SHR n=46) groups to compare post-operative SSI rates. *Results:* 62 laparoscopic cholecystectomies (n=34 SHS, n=28 SHR) were performed; 21 other gastrointestinal surgical procedures were done. Our study recorded nil SSI in both groups at both the 7-day and 31-day postoperative follow-up. Average sanitization times were noted in SHS 3.48 and SHR 1.56 minutes respectively; a difference of nearly 2 minutes. Mean water utilized per SHS was 3.8L, SHR consumed no water beyond initial rinse. *Conclusions:* Initial results of our original research work suggest that alcohol-based hand rubs may offer a comparable alternative to traditional scrubbing, with added practical benefits of summary findings on 'saving water by Surgical Hand rubbing'.

Keywords: Surgical wound infection, Hand Disinfection, Surgical hand rubbing, Hand Sanitizers, Hospital acquired infection.

Introduction

Surgical wound infection (Syn. Surgical site infection SSI) is the global leading cause of postoperative morbidity, including prolonged hospital stay and hiked healthcare costs [1]. CDC defined SSIs as events after surgery from superficial dermal infections or deeper involving tissues beneath skin, organs, or implanted material [2]. Effective surgical hand antisepsis is a cornerstone of prevention of SSIs that are computed as per standard definitions of SSIs per 100 surgeries [3]. Historically, surgical hand scrub (SHS) with soap and water was an established standard. Emerging data suggested that alcohol-based surgical hand rubbing (SHR) is a safe, time-efficient, and environmentally sustainable alternative [4-6]. In a landmark randomized equivalence trial, Parienti et al. demonstrated that alcohol-based hand rub was as effective as traditional scrub to prevent postoperative SSIs at 30 days [4].

Research group confirmed no statistically significant difference between SHS and SHR in reducing pre- and post-operative bacterial load [5]. Further, SHR preserve skin integrity,

reduce the risk of water-transmitted re-contamination, and improve compliance in high-volume surgical settings [6-7]. Despite recommendations from global experts favoring alcohol-based hand rubs, inclusive of WHO and CDC, SHS remains a pragmatic fixed-mindset practice inside operating rooms of low and middle-income countries (LMICs) out of habit or misperception of superiority. This study was conducted with the objectives to compare rates of post-operative SSIs on 7th and 31st day amid preoperative hand disinfection using Chlorhexidine surgical hand scrub and surgical hand rub. In addition to patient safety issues, the study evaluated compliance, preparation time, and estimated water savings parameters of growing relevance in the evolving landscape of sustainable surgical practice in high-income countries (HICs) and LMICs amid global warming.

Material and Methods

This prospective observational open-label two-arm longitudinal study was conducted at Manipal Hospital Salt Lake and Manipal Hospital Broadway to compare surgical site infection (SSI) rates between the two intervention groups: traditional surgical hand scrubbing (SHS) and alcohol-based hand rubbing (SHR).

Study participants: All eligible adult cases planned for elective laparoscopic or open surgeries.

Randomization: Two groups of surgeons with comparable skills in two units of our hospital were primed into two arms by randomly assigning to carry out either method by the envelope method.

1. *Group A (Surgical Hand Scrubbing):* Scrub using 4% Chlorhexidine Gluconate (CHG) surgical scrub (Microshield ™); n=37 (SHS).
2. *Group B (Surgical Hand Rubbing):* Two good quotes over 1-minute hand rub using aqueous alcohol solution 4% Chlorhexidine Gluconate Alcoholic Aqueous Solution (Microshield ™) up to elbows; n=46 (SHR).

Inclusion Criteria: Elective open and laparoscopic uncomplicated gastrointestinal (GI) surgeries on comparable demographic and procedural profiles of patients.

Exclusion Criteria: Acute GI cases, Infected GI cases, Emergency GI cases.

Primary outcome variable: 7 day and 30-day postoperative SSI rate, compliance rates, time taken, and water expenses.

Data Collection procedure: SSI occurrence was assessed at two time points - on the 7th postoperative day and on the 31st day. At 7 postoperative days, patients were physically examined during their first postoperative outpatient department (OPD) visit, and a structured predesigned form was used to document wound status. The 31st-day follow-up was done via telephonic interview using the same questionnaire to ensure consistency in SSI surveillance. Secondary endpoints included the mean time required for hand antisepsis and the estimated expenses of water per hand wash.

Time taken for each hand scrubbing and hand rubbing episode was recorded using a stopwatch, and group averages were computed. To calculate water usage, water from ten consecutive hand scrubbing episodes was collected in a calibrated container, and the average volume per scrub was determined. Additionally, compliance with the assigned antisepsis technique was assessed discreetly by an independent observer using a pre-standardized checklist based on WHO hand hygiene guidelines.

The 4 components of the SSIs have the patient identifiers and demographic characteristics along with the date of the procedure/surgical intervention, date of development of SSIs, wound culture, assessment of the body temperature to rule out fever, and total blood counts, the dose and the duration of the antibiotics that the patient was receiving, and the alternate antibiotic in case there is a change in the next two days. Different types of formats for documentation were used for looking into the postsurgical patients with routine review for the purpose of monitoring compliance. The infection control team was deputed to collect the data daily on a ward-wise basis. SSI rates calculated as per the standard definitions, ratified by the Infection Control Officer, analysed, reported and presented before the Infection Control

Committee as a part of routine infection control monitoring and surveillance activities. For the study, these routine processes of data collection, as above, were utilised only for research across the hospital to nullify the possible effects of bias of interventions.

Data analysis: The data collected was listed on a Microsoft Excel sheet and analysed using SPSS version 21.0. Measures of central tendency viz. mean and standard deviation represented the continuous data. Any variation in the infection rate was calculated as the difference between the mean rates of SSIs from 1st January 2025 to 1st March 2025 and expressed as a percentage.

Results

Among 83 patients with comparable demographic and procedural profiles undergoing gastrointestinal surgeries 37 received traditional hand scrubbing (SHS group) and 46 received alcohol-based hand rubbing (SHR group), both containing Chlorhexidine.

Surgical Site Infections (SSI): No SSI was reported in either group at both 7-day and 31-day postoperative data. A 7-day follow-up was conducted during first postoperative outpatient visit with in-person wound examination, while a 31-day follow-up was done via telephonic interview using a standardized questionnaire. SSI at both days were nil in both groups [Table 1].

Table-1: SSI Rates at 7 and 31 days, average time for antisepsis, average water used between Surgical Hand Scrubbing (SHS) and Surgical Hand Rubbing (SHR) groups

Parameters	Surgical Hand Scrubbing (SHS)	Surgical Hand Rubbing (SHR)
Total Patients	37	46
SSI at 7 Days	00	00
SSI at 31 Days	00	00
SSI Rate	0%	0%
Avg. Time for Antisepsis	3.48 minutes	1.56 minutes
Avg. Water Used (litres)	3.8	00

Time Taken for Hand Antisepsis: The mean time taken for traditional surgical hand scrubbing was 3.48 minutes, compared to 1.56 minutes for alcohol-based hand rubbing; a difference of nearly 2 minutes was clinically and operationally vital, indicating superior time efficiency of SHR [Table 1].

Water Usage: The average volume of water used per traditional hand scrub was 3.8 litres, calculated by averaging total water collected from ten consecutive SHS episodes. Hand rubbing required no additional water beyond initial brief rinse as conserving system [Table 1].

Table-2: Frequency distribution of different types of Operations performed with SHS, and SHR and respective SSIs at 7 and 31 days

Surgery type	No.	SHS	SHR	7-day SSI	31-day SSI
Lap chole	62	34	28	0	0
Lap chole + on-table cholangiogram	2	0	2	0	0
Open mesh hernioplasty	4	0	4	0	0
Rives Stoppa repair	1	1	0	0	0
Open umbilical hernia repair	1	0	1	0	0
Lap chole + repair of duodenal perforation	1	0	1	0	0
Lap chole + adhesiolysis	1	0	1	0	0
Bilateral Total Extraperitoneal laparoscopic	2	0	2	0	0
Laparoscopic Intraperitoneal Onlay Mesh Plus	2	0	2	0	0
Laparoscopic appendicectomy	2	0	2	0	0
Abdominal wall reconstruction	1	0	1	0	0
Lap chole + hydatid cyst excision	1	0	1	0	0
Lap chole + hernia repair	1	1	0	0	0
Laparoscopic Total Extraperitoneal	2	1	1	0	0
Total	**83**	**37**	**46**	**0**	**0**

Lap chole = Laparoscopic cholecystectomy

Procedure-wise Distribution: Different types of surgical procedures were performed by two antisepsis method (SHS and SHR) and corresponding 7-day and 31-day SSI rates were recorded. The majority were laparoscopic cholecystectomies (n = 62) (34 in SHS, 28 in SHR group). Several complex and contaminated procedures viz., laparoscopic cholecystectomy with on-table cholangiogram (OTC), repair of duodenal perforation, hydatid cyst excision, and abdominal wall reconstruction, were performed without a single recorded SSI, reinforcing the robustness of hand antisepsis protocols used in both groups [Table 2].

Discussion

The data of our randomized control trial compared average times taken for each technique, average quantity of water utilized in traditional hand washing techniques and rate of compliance with hand sanitization protocols and compared rates of 7 day and 31 day postoperative SSIs rates. Further, compliance rates, time and water usage between hand asepsis protocols viz. SHS and SHR prior to each spell of surgery in the operation rooms were noted.

Surgical hand scrub (SHS): The mean volume of water used per SHS was 3.8 liters in our study. Ahmed et al. noted use of 29.2% of water during surgical scrubbing as necessary; rest lost in continuous flow systems. Each spell of the pragmatic asepsis method consumes 3-7 minutes mean water flow of 4.2L/minutes, a total volume 20.2 litres (5.9L actually used for washing hands); yearly estimate use over 2 Lacs litres water; suggested foot pedal taps for cost savings [8]. Hu et al. at a high-volume US academic center observed that 34.2% of water used in wet scrubs amounts to over 3.37 Lacs liters per year [9].

Surgical Site Infections (SSI): In our study nil SSIs was reported at both 7-day and 31-day postoperative data in all patients. This underscores the robustness of our antisepsis protocol and suggests that equivalence of asepsis of hand rubbing. This real-world finding provides additional clinical weight to the argument that SHR can be safely employed in variable surgical settings, including those with unexpected contamination.

The highly congested operating theatre, poor hygiene of the hands, and uncontrolled and unregulated use of random antibiotics are the reasons for a high rate of SSI in developing countries [10]. WHO May 2009 Guidelines on hand hygiene in health care expect that hospitals must ensure that hand washing is as per protocol and standard, with full compliance for all healthcare workers and document throughout [11].

Surgical hand antisepsis remains a cornerstone of infection prevention, particularly in high-risk procedures such as gastrointestinal surgeries. Our randomized controlled study demonstrated that alcohol-based hand rubbing (SHR) was not only non-inferior to traditional surgical hand scrubbing (SHS) in preventing surgical site infections (SSI), but also offered significant advantages in terms of time efficiency and water conservation.

These findings align with and extend upon global literature, contributing region-specific data from an Indian surgical context. No SSIs were reported in either group at both 7 and 31 days postoperatively, reaffirming the efficacy and safety of both methods. These results are consistent with the findings of Parienti et al., whose landmark equivalence trial in JAMA showed no difference in 30-day SSI rates between SHR and SHS across a broad surgical population [1].

Similarly, the meta-analysis by Feng et al. found no statistically significant differences in bacterial colony-forming unit (CFU) counts immediately after hand preparation or at the end of surgery between SHR and SHS [2].

Time Taken for Hand Antisepsis: In our study, the mean time required for hand rubbing was 1.56 minutes, compared to 3.48 minutes for traditional scrubbing nearly 55% reduction in preparation time. This has direct implications in high-volume operating theaters where thorough punctuality and team coordination are critical. Widmer's critical review on the superior speed of SHR emphasized that traditional scrubbing takes decisively more time than SHS [3].

Water Usage: Water usage presented another compelling difference in the meticulous measurements in this argument. In this nitty-gritty part of our study, traditional scrubbing consumed an average of 3.8 liters per session. In contrast, SHR required no water beyond a brief rinse, a detail often overlooked in clinical discussions but critically important from a sustainability standpoint. Globally, health care contributes significantly to resource consumption. Ahmed's early work demonstrated that over 70% of water used during surgical hand washing is wasted, largely due to poor water control mechanisms [4]. Hu et al. studied in a U.S. tertiary center that SHS consume huge water annually equivalent to the daily drinking needs of 106,000 people [5].

Notably, 34.2% of total water associated with wet scrubs was wasted, largely due to timer-controlled sink systems. Such waste is ethically and economically unacceptable in modern surgical practice, particularly in countries like India where water conservation remains a growing concern. Institutions should be encouraged to incorporate SHR protocols not only for efficacy, but also as part of environmentally responsible surgery programs. Another area of potential variability in studies comparing SHS and SHR is the antiseptic agent used. Conventionally, SHS is performed with chlorhexidine or povidone-iodine, depending on institutional norms. However, the choice of agent is not trivial. Darouiche et al. demonstrated in a high-powered RCT that chlorhexidine-alcohol was significantly more effective than povidone-iodine in reducing SSI rates [6].

Procedure-wise distribution: Apart from planned laparoscopic cholecystectomies, complex and contaminated procedures viz., laparoscopic cholecystectomy with on-table cholangiogram, repair of duodenal perforation, hydatid cyst excision, and abdominal wall reconstruction, were performed without a single recorded SSI, whether SHS or SHR was followed for pre-operative sanitization.

In our study, to ensure consistency and eliminate this confounding variable, both SHR and SHS were standardized using chlorhexidine-based formulations, aligning with the CDC and WHO recommendations [2, 9]. WHO Guidelines on Hand Hygiene in Health Care explicitly endorse alcohol-based hand rubs as the preferred method for surgical hand antisepsis, unless hands are visibly soiled [9]; emphasize residual activity of chlorhexidine-based rubs and the reduced risk of contamination from water, especially when using communal sinks - a concern in many. There also remains a cultural inertia in many institutions particularly in India that favors the "first scrub of the day" tradition, where a full scrub is perceived as mandatory.

This practice, although well-intentioned, is increasingly challenged by evidence. Widmer and WHO both advocated that alcohol-based hand rubs can be safely used for all scrubs, including the first of the day, provided hands are not visibly dirty [5, 9]. Trials have shown that surgical hand antisepsis with alcohol-based hand rub resulted in a similar bacterial reduction, irrespective of whether it was applied for 3 or 1.5 minutes [12].

Compliance: n our study, compliance with the assigned antisepsis technique was assessed discreetly by an independent observer using a pre-standardized checklist of random assignments of hand asepsis viz. SHS or SHR for pre-operative sanitization.

Notably, although all surgeries were initially planned as elective laparoscopic cholecystectomies, 14 cases were intraoperatively identified as empyema gallbladders, indicating the presence of localized pus collections and converting these cases into contaminated surgical procedures by CDC classification [13]. A research group from Bihar reported during the COVID-19 pandemic that surgeons and other surgical healthcare professionals had meticulously controlled SSI with strict hand hygiene compliance [14].

Despite the clear benefits, compliance with SHR protocols can vary. Widmer observed that behavioral resistance, more than clinical evidence, often drives reluctance to adopt hand rubbing. This may be due to ingrained beliefs, perceived inadequacy of a quicker method, or unfamiliarity with application techniques. In our study, compliance

monitoring was performed via a discreet standardized checklist, and full quantitative data on adherence will be reported separately. Importantly, cost savings from SHR are not limited to water bills. Javitt et al. showed that transitioning to SHR resulted in savings exceeding $280,000 per operating room per year, primarily due to shorter prep times and lower personnel costs [13]. In resource-limited settings, this can translate into significant systemic gains [15].

In our study using chlorhexidine surgical hand scrubs and chlorhexidine surgical hand rubs were used for compliance with the modernized global standards in our tertiary care centre of eastern India. Olson et al demonstrated value of the addition of a critical level of antimicrobial agent viz., chlorhexidine gluconate (CHG) to alcohol-based surgical antiseptics, adding value to both SHS and SHR to substantially limit inhabitant microbial flora for the longest possible duration of the entire surgical proceedings as the lowest possible levels [16].

Research groups stressed on the capacity building stressing on get updated on the critical issues of preoperative asepsis to reduce post-operative SSIs. Increasing awareness by on-job continuous education system for all levels of healthcare professionals reduces SSIs by improving compliance to standard office procedures (SOPs) and clinical practice guidelines [17-18]. Widmer's seminal review emphasized superior skin tolerability and less likelihood of hand colonization post-surgery, citing that traditional scrubbing often leads to micro-abrasions and skin damage, paradoxically increasing microbial load over time [5].

Strengths of the study: Limited studies have addressed the practical transition to SHR within Indian surgical contexts. Our novel study evaluated whether SHR is as effective as traditional SHS to limit SSIs, while offering additional benefits of compliance, time, and water savings, echoing global concerns about resource conservation in healthcare and underlining the pressing need to re-evaluate wet scrub protocols in favor of waterless alternatives. The study also evaluated compliance, preparation time, and estimated water savings. Beyond clinical efficacy, the ecological and economic advantages of SHR are becoming increasingly significant, particularly in gastrointestinal surgery.

Limitations of the study: Limitations of our study include the relatively short observation window and a modest sample size in this self-funded study. Additionally while SSI is a robust clinical endpoint, surrogate microbiological endpoints such as bacterial load were not measured. The data on limited number of cases in our hospital (46 vs. 37) was not compared with statistical tests. Further emergency surgeries, where time is limiting factor for infection, other varieties of surgeries, together with re-do surgery, infected cases etc. were not included.

Future directions of the study: In the background of the evolving landscape of global warming, there is an urgent need for soul-searching on the parameters of growing relevance in the sustainable surgical practice. We wish to broaden in our futuristic vision in our hospitals, the SOP of following up SSI for a period of 1 year post-surgery through follow-up. Future studies may benefit from a multicenter design, longer follow-up, and inclusion of skin tolerance and satisfaction data.

Conclusion

Our findings strongly support the integration of hexidine-based surgical hand rubbing protocols in the Indian operating room milieu in general and gastrointestinal surgery practice in particular. As per our SOPs, our surgical research team carried out each step religiously with appropriate technique and standardized antiseptic agents; antimicrobial milieu remains effective even under challenging intraoperative conditions, with no postoperative SSIs reported in any of these patients in this study.

In contrast to SHS, SHR required no additional water beyond an initial brief rinse, making it the appreciable, both water and time-conserving technique. Further, the mean time taken for traditional SHS was 3.48 minutes, compared to 1.56 minutes for SHR. SHR was not only uniformly safe and effective as traditional SHS, but it also offers critical advantages in time efficiency, water

conservation, cost-effectiveness, and skin health. Adoption of this practice can lead to sustainable, modern, and patient-safe surgical environments for a goal toward which all institutions and countries should strive for the days to come to champion global targets of the sustainable development programme.

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