Infection control in anaesthesia in regional, tertiary and central hospitals in KwaZulu-Natal. Part 3: Decontamination practices

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Abstract

Background: Anaesthetic equipment is a potential vector for the transmission of disease. This study was undertaken to observe current infection control practices among anaesthetic nurses regarding the decontamination of anaesthetic equipment in regional, tertiary and central hospitals in KwaZulu-Natal.

Method: All hospitals that were classified as regional, tertiary and central hospitals on the KwaZulu-Natal Department of Health website (15 in total) were visited. All available anaesthesia nurses were invited to participate in a structured interview.

Results: Thirty-four anaesthesia nurses were interviewed. Results revealed that decontamination of anaesthetic equipment and other infection control practices were inadequate or inappropriate in several of the hospitals. Practices varied from one healthcare facility to another, as well as within the same facility.

Conclusion: Current infection control practices among anaesthesia nurses regarding the decontamination of anaesthetic equipment in the observed hospitals are poor. In light of the high prevalence of many infectious diseases, in particular human immunodeficiency virus, hepatitis B and tuberculosis in KwaZulu-Natal, it is critical that issues relating to decontamination practices are urgently addressed.

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Introduction

Inadequately decontaminated anaesthetic equipment is a potential vector for infection in the nosocomial transmission of disease.[1-3] The transmission of hepatitis C virus between patients in a hospital in Australia from contaminated breathing circuitry has been reported.[4] Our study was undertaken to examine the decontamination practices of selected anaesthetic equipment by anaesthesia nurses in operating theatres in regional, tertiary and central hospitals in KwaZulu-Natal.

Method

Research approval was obtained from the Biomedical Research Ethics Administration and the Postgraduate Education Committee of the University of KwaZulu-Natal. Thereafter, further permission was obtained from the KwaZulu-Natal Department of Health and the respective hospital managers of all hospitals that were classified as regional, tertiary and central hospitals on the KwaZulu-Natal Department of Health website.[5] Names of the visited hospitals and the interviewed healthcare workers were kept strictly anonymous. Fifteen hospitals were visited. This included one central, two tertiary and 12 regional hospitals.

The study involved a structured interview with individual anaesthesia nurses (Table I).

Anaesthesia nurses who were present and available on the day of the hospital visits were invited to be interviewed. Informed consent was obtained. The questions were open-ended. Specific key phrases were looked for in the responses. The obtained responses were compared to a set of model answers, based on current international best practice. For example, laryngoscope blades, Magill forceps and nasopharyngeal temperature probes require at least high-level disinfection (HLD) for decontamination.[1,2,6,7]

Table I: Anaesthesia nurse interview

Question 1
Explain in detail the steps taken to clean the following anaesthetic equipment:
- Laryngoscope blades.
- Nasopharyngeal temperature probes.
- Magill forceps.
- Laryngoscope handles.

Question 2
How many of the Macintosh® 3 and Macintosh 4® laryngoscope blades are present in each operating theatre?

Question 3
How many Magill forceps are available in each operating theatre?

Question 4
With regard to the bowl containing water to clean the suction tubing and suction bowl (Yankauer®):
- How often is the water changed?
- How often is the bowl changed?

Question 5
With regard to humidification and exchange moisture and filters:
- Describe where they should be placed in the anaesthetic circuitry.
- Are they routinely used in all or only in selected patients, or are they not routinely used?

Question 6
Are oropharyngeal airways resued or disposed after each use? If reused, describe their decontamination.

Question 7
Describe how self-inflating resuscitation bags (Ambu®) are decontamined?

Question 8
Do you feel that you have enough time between each case to adequately clean anaesthetic equipment and still perform your other duties?

There are three essential stages in HLD:[8,9]

- *Cleaning:* Removal of all visible contamination from all surfaces with water and friction, e.g. use of a brush, and fluidics, i.e. fluids under pressure, together with enzymatic products. Sequestered organic material poses the greatest risk of cross-contamination for patients as it impedes the effectiveness of these cleaning processes by reacting chemically with the germicide, and/or by forming a protective physical barrier for microorganisms.
- *Immersion in a high-level disinfectant:* For example, orthophthalaldehyde (Cidex-OPA®) and glutaraldehyde (Cidex®). The duration of immersion should be in accordance with the manufacturer's recommendations.
- *Removal of the disinfectant:* This is achieved by adequate rinsing under tap water.

All three steps are fundamental to the effectiveness and safety of HLD. Definitions used in infection control practices are given in Table II.[1,2,6,8,9]

Table II: Definitions and classifications used in infection control practices

Decontamination	A process of removing pathogenic microorganisms from an object or surface so that it is no longer capable of transmitting infectious particles. It is a combination of the processes of cleaning, disinfection, and/or sterilisation.
Cleaning	A process of removing organic and inorganic material from an object or surface with water and enzymatic products or detergent. It is the first step in all decontamination processes.
Disinfection	A process that eliminates many or all pathogenic microorganisms, except bacterial spores, on objects or surfaces. There are three levels of disinfection based on the antimicrobial spectrum and rapidity of action: **High-level disinfection** • Destroys all microorganisms (mycobacteria, vegetative bacteria, viruses and fungal spores), except large numbers of bacterial spores in a relatively short exposure time. • *Examples of disinfectants:* Glutaraldehyde, orthophthalaldehyde, hydrogen peroxide and peracetic acid. • Used for semi-critical instrument decontamination. **Intermediate-level disinfection** • Destroys mycobacteria, vegetative bacteria, most viruses, and most fungi, but does not kill bacterial spores. • *Examples of disinfectants:* 70% isopropyl alcohol, iodophor and phenolic compounds, concentrated quaternary ammonium compounds, e.g. hospital cleaners and disinfectants with a tuberculocidal claim. • Used for non-critical instruments and environmental surfaces when a tuberculocidal agent is necessary. **Low-level disinfection** • Destroys lipid or medium-sized viruses, some fungal spores and vegetative bacteria. • *Examples of disinfectants:* Diluted quaternary ammonium compounds, e.g. hospital cleaners and disinfectants without a tuberculocidal claim. • Used for non-critical items and surfaces when a tuberculocidal agent is not needed.
Sterilisation	A process whereby all types of microorganisms, e.g. mycobacteria, vegetative bacteria, viruses and fungal spores, including bacterial endospores, are eliminated. Examples of methods include pressurised steam (autoclaves) or low-temperature sterilisation methods, e.g. ethylene oxide gas and hydrogen peroxide plasma, as well as hot air ovens. It is used for critical instrument decontamination.

Table III: Decontamination practices regarding laryngoscopes, nasopharyngeal temperature probes Magill forceps and laryngoscope handles

Hospital	Laryngoscope blade decontamination		Magill's forceps decontamination		Nasopharyngeal temperature probe decontamination		Laryngoscope handle decontamination	
	Method	Non-compliance	Method	Non-compliance	Method	Non-compliance	Method	Non-compliance
A	Sodium bicarbonate soak and Hibitane®	No HLD	Soap and water	No HLD	Soap and water	No HLD	Cleaned once a week	Not cleaned after each patient
	Wash, brush and Hibitane®		Soap, water and Hibitane®		Soap, water, and Hibitane®		Cleaned once a day	
B	HLD	No brushing	HLD	Nil	HLD	Nil	Wiped with Biocide D®	
C	Soap and water	No brushing. No HLD	Steam sterilisation	Nil	Not used		Not cleaned	Not cleaned
							Wiped with Hibitane®	Performed daily
D	HLD	No brushing. No soap detergent	Steam sterilisation	Practice varies	HLD	Practice varies	Wiped with Hibitane®	Performed daily, or not performed at all
			Soap and water		Soap and water			
			HLD					
E	HLD	No soap detergent	HLD	No soap detergent	HLD	Nil	Wiped with Biocide D®	Nil
					Water only	No HLD	Wiped with water	No disinfectant
F	HLD	No initial washing. No brushing. No soap detergent	HLD	No initial washing prior to disinfection	Sheath	No HLD	Wiped with Hibitane®	Wiped with Biocide D®
G	HLD	Nil	HLD	Nil	HLD	Nil	Not cleaned	Not cleaned
H	HLD	Nil	HLD	Nil	Not used		Wiped with soap and water	No disinfectant
I	HLD	Nil	HLD	Nil	Glove covering	No HLD	Wiped with Biocide D®	Performed daily
J	HLD	No soap detergent. No brushing	HLD	No soap detergent. No brushing	HLD	No soap detergent. No brushing	Wiped with Hibitane®	Performed weekly
							Wiped with glutaraldehyde	Inappropriate disinfectant, performed daily
K	HLD	Nil	HLD	Nil	HLD	Nil	Sterilisation	Performed weekly
							Wiped with Biocide D®	Nil
L	HLD	No brushing	Soap and water	No HLD, performed daily	Not used		Soap and water	No disinfectant, performed daily
	Soap and water	No HLD	Steam sterilisation	Nil			Not cleaned	No cleaned
M	HLD	No soap detergent. No brushing	HLD	No soap detergent. No brushing	Glove covering	No HLD	Wiped with Hibitane®	Performed weekly
			Steam sterilisation	Nil	Soap and water	No HLD		
N	HLD	Nil	Steam sterilisation	Nil	Wiped with Hibitane®	No HLD	Wiped	Performed daily
O	Soap and water	No HLD	Soap and water	No HLD	Soap and water	No HLD	Wiped with water	No disinfectant, performed daily

HLD: high level disinfection

Results

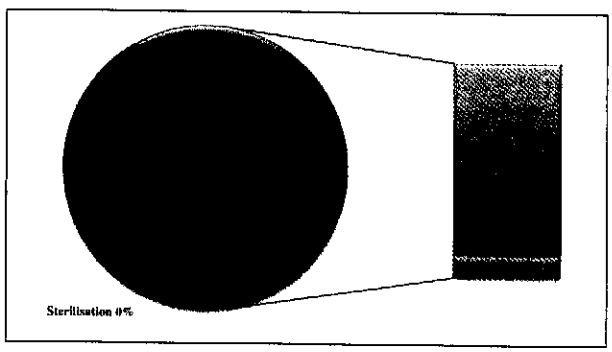
During the study period, 35 anaesthesia nurses were available, 34 of who consented to being questioned. The results pertaining to the questions posed in the nurse interview are now presented.

Question 1: Explain in detail the steps taken to clean the following anaesthetic equipment: laryngoscope blades, nasopharyngeal temperature probes, Magill forceps and laryngoscope handles

The responses pertaining to Question 1 on the decontamination of laryngoscope blades, nasopharyngeal temperature probes, Magill forceps and laryngoscope handles and are presented in Table III and summarised in Figures 1-4. Sterilisation or HLD are the recommended methods of decontamination with regard to laryngoscope blades, nasopharyngeal temperature probes and Magill forceps (Figures 1-3). Use of other non-recommended practices implies that the required minimum standard for decontamination of the equipment was not met. This includes the following categories:

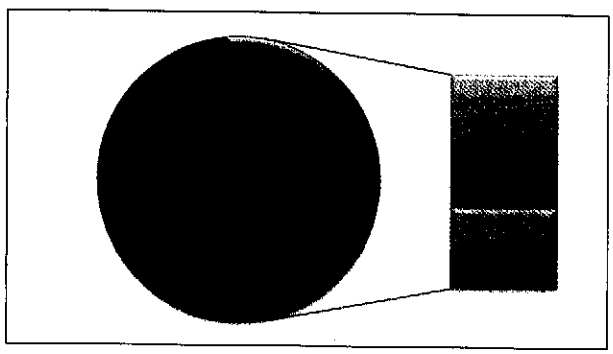
- *Inadequate HLD:* Non-compliance to HLD protocol noted, e.g. omission of washing with soap and water.
- *Neither sterilisation nor HLD:* For example, cleaning with alcohol or soap and water only.
- *Varying practice:* The method of decontamination practised in the operating theatre unit varied between recommended and other non-recommended methods, e.g. soap and water. Practice depended on the preference of the anaesthesia nurse, rather than established protocol.

Results for the practices concerning laryngoscope handle decontamination were the most varied (Figure 4). Hibitane®, an alcohol-based disinfectant, and Biocide D®, a chloride-based disinfectant, were used at hospitals where low to intermediate disinfection was practised. However, only one hospital practised disinfection with the appropriate disinfectant using the appropriate frequency, i.e. after each use.



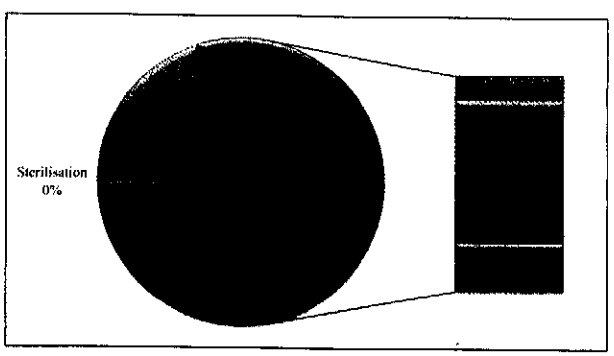
HLD: High-level disinfection

Figure 1: Laryngoscope blade decontamination



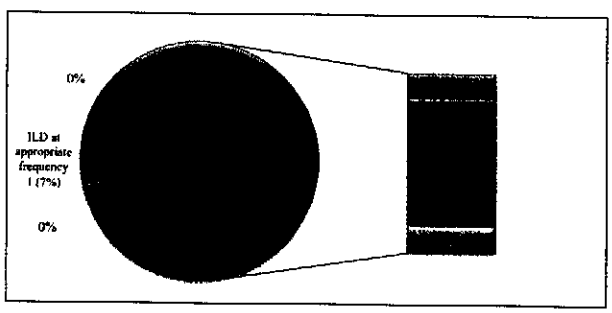
HLD: high-level disinfection

Figure 2: Magill forceps decontamination



HLD: high-level disinfection, NPTP: nasopharyngeal temperature probe

Figure 3: Nasopharyngeal temperature probe decontamination

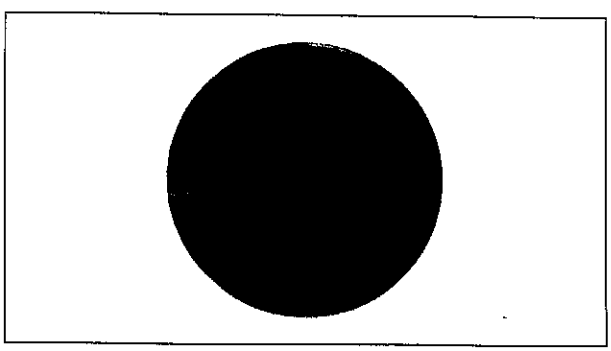


ILD: intermediate-level disinfection

Figure 4: Laryngoscope handle decontamination

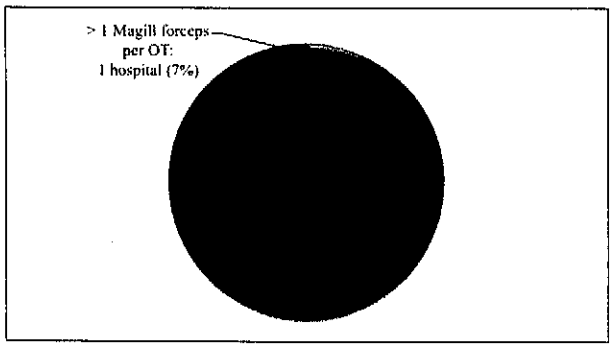
Questions 2 and 3: How many of the Macintosh® 3 and Macintosh® 4 laryngoscope blades are present in each operating theatre? How many Magill forceps are available in each operating theatre?

The results pertaining to Questions 2 and 3 are shown in Figures 5 and 6.



OT: operating theatre

Figure 5: Adequacy of numbers of laryngoscope blades per operating theatre



OT: operating theatre

Figure 6: Adequacy of numbers of Magill forceps per operating theatre

Question 4: With regard to the bowl containing water to clean the suction tubing and suction bowl (Yankauer®) how often is the water changed? How often is the bowl changed?

Table IV: Decontamination of the suction bowl

Hospital	Frequency of changing items	
	Water only	Bowl and water
A	After each patient	Daily
		Weekly
B	After each patient	Daily
C	Daily	Daily
		Not changed
D	After each patient	Not changed
	Daily	
E	Not used	Not used
F	Not used	Not used
G	After each patient	After each patient
H	After each patient	Daily
I	After each patient	After each patient
J	After each patient	Daily
K	After each patient	Not changed
L	After each patient	Not changed
M	After each patient	After each patient
N	After each patient	Daily
O	Daily	Daily

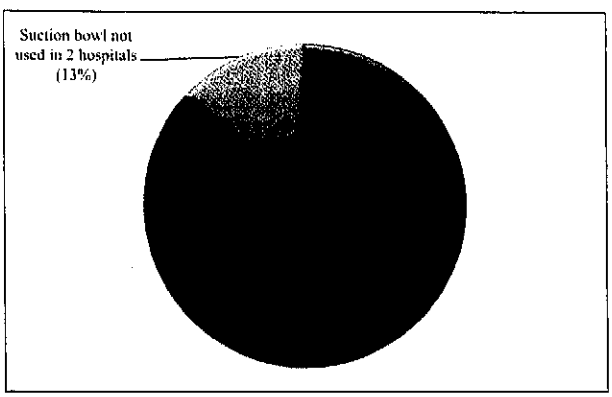


Figure 7: Changing of suction bowl and water

The results pertaining to Question 4 are tabulated in Table IV and shown in Figure 7.

Question 5: With regard to humidification and exchange moisture and filters, describe where they should be placed in the anaesthetic circuitry. Are they routinely used in all or only in selected patients, or are they not routinely used?

Results pertaining to Question 5 on the correct placement of humidification and exchange moisture and filters in the anaesthetic circuitry are depicted in Figure 8. There was incorrect placement of the breathing system filter at only one hospital, where the reusable angle piece was placed between the filter and the facemask. The angle piece was reused without decontamination. All hospitals used a new filter for each patient.

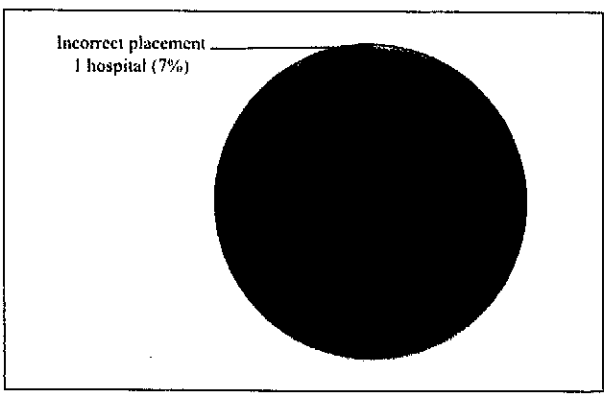
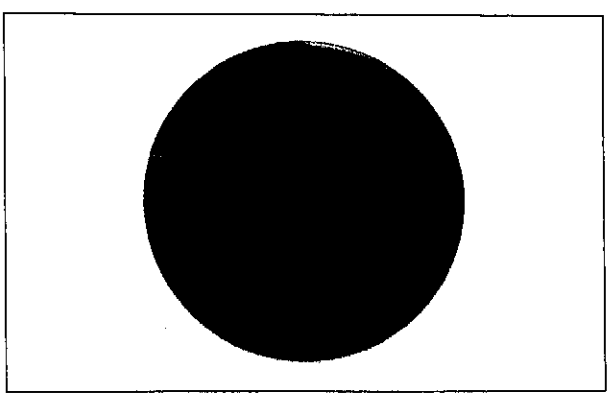


Figure 8: Placement of humidification and exchange moisture and filters in the anaesthetic circuitry

Question 6: Are oropharyngeal airways resued or disposed after each use? If reused, describe their decontamination

Results pertaining to Question 6 on the use of either disposable oropharyngeal airways or reused airways after their sterilisation are tabulated in Table V and is shown in Figure 9. Disposable oropharyngeal airways were used at 12 hospitals. Three hospitals reused them after decontamination by sterilisation.



OPA: oropharyngeal airways

Figure 9: Used oropharyngeal airways

Table V: Type of oropharyngeal airway used

Hospital	Method
A	Disposable
B	Disposable
C	Sterilisation
D	Disposable
E	Disposable
F	Disposable
G	Disposable
H	Disposable
I	Disposables
J	Disposables
K	Disposables
L	Sterilisation
M	Disposables
N	Sterilisation
O	Disposables

Question 7: Describe how self-inflating resuscitation bags (Ambu®) are decontamined?

Results pertaining to Question 7 on Ambu® bag decontamination are tabulated in Table VI and shown in Figure 10. Only one hospital sterilised the Ambu® bag after each use. Thirteen other hospitals used some other method of cleaning. The Ambu® bag was not cleaned between patients at one hospital.

Table VI: Ambu® bag decontamination

Hospital	Method
A	Soap and water
B	Wiped with Biocide D®
C	Wiped with Hibitane®
D	Wiped with Biocide D®
E	Not cleaned
F	Soaked in Biocide D®
G	Soaked in Biocide D®
H	Wiped with Biocide D®
I	Wiped with Hibitane®
J	Wiped with Biocide D®
K	Sterilisation (gas)
L	Soaked in Biocide D®
M	Soap and water
N	Soaked in Biocide D®
O	Soap and water

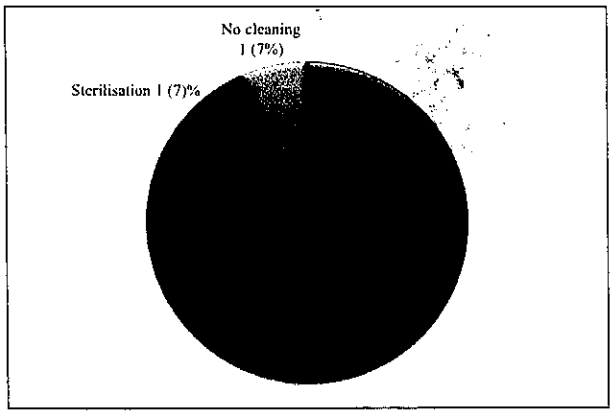


Figure 10: Ambu® bag decontamination

Question 8: Do you feel that you have enough time between each case to adequately clean anaesthetic equipment and still perform your other duties?

Results pertaining to Question 8 on adequacy of time allocated for decontamination are shown in Figure 11.

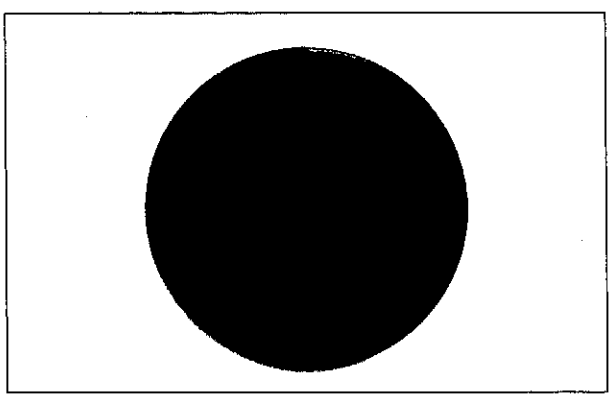


Figure 11: Adequacy of time allocated for decontamination

Discussion

Anaesthesia nurses are responsible for the routine decontamination of anaesthetic equipment. It was clear from their responses that current infection control practices regarding the decontamination of anaesthetic equipment in regional, tertiary and central hospitals in KwaZulu-Natal are poor.

Decontamination of laryngoscope blades, nasopharyngeal temperature probes and Magill forceps require at least HLD or sterilisation, which needs to be carried out in strict accordance with accepted guidelines. With regard to the decontamination of laryngoscope blades, nasopharyngeal temperature probes and Magill forceps, 67%, 60% and 53% of hospitals did not meet the minimum standard required for their reprocessing, respectively. This means that many of the hospitals did not meet the minimum required standards pertaining to decontamination or reprocessing. They either did not practise sterilisation or HLD, or were noncompliant with the HLD protocol, for example, the omission of cleaning prior to immersion.

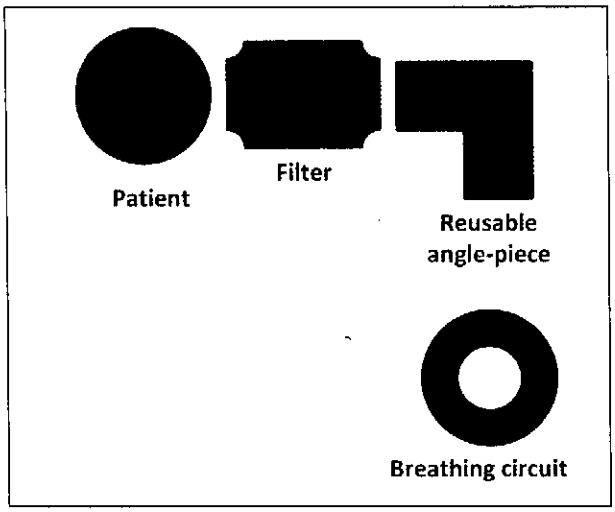


Figure 12: Correct placement of filter

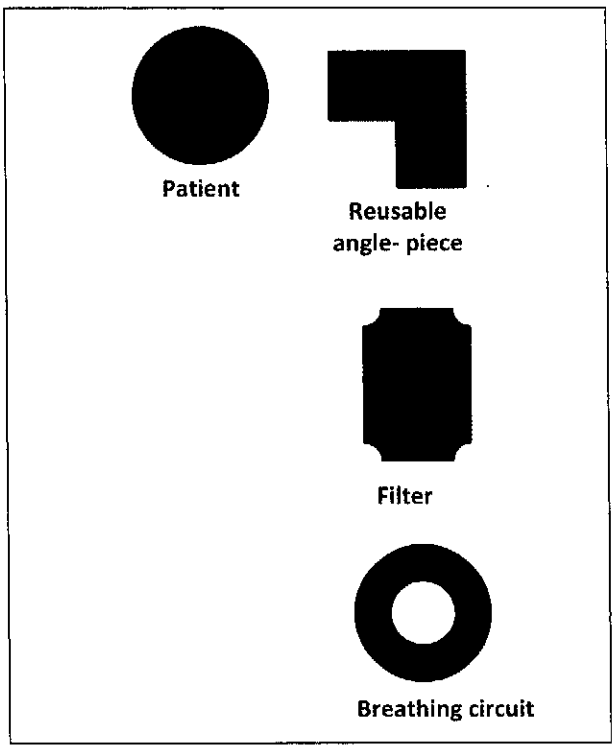


Figure 13: Incorrect placement of filter

The laryngoscope handle presents a potential route for patient-to-patient transmission of blood and organisms from the oropharynx.[10-12] Only one hospital decontaminated laryngoscope handles after each use (Table III and Figure 4).

The suction bowl becomes contaminated with oral secretions, blood and vomitus when the anaesthetist dips the catheter into the water. The catheter is often then reused on a patient. Changing the water only is ineffective as the bowl becomes contaminated with blood and secretions with each use, and will contaminate the clean new water placed in it. Some hospitals also used these bowls as a common receptacle for used laryngeal mask airways and oropharyngeal airways. Of the hospitals that used these bowls, 77% did not decontaminate them between patients.

Breathing system filters significantly reduce the transmission of microbes and other particulate matter in breathing systems.[13-17] If the breathing circuit is to be reused, the use of an effective filter is recommended.[2,18] The position of the filter is also important (Figures 12 and 13). Although all the surveyed hospitals in this study used filters, the filter was placed in an incorrect position on the breathing circuit, behind the angle piece, at one hospital. In this position, the angle piece, which is reused, is not protected from contamination.

Oropharyngeal airways are regularly contaminated with blood and microorganisms.[19] They are for single-patient use only and must be discarded after each use.[2] However, 20% of the surveyed hospitals reused them after sterilisation.

Self-inflating resuscitation devices, e.g. Ambu® bags, are used in resuscitation situations and during the transportation of critically ill patients between the critical care unit and operating theatre, and must be sterilised after each use.[2] Only one hospital practiced appropriate decontamination of the Ambu® bag (Table VI and Figure 10). Paediatric Ambu® bags in the obstetric theatre are used more frequently than adult ones and have been linked with disease transmission.

Our results show that current infection control practices in anaesthesia in regional, tertiary and central hospitals in KwaZulu-Natal are grossly inadequate and inconsistent, with practices varying from one healthcare facility to another, as well as within the same facility. Several factors may be responsible for this. Healthcare professionals may erroneously conclude that the risk of nosocomial infection associated with contaminated anaesthesia equipment is sufficiently low enough to permit complacency and ignorance of minimum reprocessing standards. The varying recorded practices within the same theatre complexes suggest that this is a human factor, i.e. owing to complacency and ignorance. Insufficient time may be allocated to the decontamination process. Our findings also revealed that inadequate numbers of laryngoscope blades and Magill forceps were available per theatre to allow for compliance with the minimum duration of exposure in order to achieve effective HLD in 73% and 93% of hospitals, respectively. Hence, the items are reused according to need, rather than after adequate decontamination. An erroneous concern over cost containment is compromising patient safety.

Furthermore, reprocessing instructions provided by manufacturers of these operating theatre instruments may be incomplete or inadequately communicated, and may also vary from one manufacturer to another. Another pertinent factor was the lack of a comprehensive set of published and endorsed guidelines on infection control in anaesthesia. The contribution of such guidelines by anaesthesia bodies (such as American Society of Anesthesiologists, Association of Anaesthetists of Great Britain and Ireland

and Australian and New Zealand College of Anaesthetists) to standardisation and effective communication of infection control practices and guideline compliance, as well as to the prevention of nosocomial infections in those countries, is indisputable.[1,2,20] However, regulations and guidelines are only effective if coupled with healthcare worker compliance. Therefore, infection control practices should be audited on a regular basis.

A major limitation of this study was that with one-on-one interviews, some of the nurses may have felt compelled to give "the correct answer" instead of describing what was actually practised. Furthermore, only regional, tertiary and central hospitals were surveyed. This begs the question that if such substandard practice is prevalent in academic centres and major hospitals, what practices are being carried out in smaller district hospitals?

Conclusion

Lack of adherence to recommended best practice facilitates the nosocomial transmission of potential pathogens. In light of the high prevalence of many infectious diseases, particularly human immunodeficiency virus, hepatitis B and tuberculosis in KwaZulu-Natal, it is critical that infection control in anaesthesia is urgently addressed. The use of sterilisation for the decontamination of anaesthetic equipment and the use of single-use anaesthetic equipment of appropriate quality must be promoted. There is a need to adopt and standardise decontamination protocols at a national level. Systems must also be established for monitoring and regular auditing of practice.

Conflict of interest

There is no conflict of interest to declare.

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