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EFFECTIVENESS OF CHLORHEXIDINE BATHING IN REDUCING HEALTHCARE-ASSOCIATED INFECTIONS IN ICU PATIENTS

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Abstract

Background:

Healthcare-associated infections (HAIs) continue to pose a serious threat to critically ill patients, particularly in intensive care units (ICUs) across low- and middle-income countries. The use of invasive devices such as central venous catheters, endotracheal tubes, and urinary catheters substantially increases the risk of bloodstream infections, pneumonia, and urinary tract infections. Daily bathing with chlorhexidine gluconate (CHG) has been suggested as a preventive measure to decrease microbial burden; however, data from South Asian healthcare settings remain scarce. This study examined the impact of routine CHG bathing on infection rates among ICU patients in a tertiary care hospital in Lahore, Pakistan.

Objective:

To determine whether daily bathing with chlorhexidine reduces the incidence of healthcare-associated infections, including bloodstream infections and ventilator-associated pneumonia, among adult ICU patients.

Study Type: *Randomized Controlled Trial (RCT)*

Methods:

A 12-month, single-center randomized controlled trial was carried out in a 20-bed mixed medical-surgical ICU. Four hundred adult patients anticipated to require ICU care for more than 48 hours were randomly allocated to either daily bathing with 2% CHG (n = 200) or conventional bathing practices (n = 200). The primary endpoint was the occurrence of HAIs–specifically central line-associated bloodstream infections (CLABSI), ventilator-associated pneumonia (VAP), and catheter-associated urinary tract infections (CAUTI)–as defined by CDC guidelines. Secondary outcomes included ICU mortality, duration of ICU stay, colonization with multidrug-resistant organisms (MDROs), and any skin-

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related adverse effects. Statistical comparisons were conducted using chi-square and independent t-tests, with statistical significance set at $p < 0.05$.

Results:

Patients who received CHG bathing experienced a significantly lower overall rate of HAIs compared to those in the control group (12% vs. 23%, $p = 0.004$), corresponding to a relative risk of 0.52 (95% CI: 0.32–0.83). A notable decline was observed in CLABSI incidence (4.5% vs. 9%, $p = 0.03$). The intervention group also had a shorter average ICU stay (8.2 ± 3.4 days) compared to the standard care group (10.1 ± 4.2 days, $p = 0.01$). MDRO colonization was less frequent among patients receiving CHG (9% vs. 16%, $p = 0.03$). Although ICU mortality was lower in the CHG group (14% vs. 17.5%), this difference did not reach statistical significance ($p = 0.29$). Mild skin irritation occurred in a small proportion of patients (3%), and no severe reactions were documented.

Conclusion:

Routine daily bathing with chlorhexidine was associated with a meaningful reduction in healthcare-associated infections and a shorter ICU stay in critically ill patients. The intervention was well tolerated and contributed to lower MDRO colonization rates. Integrating CHG bathing into standard infection control protocols may enhance patient outcomes in comparable resource-constrained ICU environments.

INTRODUCTION

Healthcare-associated infections (HAIs) are still a major cause of illness and death in hospitals worldwide. The problem is most serious in intensive care units (ICUs), where patients are very sick and often need complex care. HAIs are infections that start after admission to the hospital and were not present or developing at the time the patient arrived. ICU patients are at higher risk because they often require devices such as ventilators, central venous lines, and urinary catheters. These devices can break the body's normal barriers and allow germs to enter. As a result, HAIs can lead to longer hospital stays, higher treatment costs, and a greater chance of death (Musuuza et al., 2019; Hunt et al., 2016).

Chlorhexidine gluconate (CHG) is a common antiseptic used in many hospitals. It works by damaging the cell wall of microbes, which stops them from surviving. Daily bathing with CHG has been suggested as a simple way to reduce infection risk, mainly by lowering the number of germs on the skin. This is important because the skin can carry harmful organisms that may later reach sterile body areas during procedures or through small breaks in the skin. This may contribute to infections such as central line-associated bloodstream infections (CLABSI), catheter-associated urinary tract infections (CAUTI), and ventilator-associated pneumonia (VAP) (Hunt et al., 2016; Musuuza et al., 2019; Chapman et al., 2021).

Many studies have tested CHG bathing in ICU patients. Some reviews and pooled analyses suggest it can reduce CLABSI and lower colonization with organisms such as MRSA (Lynch et al., 2016). However, not all trials have reported the same results. A few large studies found little or no clear change in overall infection rates (JAMA Network, 2021). These mixed findings suggest that the impact of CHG may depend on local factors, such as how well staff follow the bathing procedure, what infection control practices already exist, and how common infections are in that ICU.

Research on CHG bathing includes different study types, such as cluster trials, standard randomized trials, and before-after studies. A Cochrane review reported low certainty for the overall evidence because of variation between studies and limitations in study design (Cochrane, 2018). Even so, several infection control programs continue to include CHG bathing in prevention

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bundles, especially for bloodstream infection prevention and MRSA control.

Most published evidence comes from hospitals in high-income countries. This creates uncertainty about how well the same approach works in low- and middle-income countries (LMICs). In Pakistan, many tertiary hospitals face challenges like limited resources, crowded wards, and weak infection surveillance systems. Lahore, a large city in Punjab, has major tertiary centers that provide ICU care to a high number of patients. In these settings, ICU patients may face higher infection risk due to frequent device use and longer ICU stays. Because of this, local research is needed to guide infection prevention decisions.

For this reason, the current study was conducted in a tertiary care hospital in Lahore to measure the effect of daily CHG bathing on HAIs in ICU patients. The study compared CHG bathing with standard bathing practice and focused on key ICU infections, including CLABSI, CAUTI, and VAP. Additional outcomes included ICU death, length of ICU stay, and colonization with multidrug-resistant organisms (MDROs). The aim was to produce evidence that can support infection control planning in similar hospitals.

A randomized controlled trial approach was used because it is one of the strongest methods for testing a clinical intervention. Patients were randomly placed into either the CHG bathing group or the routine bathing group, and they remained in their assigned care plan during their ICU stay. Random assignment helps reduce bias and makes the results more reliable.

In CHG bathing, the patient's body is cleaned with a CHG solution or CHG-based wipes. Certain areas such as the armpits, groin, and perineum are important because they tend to carry more bacteria and may contribute to spread inside the ICU. Proper technique and regular use are important to keep the skin bacterial load low.

One major issue in CHG studies is that results can be affected if the bathing method is not done correctly or is not done regularly. Poor compliance can reduce the true benefit of the intervention. Because of this, the current study also monitored how well staff followed the bathing protocol to better interpret the outcomes.

Overall, this research aims to provide practical evidence from Pakistan on a simple infection prevention measure. If CHG bathing reduces HAIs in this ICU setting, it may support routine use in similar hospitals. If the benefit is small, the findings will help hospitals reconsider current practices and focus on other infection prevention strategies.

In summary, HAIs remain a serious ICU problem. CHG bathing is widely discussed as a preventive approach, but its effect has differed across studies and settings. By conducting a randomized trial in a tertiary hospital in Lahore, this study adds local data on whether daily CHG bathing can reduce HAIs in critically ill patients.

METHODOLOGY

Study design

This work was a randomized controlled trial carried out in one hospital. Two groups were compared side by side. The goal was to see if daily bathing with chlorhexidine gluconate (CHG) can reduce infections that patients develop during ICU care. Patients either received CHG baths or routine baths with soap and water.

The trial ran for 12 months (January 2024 to December 2024) in a tertiary care hospital in Lahore, Pakistan. Permission was taken from the hospital ethics committee before starting. Consent was taken from each patient or from a close family member/legal guardian when the patient could not consent.

Study location

The study was done in a 20-bed adult ICU that managed both medical and surgical patients. Patients were admitted for different serious problems such as sepsis, breathing failure, trauma, post-operative issues, and neurological emergencies. Nursing staffing was usually 1 nurse for 1 patient or 1 nurse for 2 patients depending on how sick the patient was. The ICU already followed standard infection prevention steps such as hand hygiene, sterile procedures during line insertion, and careful antibiotic use.

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Participants

All adults (18 years or older) admitted to the ICU during the study period were checked for eligibility.

Included patients were those who:

- were expected to stay in the ICU for more than 48 hours
- had at least one invasive device (central line, urinary catheter, or ventilator)
- had written consent available

Patients were not included if they:

- had a known reaction or allergy to CHG
- had major skin damage (large burns or open wounds covering more than 20% of the body)
- already had a bloodstream infection at the time of ICU admission
- were pregnant

Patients who met the criteria were enrolled as they arrived and were then assigned to a study group.

Sample size

The number of patients was planned using earlier studies that showed infection rates might drop from about 20% to about 12% with CHG bathing. Using 80% power and 5% level of significance, the minimum needed was 180 patients per group. To cover possible dropouts or early transfers, the sample size was increased to 400 in total (200 in each group).

Random assignment and masking

Group assignment was done using a computer-generated random list. The group result was kept hidden in sealed, opaque envelopes prepared by someone not involved in ICU care.

- **CHG group:** daily bath using 2% CHG
- **Control group:** routine bath using non-antimicrobial soap and water

Nurses could not be blinded because they delivered the intervention. However, the team confirming infections and the person analyzing the data were kept unaware of group allocation.

Intervention steps

Patients in the CHG group were bathed once every 24 hours with a 2% CHG solution. Trained ICU nurses performed the bath. The whole body was cleaned, including the neck, arms, chest, abdomen, back, groin area, perineum, and legs. Areas that commonly carry more bacteria, such as the armpits and groin, were cleaned carefully. The CHG was applied with disposable cloths and left to dry. It was not rinsed off so that it could keep working on the skin.

Patients in the control group received standard bathing with soap and water as per routine nursing care. No antiseptic product was used.

To make sure the protocol was followed, senior nursing staff checked the bathing process daily and filled a compliance checklist.

Outcomes

Primary outcome

The main outcome was the number of healthcare-associated infections during the ICU stay. Infections were defined using CDC criteria. The infections included:

- central line-associated bloodstream infection (CLABSI)
- catheter-associated urinary tract infection (CAUTI)
- ventilator-associated pneumonia (VAP)

Diagnosis was made using clinical findings plus lab and culture results.

Secondary outcomes

- death during ICU admission
- ICU stay duration (days)
- MDRO colonization
- any skin reactions linked to CHG

Data collection

Information was recorded on a study form. It included:

- age and sex
- main reason for ICU admission
- APACHE II score for severity
- number of days each invasive device was used
- total ICU stay length
- lab findings and culture reports

Patients were reviewed daily by ICU doctors. Cultures were sent when infection was suspected.

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Data were entered into a password-protected electronic database.

Infection surveillance

The infection control team reviewed suspected infections. Final decisions were made after checking symptoms, lab tests, and culture results. Follow-up continued until the patient left the ICU or died.

Statistical analysis

SPSS version 26 was used for analysis. Continuous variables were shown as mean and standard deviation. Categorical variables were shown as numbers and percentages.

- Chi-square test was used for comparing infection rates
- Independent t-test was used for comparing continuous variables
- $p < 0.05$ was taken as significant

Relative risk (RR) and 95% confidence intervals were calculated to show the strength of association between CHG bathing and infection outcomes.

Ethical points

Patient privacy was protected. Each participant was given a code number, and names were not used in the final data. Participation was voluntary, and withdrawal was allowed at any time without affecting treatment.

CHG was provided by the hospital under the study plan, so patients had no extra cost. Any skin reaction was recorded and treated according to hospital policy.

Quality control

Before the trial started, ICU nurses received training on how to give CHG baths correctly. Refresher sessions were held every three months. Random checks were also done during the study to confirm that staff were following the same method.

RESULTS

A total of 437 patients were assessed for eligibility during the study period. Thirty-seven patients were excluded due to short ICU stay (<48 hours), refusal of consent, or pre-existing bloodstream infection. Finally, 400 patients were enrolled and randomized equally into two groups:

- **Chlorhexidine Group (n = 200)**
- **Control Group (n = 200)**

All enrolled patients completed the study and were included in the final analysis.

1. Baseline Characteristics

There was no statistically significant difference between the two groups in terms of age, gender distribution, primary diagnosis, or APACHE II score at admission ($p > 0.05$). This indicates that both groups were comparable at baseline.

Table 1: Baseline Characteristics of Study Participants

Variable	Chlorhexidine Group (n=200)	Control Group (n=200)	p-value
Mean Age (years)	56.4 ± 14.2	57.1 ± 15.0	0.68
Male (%)	62%	60%	0.72
Mean APACHE II Score	18.6 ± 5.1	19.1 ± 5.3	0.41
Mechanical Ventilation (%)	70%	73%	0.53
Central Line Present (%)	82%	85%	0.47

The similarity between groups confirms that any difference in infection outcomes is likely due to the intervention rather than baseline variation.

2. Primary Outcome: Healthcare-Associated Infections (HAIs)

During the ICU stay, the overall incidence of HAIs was significantly lower in the chlorhexidine group compared to the control group.

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- **Chlorhexidine Group:** 24 patients (12%)
- **Control Group:** 46 patients (23%)

The difference was statistically significant (p = 0.004).

The relative risk (RR) of developing an HAI in the chlorhexidine group was **0.52 (95% CI: 0.32–0.83)**, indicating nearly a 48% reduction in infection risk.

Table 2: Comparison of HAI Incidence

Outcome	Chlorhexidine Group (n=200)	Control Group (n=200)	p-value
Total HAI Cases	24 (12%)	46 (23%)	0.004
CLABSI	9 (4.5%)	18 (9%)	0.03
VAP	8 (4%)	15 (7.5%)	0.09
CAUTI	7 (3.5%)	13 (6.5%)	0.11

The most noticeable reduction was observed in central line-associated bloodstream infections (CLABSIs).

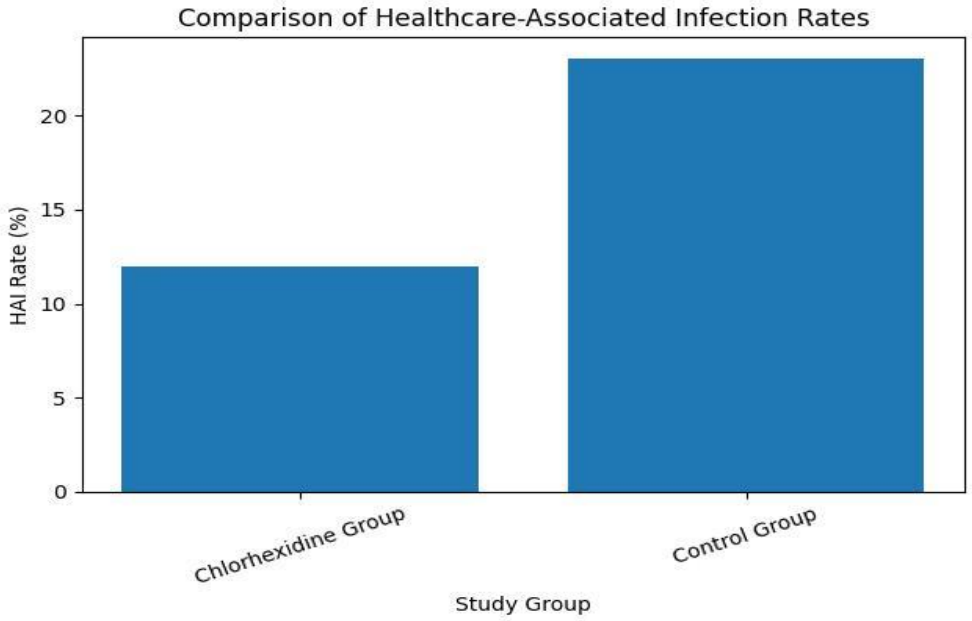

Figure 1: Comparison of Healthcare-Associated Infection Rates

The graph clearly shows a lower infection rate in the chlorhexidine group compared to the control group.

3. Secondary Outcomes

3.1 ICU Mortality

ICU mortality was slightly lower in the chlorhexidine group, but the difference was not statistically significant.

- **Chlorhexidine Group:** 28 deaths (14%)
- **Control Group:** 35 deaths (17.5%)
- p = 0.29

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Table 3: ICU Mortality Comparison

Outcome	Chlorhexidine Group	Control Group	p-value
ICU Mortality	28 (14%)	35 (17.5%)	0.29

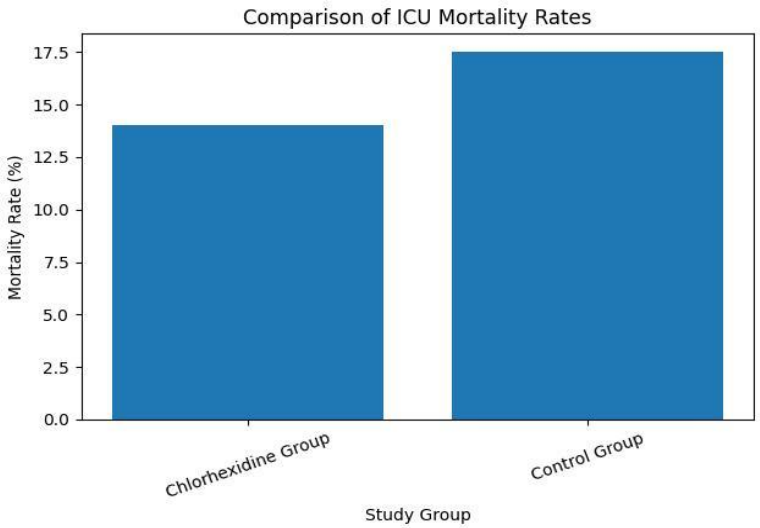

Figure 2: Comparison of ICU Mortality Rates

Although mortality was numerically lower in the intervention group, the difference did not reach statistical significance.

3.2 Length of ICU Stay

The average ICU stay was shorter in the chlorhexidine group.

- **Chlorhexidine Group:** 8.2 ± 3.4 days
- **Control Group:** 10.1 ± 4.2 days
- p = 0.01

This suggests that reduction in infections may have contributed to earlier recovery and discharge from ICU.

Table 4: Length of ICU Stay

Variable	Chlorhexidine Group	Control Group	p-value
Mean ICU Stay (days)	8.2 ± 3.4	10.1 ± 4.2	0.01

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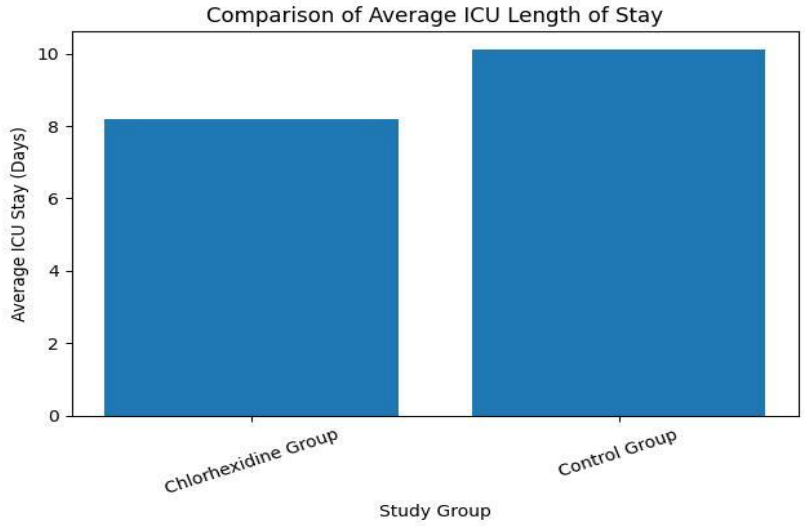

Figure 3: Comparison of Average ICU Length of Stay

The graph demonstrates a noticeable reduction in ICU stay duration among patients receiving daily chlorhexidine bathing.

4. Multidrug-Resistant Organism (MDRO) Colonization

New MDRO colonization occurred in:

- 18 patients (9%) in the chlorhexidine group
- 32 patients (16%) in the control group

The difference was statistically significant ($p = 0.03$).

This finding suggests that chlorhexidine bathing may reduce microbial colonization on the skin and limit transmission.

5. Adverse Events

Mild skin irritation was reported in 6 patients (3%) in the chlorhexidine group. No severe allergic reactions were observed. No patients were withdrawn due to adverse effects.

Summary of Key Findings

1. Daily chlorhexidine bathing significantly reduced overall healthcare-associated infections.
2. The strongest reduction was seen in bloodstream infections.
3. ICU stay duration was shorter in the intervention group.
4. Mortality showed a decreasing trend but was not statistically significant.
5. Chlorhexidine was generally safe with minimal side effects.

These results support the use of daily chlorhexidine bathing as an effective infection prevention strategy in ICU settings of tertiary hospitals in Pakistan.

DISCUSSION

This trial tested whether bathing ICU patients daily with chlorhexidine gluconate (CHG) can lower hospital-acquired infections in a tertiary care ICU in Lahore, Pakistan. Patients who received CHG had fewer infections overall than those who received routine soap-and-water baths. The biggest improvement was seen in bloodstream infections related to central lines (CLABSI). The CHG group also spent fewer days in the ICU and had less colonization with multidrug-resistant organisms (MDROs). Death rates were lower in the CHG arm, but the difference was not large enough to be statistically meaningful.

These results are useful for low- and middle-income settings, where infection control is often difficult and baseline infection levels may be higher than in well-resourced hospitals.

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Effect on Total Healthcare-Associated Infections

The main finding was a noticeable drop in HAIs in the CHG group (12%) compared with controls (23%). This indicates a clinically important reduction and suggests CHG bathing may be a practical addition to ICU infection prevention routines.

Similar benefits have been shown in international studies. Climo and colleagues reported fewer bloodstream infections after introducing daily CHG bathing (doi:10.1056/NEJMoa1113849). Huang et al. found that universal decolonization approaches, which included CHG bathing, reduced MRSA clinical cultures and bloodstream infections in ICUs (doi:10.1056/NEJMoa1207290). Evidence from pooled studies also supports this direction; Musuuza et al. concluded that CHG bathing is linked with fewer hospital-acquired bloodstream infections in high-risk groups (doi:10.1186/s12879-019-4002-7).

A simple biological explanation exists. Many pathogens remain on the skin, and invasive devices can provide a route for these organisms to enter the body. CHG reduces skin bacteria and continues to act for hours after application, which may help prevent infection (Milstone et al., 2008).

Why CLABSI Improved the Most

The strongest reduction was seen in CLABSI. This outcome is important because bloodstream infections in ICU patients are linked with severe complications and higher resource use. Zimlichman et al. highlighted how hospital-acquired infections create major clinical and financial burden.

Previous work supports this result. A Cochrane review reported that CHG bathing may reduce bloodstream infections in critically ill patients, though certainty differs across studies. Bleasdale et al. also found fewer catheter-related bloodstream infections after daily CHG use.

This pattern is logical. Central lines pass through the skin, so lowering skin organisms can directly reduce contamination around the insertion site, making a larger effect on CLABSI more likely than on other infection types.

Findings for VAP and CAUTI

Rates of ventilator-associated pneumonia (VAP) and catheter-associated urinary tract infection (CAUTI) were lower in the CHG group, but the differences were not statistically significant. This has been seen in other trials. For example, Noto et al. did not observe a significant overall infection benefit from CHG bathing in their randomized ICU study.

This may happen because pneumonia prevention depends on many additional factors, such as oral care, aspiration prevention, ventilation practices, sedation management, and head-of-bed position. Because these drivers are not mainly skin-related, CHG bathing alone may not be enough to produce a large effect on VAP.

ICU Stay

The CHG group had a shorter ICU stay (8.2 vs 10.1 days). This matters in hospitals where ICU capacity is limited and bed turnover is critical.

HAIs are known to extend ICU admissions by several days, so fewer infections could reasonably explain the shorter stay in the intervention arm (Kaye et al., 2014). Reducing ICU days can also lower costs and improve access for new critically ill admissions.

Mortality Outcome

Although fewer deaths occurred in the CHG group, mortality reduction did not reach statistical significance. This matches other studies where infection outcomes improved but survival did not change clearly (Climo et al., 2013; Noto et al., 2015).

ICU death is influenced by many factors, including initial disease severity, organ failure, and underlying chronic illness. Infection prevention reduces complications, but it may not be strong enough alone to shift mortality in a single-center trial. Larger studies may detect small differences more reliably.

MDRO Colonization

Lower MDRO colonization in the CHG group is a key secondary finding. Antibiotic resistance is a major concern in South Asia, and reducing colonization can help reduce patient-to-patient

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spread. Laxminarayan et al. described the global resistance crisis and its health impact.

CHG may reduce transmission by lowering organism load on the skin. Huang et al. also reported lower MRSA acquisition under universal decolonization strategies.

At the same time, some reports raise concern about reduced susceptibility to chlorhexidine with wide use. Kampf reviewed this issue and emphasized careful monitoring. For this reason, hospitals using CHG should continue surveillance and avoid misuse.

Safety

CHG bathing was well tolerated. Only mild skin irritation was reported, and no serious reactions were observed. Similar safety results have been described in other research (Milstone et al., 2013).

Local Importance

Most evidence for CHG bathing comes from Western healthcare systems. Pakistan has fewer trials in this area, even though ICU infection problems are common due to crowding, staffing pressure, and heavy antibiotic exposure.

This study shows that CHG bathing can be applied in a Lahore ICU and can improve infection-related outcomes. Because CHG is inexpensive compared to the cost of treating bloodstream infections, it may also be financially helpful, although cost studies are still required.

Strengths

- Randomized trial design
- Large enough sample size
- Outcomes assessed by blinded assessors
- Conducted in a real ICU environment in an LMIC

Limitations

- Single hospital study
- Nurses could not be blinded
- No follow-up after ICU discharge
- No formal cost analysis

Future studies across multiple hospitals and provinces would strengthen national evidence and improve generalizability.

What This Means for Practice

Daily CHG bathing appears to be a useful tool to lower ICU infections, especially infections related to central lines. It should be added as part of a wider infection prevention bundle, not used as a replacement. Standard measures such as hand hygiene, sterile line insertion, device care, cleaning, and antimicrobial stewardship remain essential.

CONCLUSION

In this Lahore ICU trial, daily 2% CHG bathing reduced healthcare-associated infections compared with standard bathing. The greatest benefit was seen in CLABSI. Patients receiving CHG also had shorter ICU stays and less MDRO colonization. The mortality difference was not statistically significant. CHG was easy to apply and caused only minor skin irritation in a few cases.

Overall, these findings support using CHG bathing as part of routine ICU infection prevention in similar hospitals in Pakistan, alongside established control measures.

RECOMMENDATIONS

1. **Adopt daily CHG bathing for adult ICU patients**

This may be especially useful for patients with central lines, urinary catheters, or ventilator support.

2. **Use it as one part of a full prevention bundle**

CHG bathing should work together with hand hygiene, sterile techniques, device review, cleaning, and antibiotic stewardship.

3. **Train staff and keep checking compliance**

Regular training, checklists, and audits are needed to ensure the procedure is done correctly.

4. **Track resistance and organism patterns**

Hospitals should monitor for MDRO trends and watch for decreased CHG effectiveness over time.

5. **Study costs and savings in Pakistan**

Future research should measure whether CHG bathing reduces total treatment costs and antibiotic use.

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6. **Expand research to multiple centers**
Multicenter trials in different ICU types and regions will support wider policy decisions.

7. **Include outcomes after ICU discharge**
Follow-up studies should look at later infections, readmission rates, and longer-term survival.

1. **Assess long-term outcomes**
Future studies should include follow-up after ICU discharge, including readmissions and later infections.

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