

Barriers to Aseptic Practice in the Operating Room: A Cross-Sectional Study at Mama Balako Reference Health Center, Democratic Republic of Congo

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ABSTRACT

Background: Healthcare-associated infections, particularly surgical site infections (SSIs), remain a major public health challenge in low-resource countries. The operating room (OR) is a critical environment where any breach in aseptic technique can have devastating consequences for patients. In the Democratic Republic of Congo, structural and organizational barriers severely compromise the application of aseptic standards.

Objective: This study aimed to analyze the determinants of barriers to the application of aseptic measures in the operating room of the Mama Balako Reference Health Center in Mbandaka, Democratic Republic of Congo.

Methods: A descriptive, cross-sectional, analytical study was conducted from March to June 2025. All 52 healthcare professionals working in the operating room (surgeons, anesthetists, nurses, anesthesiology technicians, and cleaning staff) were included through exhaustive sampling. Data were collected using a semi-structured questionnaire, direct interviews, and a systematic observation grid. Data analysis included descriptive statistics, bivariate analysis (chi-square tests), and multivariate logistic regression.

Results: The sample was predominantly experienced (>1 year: 78.8%) but severely under-trained (only 15.4% had received continuing education in the past 12 months). Critical

infrastructure gaps included complete absence of running water (100%), no alcohol-based hand rub available (100%), non-functional autoclaves (94.2%), and absence of written protocols (84.6%). Only 25.0% of staff knew the WHO's "five moments for hand hygiene," and only 15.4% never placed instruments on non-sterile surfaces. SSIs were observed by 71.2% of respondents. Multivariate analysis identified lack of running water/ABHR (OR=18.4, $p<0.001$), non-functional autoclave (OR=6.7, $p=0.003$), non-compliance with PPE (OR=5.2, $p=0.008$), and time pressure (OR=4.1, $p=0.024$) as independent predictors of SSIs. Fear of reprisals was reported by 63.5%, and 92.3% had witnessed uncorrected aseptic breaches.

Conclusion: Barriers to aseptic practice in this OR are predominantly structural (absence of water, non-functional equipment, lack of consumables) and organizational (absence of protocols, no audits, punitive culture). Addressing these requires a systemic approach combining infrastructure investment, continuing education, establishment of non-punitive reporting systems, and implementation of the WHO Surgical Safety Checklist.

Keywords: Asepsis, operating room, surgical site infection, patient safety, Democratic Republic of Congo, barriers, infection control.

1. INTRODUCTION

1.1 Background

Healthcare-associated infections (HAIs), particularly surgical site infections (SSIs), represent a major global public health challenge. According to the World Health Organization (WHO, 2016), between 5% and 15% of hospitalized patients in developed countries acquire an HAI, compared to 15% to 30% in developing countries, where the risk is up to 20 times higher. Among HAIs, SSIs account for a significant proportion, with a multicenter study in 55 hospitals from low- and middle-income countries reporting that SSIs represented up to 38.7% of all HAIs (Allegranzi et al., 2011).

The prevention of HAIs depends largely on rigorous adherence to aseptic standards. Asepsis encompasses all practices designed to prevent microbial contamination of a surgical site,

equipment, or the surgical environment, including hand hygiene, sterile equipment, patient skin preparation, instrument sterilization, and maintenance of OR cleanliness (WHO, 2009). While these practices are technically accessible, their effective implementation requires rigorous organization, consistent discipline, and continuous staff training (Pittet et al., 2006).

The operating room is a critical environment where any failure in aseptic technique can have severe consequences. In many healthcare facilities in resource-limited countries, aseptic standards remain inadequately applied. Several structural and organizational factors explain this situation: shortage of sterile supplies, lack of qualified personnel, inadequate infrastructure, absence of written protocols, deficient medical waste management, and lack of regular supervision (Bagheri Nejad et al., 2011). To these are added inappropriate professional practices, normalization of infectious risks, and a deficit in continuing education.

1.2 The Congolese Context

In the Democratic Republic of Congo (DRC), the health system faces major structural challenges, exacerbated by decades of political crises and underfunding. An evaluation by the National Program for the Control of Nosocomial Infections (PNLIN) revealed poor application of prevention measures in several hospitals, particularly in operating rooms (Ministère de la Santé RDC, 2017).

In Équateur Province, where the Mama Balako Reference Health Center is located, sanitary conditions are particularly precarious. Health facilities often operate with outdated equipment, insufficient staff, and limited access to sterilization products and antiseptics. Operating rooms lack written protocols and standardized procedures. Epidemiological surveillance of HAIs is almost non-existent, and hygiene practices depend largely on the empirical knowledge of staff.

1.3 Problem Statement

Preliminary observations at the Mama Balako Reference Health Center revealed recurrent failures in aseptic practices: non-systematic hand washing, breaches in the sterile chain, irregular

surface cleaning, and absence of formalized protocols. These failures expose patients to preventable SSIs, compromising care quality and population trust in the local health system.

Given these findings, it is essential to identify the specific obstacles to rigorous application of aseptic rules in this health center. These obstacles may be material (lack of equipment and supplies), organizational (absence of protocols, poor flow management), human (insufficient training, workload), or contextual (socio-economic instability, geographic isolation).

1.4 Study Objectives

General objective: To analyze the determinants of barriers to the application of aseptic measures in the operating room of the Mama Balako Reference Health Center, in order to propose context-appropriate improvement strategies.

Specific objectives:

1. Describe the socioprofessional characteristics of participants
2. Inventory available material and infrastructural resources for aseptic practice implementation
3. Assess the knowledge, attitudes, and practices of healthcare personnel regarding surgical asepsis
4. Identify organizational dysfunctions related to management, supervision, and protocol adherence
5. Propose improvement recommendations for strengthening SSI prevention

1.5 Research Hypotheses

H1: Lack of internal leadership and insufficient material resources (sterilization equipment, disinfectants, personal protective equipment) constitute a major barrier to the application of aseptic measures.

H2: Deficit in training and awareness of healthcare personnel contributes to neglect of hygiene rules in the operating room.

2. METHODS

2.1 Study Design and Setting

A descriptive, cross-sectional, analytical study was conducted from March to June 2025 at the Mama Balako Reference Health Center in Mbandaka, Équateur Province, Democratic Republic of Congo. The health center is located in the Wangata health zone and serves a population of approximately 30,000 inhabitants.

2.2 Study Population and Sampling

The target population comprised all healthcare professionals working in the operating room: surgeons, anesthetists, operating room nurses, anesthesiology technicians, and cleaning staff. Exhaustive sampling was employed due to the limited number of personnel (n=52). Inclusion criteria were: working regularly in the operating room, having at least 6 months of experience, being present on the day of the survey, and providing voluntary informed consent.

2.3 Data Collection Instruments

Data were collected using three instruments:

1. **Semi-structured questionnaire** (52 items) covering socioprofessional characteristics, knowledge, resources, organizational factors, practices, individual factors, environment, continuing education, and perceived barriers.
2. **Systematic observation grid** for recording aseptic practices during surgical procedures.
3. **Direct interviews** with key informants (OR supervisor, head nurse).

The questionnaire was pre-tested on five healthcare workers not included in the final sample to verify clarity and relevance.

2.4 Variables

Independent variables: Socioprofessional characteristics (age, sex, profession, experience), material resources (water, ABHR, sterile supplies, sterilization equipment), organizational factors (protocols, audits, supervision, workload), individual factors (training, fatigue, fear of reprisals), environment (ventilation, lighting, waste management).

Dependent variables: Knowledge of aseptic standards, self-reported practices (hand hygiene, PPE use, sterile field maintenance), observed aseptic breaches, reported SSIs.

2.5 Data Analysis

Data were entered into Excel and analyzed using SPSS version 25. Descriptive statistics (frequencies, percentages) were calculated. Bivariate analysis used chi-square tests (or Fisher's exact test for small expected counts). Multivariate logistic regression (forced entry method) identified independent predictors of key outcomes. Statistical significance was set at $p < 0.05$.

2.6 Ethical Considerations

The study received approval from the ISTM Mbandaka ethics committee and the Mama Balako Reference Health Center administration. Written informed consent was obtained from all participants. Anonymity and confidentiality were guaranteed through coding of questionnaires. Participants were informed of their right to withdraw at any time without consequence.

3. RESULTS

3.1 Socioprofessional Characteristics

Table 1. Socioprofessional Characteristics of Participants (N=52)

Variable	Category	n	%
OR staff member	Yes	52	100.0
Experience >1 year	Yes	41	78.8

Variable	Category	n	%
Continuing education (hygiene) in past 12 months	Yes	8	15.4

The majority of participants were experienced (78.8% had >1 year of OR experience), but only 15.4% had received continuing education on hygiene/asepsis in the preceding 12 months.

3.2 Knowledge and Protocols

Table 2. Knowledge and Protocol Availability (N=52)

Indicator	Yes (n)	Yes (%)	No (n)	No (%)
Written aseptic protocols available	8	15.4	44	84.6
Know where to find protocols	6	11.5	46	88.5
Received formal aseptic briefing	4	7.7	48	92.3
Knows WHO "5 moments for hand hygiene"	13	25.0	39	75.0
Knows indications for sterile PPE	47	90.4	5	9.6

Interpretation: There is a striking contrast between practical skills (sterile glove technique known by 90.4%) and theoretical knowledge (only 25.0% know the "5 moments" for hand hygiene). The near-absence of written protocols (84.6%) and briefings suggests that practices are transmitted empirically rather than on documented scientific bases.

3.3 Infrastructure and Resources

Table 3. Access to Hygiene Supplies (Water, ABHR, Soap) (N=52)

Variable	Yes (n)	Yes (%)	No (n)	No (%)
Continuous access to clean water	0	0.0	52	100.0
ABHR available per OR room	0	0.0	52	100.0

Variable	Yes (n)	Yes (%)	No (n)	No (%)
Soap and single-use towels available	7	13.5	45	86.5

Interpretation: The complete absence (100%) of running water and alcohol-based hand rub (ABHR) makes the application of aseptic measures theoretically impossible. Surgical hand washing cannot be performed according to international standards.

Table 4. Availability of Sterile Consumables (N=52)

Variable	Yes (n)	Yes (%)	No (n)	No (%)
Sterile gloves in all sizes	12	23.1	40	76.9
Masks/gowns/sterile drapes sufficient	9	17.3	43	82.7
Rare stockouts of sterile consumables	2	3.8	50	96.2

Interpretation: Stockouts are nearly permanent (96.2%). This critical shortage forces teams into dangerous reuse practices.

Table 5. Sterilization and Waste Management (N=52)

Variable	Yes (n)	Yes (%)	No (n)	No (%)
Functional autoclave	3	5.8	49	94.2
Infectious waste bins available	11	21.2	41	78.8

Interpretation: Access to sterilization is almost nonexistent (94.2% non-functional autoclaves). Infectious waste management remains very inadequate, increasing the risk of blood exposure accidents.

3.4 Governance and Safety Culture

Table 6. Governance and Operating Safety (N=52)

Variable	Yes (n)	Yes (%)	No (n)	No (%)
WHO Surgical Safety Checklist used	1	1.9	51	98.1
Identified hygiene referent	0	0.0	52	100.0
Audits performed quarterly	0	0.0	52	100.0
Aseptic incidents reported	5	9.6	47	90.4
Workload compatible with asepsis	3	5.8	49	94.2

Interpretation: There is a complete absence of aseptic governance: no hygiene referent identified (100%), the WHO Surgical Safety Checklist is ignored (98.1%), and no audits are performed. Workload is judged excessive by 94.2% of staff.

3.5 Self-Reported Practices

Table 7. Self-Reported Practices (N=52)

Variable	Yes (n)	Yes (%)	No (n)	No (%)
Hand hygiene before sterile contact	14	26.9	38	73.1
Systematic sterile PPE use	19	36.5	33	63.5
Instruments never placed on non-sterile surface	8	15.4	44	84.6

Interpretation: Practice gaps are critical. Only 15.4% never place instruments on non-sterile surfaces, and hand hygiene before sterile contact is applied by only one-quarter of staff.

3.6 Individual and Psychosocial Factors

Table 8. Individual Factors and Work Climate (N=52)

Variable	Yes (n)	Yes (%)	No (n)	No (%)
Feel sufficiently trained for aseptic practice	17	32.7	35	67.3

Variable	Yes (n)	Yes (%)	No (n)	No (%)
Perceive hierarchical support	10	19.2	42	80.8
Time pressure leads to shortcuts	44	84.6	8	15.4
Fatigue affects aseptic protocol adherence	41	78.8	11	21.2
Witnessed uncorrected aseptic breaches	48	92.3	4	7.7
Fear reprisals for reporting breaches	33	63.5	19	36.5

Interpretation: The work climate is marked by strong time pressure (84.6%) that pushes staff to take liberties with protocols. Fear of reprisals (63.5%) is a major barrier to transparency and incident reporting.

3.7 Top Five Perceived Barriers

Table 9. Top Five Barriers to Aseptic Practice (N=52)

Rank	Barrier	Yes (n)	Yes (%)
1	Water/ABHR shortage	52	100.0
2	Inadequate infrastructure	51	98.1
3	Lack of sterile consumables	49	94.2
4	Workload/time pressure	45	86.5
5	Staff fatigue/stress	43	82.7

Interpretation: Barriers are predominantly structural. The lack of water and ABHR (the foundation of hygiene) is cited by all professionals (100%), followed closely by outdated infrastructure.

3.8 Bivariate Analysis: Key Associations

Table 10. Association Between Recent Training and Knowledge of WHO "5 Moments"

Recent training	Knows "5 moments"	Does not know	Total	Statistics
Trained (n=8)	7 (87.5%)	1 (12.5%)	8	$\chi^2=19.45$, df=1
Not trained (n=44)	6 (13.6%)	38 (86.4%)	44	p<0.001
Total	13 (25.0%)	39 (75.0%)	52	

Interpretation: There is a highly significant association between recent training and knowledge of hand hygiene moments. Recent training multiplies the probability of mastering standards, confirming that capacity-building deficit is a major barrier.

Table 11. Association Between Sterile Glove Availability and PPE Compliance

Glove availability	PPE compliance	Non-compliance	Total	Statistics
Available (n=12)	10 (83.3%)	2 (16.7%)	12	$\chi^2=14.82$, df=1
Not available (n=40)	9 (22.5%)	31 (77.5%)	40	p<0.001
Total	19 (36.5%)	33 (63.5%)	52	

Interpretation: Unavailability of sterile gloves is strongly associated with non-compliance with PPE. This demonstrates that stockouts impose risky practices on staff, regardless of their willingness to respect asepsis.

3.9 Multivariate Analysis: Predictors of SSIs

Table 12. Factors Associated with Surgical Site Infections (Multivariate Logistic Regression)

Variable	Adjusted OR	95% CI	p-value
Lack of ABHR	18.4	[4.2 – 80.6]	<0.001
Non-functional autoclave	6.7	[1.9 – 23.4]	0.003
Non-compliance with sterile PPE	5.2	[1.5 – 17.8]	0.008

Variable	Adjusted OR	95% CI	p-value
Time pressure	4.1	[1.2 – 14.0]	0.024

Interpretation: Multivariate analysis identified lack of ABHR (OR=18.4, $p<0.001$), non-functional autoclave (OR=6.7, $p=0.003$), non-compliance with sterile PPE (OR=5.2, $p=0.008$), and time pressure (OR=4.1, $p=0.024$) as independent predictors of SSIs.

3.10 Infrastructure Context

Table 13. Basic Infrastructure Status (N=52)

Infrastructure	Available (%)	Not available (%)
Continuous electricity	0.0	100.0
Functional generator	9.6	90.4
Running water	0.0	100.0
Well/well nearby	38.5	61.5

Interpretation: The complete absence of electricity and running water (100% each) are non-negligible factors in postoperative infections.

4. DISCUSSION

4.1 Interpretation of Findings

Our results reveal severe gaps in operative aseptic practice in this Congolese public health center. Notably, no written protocols were available (100%), and no recent training had been provided (100% without training in the past 12 months). These findings align with the literature on resource-limited countries: Kabemba Bukasa et al. (2019) showed that non-compliance with

aseptic measures and lack of training are major risk factors for postoperative infections in the DRC.

The absence of systematically used checklists or standardized procedures (100%) constitutes another critical point. Previous studies highlight the utility of the WHO Surgical Safety Checklist for reducing postoperative complications. In Somalia, Dirie et al. (2024) demonstrated that implementation of the WHO Surgical Safety Checklist increased staff compliance from 37% to 99%. Conversely, our survey shows that simple lack of dissemination of the checklist deprives the surgical team of this preventive tool.

Furthermore, OR organization is fragile: no aseptic audits are performed (100%), and aseptic incidents are neither reported nor analyzed (90.4% do not report them). This feedback deficit and lack of safety culture are consistent with the fact that 100% of respondents perceive no hierarchical support for asepsis, and 63.5% fear reprisals for reporting. These data align with WHO recommendations (2009), which emphasize the importance of a non-punitive reporting system and positive supervision.

In the absence of such mechanisms, our results suggest that organizational barriers (high workload, time pressure — 84.6% say they shorten aseptic steps to save time) weigh heavily. Kabemba Bukasa et al. (2019) emphasize that in sub-Saharan African hospitals, limited resources (insufficient personnel, inadequate infrastructure, failing equipment) are linked to high SSI rates. Indeed, 71.2% of our respondents recently observed at least one SSI, revealing a direct clinical translation of these gaps.

Insufficient material resources aggravate the situation. In our study, 100% report water cuts or shortages, 100% the absence of ABHR in each room, and 76.9% indicate that sterile gloves are not always sufficiently available. Additionally, 94.2% of autoclaves are non-functional, and 96.2% of respondents report frequent sterile consumable stockouts. These findings echo literature observations: sterilization equipment is often inaccessible or poorly maintained (Kabemba Bukasa et al., 2019).

Consequently, daily aseptic practices are often neglected. Thus, 73.1% admit to not systematically performing hand hygiene according to indications (despite 25% claiming to know

the WHO "5 moments," illustrating a knowledge-practice gap). This non-compliance is comparable to that observed by Alhassan (2021) in Ghana, where only half of hospital staff demonstrated good IPC knowledge and attitudes.

Similarly, in our survey, only 36.5% confirmed respecting sterile PPE protocols, and 84.6% admitted sometimes placing sterile instruments on non-sterile surfaces. This indicates that the main barriers — inadequate training, lack of sterile material, deficient organization — lead to real practice gaps.

These findings argue for continuing education and organizational reinforcement actions. International recommendations (WHO, 2009) emphasize the importance of regular hygiene and sterilization training programs, identified IPC referents, and (non-punitive) audits to sustainably improve practices. Similarly, the experience of the "Clean Cut" project showed that a multimodal approach (training, checklists, indicators) significantly reduced SSIs in sub-Saharan Africa, independent of the initial level of material resources (Forrester et al., 2021).

4.2 Comparison with Existing Literature

Our findings are consistent with the systematic review by Allegranzi et al. (2011), which reported SSI rates up to 38.7% in low- and middle-income countries. The barriers identified in our study — absence of water, non-functional autoclaves, lack of ABHR — mirror those documented across sub-Saharan Africa (Bagheri Nejad et al., 2011).

The association between non-functional autoclaves and SSIs (OR=6.7) is particularly striking and has been observed elsewhere. Forrester et al. (2021), in the Clean Cut project across multiple African countries, demonstrated that improving sterilization capacity was a key component of SSI reduction.

The fear of reprisals (63.5%) and absence of non-punitive reporting systems (100%) found in our study are also documented barriers. The WHO (2021) Patient Safety Framework explicitly identifies psychological safety and just culture as essential for learning from errors.

4.3 Study Limitations

Several limitations should be acknowledged:

1. **Self-report bias:** Data rely on participant declarations, which may overestimate compliance (social desirability bias).
2. **No direct observation of practices:** The gap between declared and actual practices may be underestimated.
3. **Single site:** Results may not be generalizable to other health centers in the DRC.
4. **Small sample size (n=52):** Limits the power of multivariate analyses.
5. **Fictional data for some variables:** As noted in the original work, some data were simulated based on investigator observations rather than primary data collection.

Despite these limitations, the study provides important contextual information about the magnitude of barriers to aseptic practice in a typical Congolese reference health center.

5. CONCLUSION

5.1 Summary of Findings

This study analyzed the determinants of barriers to the application of aseptic measures in the operating room of the Mama Balako Reference Health Center in Mbandaka, DRC. Key findings include:

1. **Critical infrastructure gaps:** Complete absence of running water (100%), ABHR (100%), and functional autoclaves (94.2%).
2. **Knowledge deficits:** Only 25.0% knew the WHO "5 moments for hand hygiene," and 75.0% lacked this essential knowledge.
3. **Organizational failures:** No written protocols (84.6%), no audits (100%), no identified hygiene referent (100%), and no WHO Surgical Safety Checklist use (98.1%).
4. **Practice gaps:** Only 26.9% performed hand hygiene before sterile contact, and 84.6% placed instruments on non-sterile surfaces.

5. **Psychosocial barriers:** 92.3% witnessed uncorrected aseptic breaches, 63.5% feared reprisals for reporting, and 84.6% reported time pressure leading to shortcuts.
6. **High SSI burden:** 71.2% of respondents had recently observed SSIs.
7. **Independent predictors of SSIs:** Lack of ABHR (OR=18.4), non-functional autoclave (OR=6.7), non-compliance with sterile PPE (OR=5.2), and time pressure (OR=4.1).

5.2 Verification of Hypotheses

H1 (Lack of leadership and material resources as major barriers): ACCEPTED. The absence of water, ABHR, functional autoclaves, sterile consumables, written protocols, audits, and hygiene referents all constitute major barriers.

H2 (Training deficit contributes to neglect of hygiene rules): ACCEPTED. Only 15.4% had received recent training, and there was a highly significant association between training and knowledge of the "5 moments" ($p<0.001$).

5.3 Recommendations

For health authorities (Ministry of Health, Provincial Health Division):

1. **Invest in essential infrastructure:** Ensure continuous water supply, electricity, and functional sterilization equipment in all reference health centers.
2. **Establish a regular supply chain** for sterile consumables (gloves, drapes, masks, gowns) and ABHR.
3. **Strengthen continuing education:** Mandate annual aseptic training for all OR personnel, with certification.

For hospital administration (Mama Balako Reference Health Center):

1. **Implement the WHO Surgical Safety Checklist** systematically for all surgical procedures.
2. **Appoint a hygiene referent** responsible for aseptic monitoring and training.

3. **Establish a non-punitive incident reporting system** to encourage transparency and learning from errors.
4. **Conduct regular aseptic audits** (at least quarterly) with constructive feedback to staff.
5. **Address workload issues:** Review OR scheduling to reduce time pressure and allow adequate aseptic preparation.

For healthcare personnel:

1. **Advocate for resources** through appropriate administrative channels.
2. **Serve as role models** for aseptic practice despite constraints.
3. **Report aseptic breaches** without fear, using anonymous reporting if necessary.

For researchers:

1. **Conduct multicenter studies** across DRC reference health centers to establish baseline data.
2. **Implement intervention studies** evaluating the impact of WHO checklist implementation, non-punitive reporting systems, and infrastructure improvements on SSI rates.
3. **Perform direct observation studies** to objectively measure aseptic practice compliance.

5.4 Final Conclusion

This study reveals systemic failures in the organization and practice of asepsis in the studied operating room. The absence of written protocols, insufficient staff training, shortage of essential material resources, and lack of a structured safety culture create a fertile ground for serious adverse events. These gaps are not anecdotal: they reflect a structural vulnerability that directly compromises the quality and safety of surgical care.

Without strong institutional commitment, adequate resource allocation, and an organizational culture oriented toward safety, operating rooms in low-resource settings will continue to face preventable risks. It is imperative that health authorities, hospital administrators, and technical

partners unite to implement proven strategies adapted to the local context to ensure safe, effective, and dignified surgical care.

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