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Nasopharyngeal Temperature Probes: Is South Africa's Current Decontamination Process Adequate?

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ABSTRACT

BACKGROUND

The standard practice in many institutions incorporates nasopharyngeal probes for temperature monitoring in patients undergoing general anaesthesia. Current disinfection guidelines for these devices are not clear and they are poorly adhered to. In South Africa, these temperature probes are reused and subjected to an unstandardized decontamination processes. This study sought to investigate the nasopharyngeal temperature probe as a possible cross-contaminant and investigate the efficacy of current cleaning practices.

METHOD

This descriptive double-blind study viewed 48 nasopharyngeal temperature probe cultures across the 4 different cleaning protocols. These probes were randomized to a cleaning protocol. The cleaning protocols included water wash, alcohol based wash, dry wipe and (2.4% glutaraldehyde) Cidex® wash. After randomization, the probes were aseptically cultured and inoculated to blood agar plates. After 48hrs of aerobic culture, specimens were examined, and microorganisms identified. Logistic regression analysis assessed the efficacy of these decontamination processes.

RESULTS

Chi-Square analysis [p-value < 0,0001] established the nasopharyngeal temperature probe as a source of cross-contamination. Diverse pathogens were identified on nasopharyngeal temperature probes after exposure to a predetermined cleaning practice. Logistic regression of these cleaning methods [confidence interval of 95%] illustrates Hibitane® and CIDEX® methods as being more effective, yet only the CIDEX® group demonstrated decontamination success in excess of 90%.

CONCLUSION

The data shows that the nasopharyngeal temperature probe is indeed a source of cross-contamination. It goes on to highlight the issue of pathogenic spread due to inadequate decontamination of these temperature probes.

KEYWORDS: Nasopharyngeal temperature probes; Infection Control; Cross-contamination; Decontamination; Hibitane®; CIDEX®

INTRODUCTION

The American Society of Anaesthesiologists recommendation for temperature monitoring states "every patient receiving anaesthesia shall have temperature monitored when clinically significant changes in body temperature are intended, anticipated or suspected"[1]. As consequence of this recommendation, temperature monitoring is considered standard of care in most general anaesthesia procedures. The most frequently used temperature monitor is the nasopharyngeal temperature probe.

Infection control in anaesthesia in South Africa, a national guideline published by South African Society of Anaesthesiologist[2], recognizes these temperature probes as semi-critical devices. Semi-critical devices refer to equipment that makes contact with patient mucosa or non-intact skin. SASA guidelines recommend that nasopharyngeal temperature probes require sterilization after each use. This same document goes on to advocate for sufficient numbers of temperature probes to be present in each operating theatre.

International infection control guidelines recommend high-level disinfection for these semi-critical devices[3]. High-level disinfection requires removal of any physical material by means of washing the probe, bathing the device in disinfectant for a specified period of time and concluding with the rinsing of residual disinfectant. This ideal is often not realized in resource-constrained facilities.

Anaesthesia equipment, as a cross-contaminant, has previously been explored. Investigations into the infectious potential of laryngoscope blades and handles as well as bronchoscopy equipment encompass the bulk of this literature.

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[4–12] The nasopharyngeal probe has not previously been investigated as a pathogen vector.

The laryngoscope, a proven cross-contaminant, enjoys minimal time in contact with mucosal surface. In contrast the nasopharyngeal temperature probe remains in situ for the duration of the procedure. The risk to patient health and safety may prove greater than the established risk with routine laryngoscope usage.

There are concerns regarding the decontamination of these devices, adding to the notion of infectivity. Doctors Samuel and Gopalan proved that recommended infection control practices were not strictly adhered to in KwaZulu–Natal, South Africa[13]. Their study identified that the current decontamination practices for nasopharyngeal temperature probes include:

- Washing with soap and water
- Dry wipe
- Washing with water then bathing in (2.8% chlorhexidine) Hibitane
- Washing with water then bathing in (2.4%glutaraldehyde) CIDEX

The pathogen vector potential of anesthesia devices is well documented; however, the nasopharyngeal temperature probe has not been examined. Based on this fact and the knowledge of inappropriate decontamination processes it is postulated that the temperature probe may as act as a cross-contaminant. The authors aim to investigate the nasopharyngeal temperature probe as a pathogen vector, and secondly explore the efficacy of the current decontamination practice.

METHODOLOGY

Ethical approval was obtained from Stellenbosch University Health and Research council; further approval was obtained from Tygerberg Hospital National Health and Laboratory Service. The research was conducted in accordance with the Helsinki Declaration.

Tygerberg Hospital's Microbiology department participation was acquired.

This comparative and descriptive double-blind study reviewed 48 nasopharyngeal temperature probe cultures randomized to four decontamination practices. These practices included:

- Washing with soap and water
- Dry wipe
- Washing with water then bathing in Hibitane
- Washing with water then bathing in CIDEX

Randomization was performed by a computer-generated program, allowing for 12 probes in each group. All adult patients already assigned a nasopharyngeal temperature probe in Tygerberg Hospital theatre complex were considered eligible for this study. Children and patients with nasal or oropharyngeal pathology were excluded from participation.

During a two-month period, used nasopharyngeal temperature probes underwent a decontamination process as per the randomization process.

Theatres were assigned sealed instructions detailing the cleaning process to be followed. The anaesthesia assistant executed the assigned decontamination instructions as received in concealed envelope.

The probes were then cultured by a single data collector and immediately transferred to the laboratory. These specimens were marked with a study number. No patient demographic details were collected. Both investigator and laboratory staff were blinded to the decontamination method.

The probes were inoculated onto an agar petri dish. Reports of any non-commensal bacterial growths were generated after 48 hours of aerobic culture.

Contamination, in the context of this study, was viewed as any microbial activity over and above respiratory commensals.

Logistic regression and Chi-Square analysis were performed comparing the cleaning methods in terms of decontamination success.

RESULTS

During a two-month collection period, 48 samples were collected, with 12 samples in each pre-determined decontamination group. As depicted in Table 1, of all probes cultured 45.8% were found to have bacterial contamination. From the four cleaning methods, dry wipe techniques as well as water and soap methods were found to be highly ineffective with decontamination rates of 16,7% and 33% respectively.

Decontamination Method	Contamination		Total
	Not Contaminated (%)	Contaminated (%)	
Hibitane®	9 (75.0)	3 (25)	12
Water-wipe	4 (33.3)	8 (66.7)	12
Dry wipe	2 (16.7)	10 (83.3)	12
CIDEX®	11 (91.7)	1 (8.3)	12
Total	26 (54.2)	22 (45.8)	48

The association between contamination status and the cleansing methods was assessed using the Pearson chi-square test. The chi-square test revealed statistical association between the contamination processes and the four cleaning methods (chi-square statistic of 17.79 and P value <0.0001).

Binary Logistic regression model further assessed association between cleaning methods and contamination status. As could be seen in Table 2, a statistically significant difference was observed between water-wipe and the dry wipe methods in comparison to the Hibitane® method. These two methods are found to be significantly inferior to the Hibitane® method. The odds of being contaminated when water-wipe is used as a cleaning method is 6 times (with 95% CI (1.018, 35.374)) that of Hibitane® method. No statistically significant difference was observed between the CIDEX® cleaning method and Hibitane®.

The Hibitane® and CIDEX® group showed improved decontamination results. In these groups, probes were washed with water then laid in Hibitane® and CIDEX® respectively for period of five minutes. In the Hibitane® group the decontamination rate improved to 75%, with Staphylococcus Epidermidis being the most cultured organism in this group. This organism holds low virulence; however, this coagulase-negative staphylococcus has been linked to severe complications in patients with prostheses. The CIDEX® group showed 91.7% decontamination success. One probe cultured Micrococcus specie, which has very low virulence.

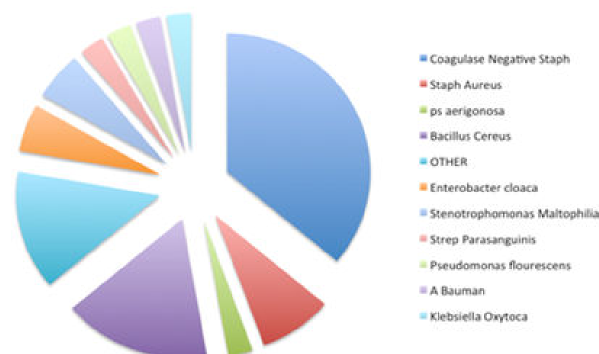
Table 2: Logistic regression for the test of association between Methods and contamination status

	Estimate	S.E	Wald	df	Sig.	OR	95% CI for OR	
							Lower	Upper
Hibitane® (*ref.*)			13.582	3	0.004			
Water-Wipe	1.792	0.905	3.918	1	0.048	6.000	1.018	35.374
Dry-wipe	2.708	1.022	7.021	1	0.008	15.000	2.024	111.174
CIDEX®	-1.299	1.239	1.100	1	0.294	0.273	0.024	3.093
Constant	-1.099	0.667	2.716	1	0.099	0.333		

Overall, we observed that the Hibitane® and CIDEX® decontamination methods are superior to the water-wipe and dry-wipe methods. In this relatively small sample size no statistically significant difference can be demonstrated between the Hibitane® and CIDEX® groups.

Further exploration of the microbial load of each probe revealed organisms cultured in the above-mentioned decontamination methods. This analysis is inclusive of all microbial growth on the probe, with the deliberate exclusion of respiratory flora. As depicted in Figure 1, the organisms cultured included Staphylococcus Aureus, Streptococcus Epidermis and Haemolytica; Pseudomonas Aeruginosa and Acinetobacter Baumani, amongst other organisms. The pathogenic effects of these organisms are well documented, and although the objective of this study was not to assess the virulence of these organisms nor claim correlation between our decontamination practices and postoperative complications, it has to be borne in mind as to the potential adverse effects of our daily practice.

Figure 1: MICROBIAL LOAD ON CONTAMINATED PROBES



DISCUSSION

It is considered an international standard to monitor temperature in patients receiving anaesthesia[14]. Perioperative thermoregulation and temperature monitoring are vital, as it alerts the anaesthesia practitioner to hypo or hyperthermia, as extremes of temperature are associated with grave systemic complications.[15]Theatre complexes both locally and internationally indicated that nasopharyngeal probes are the most commonly used perioperative temperature monitor.[16]

The South African Society of Anaesthesiologists published Infection control guidelines in 2014, in which they recommend the sterilization of nasopharyngeal temperature probes. In that same document SASA recommends that multiple probes be available in each theatre.[2]

As stated above the national infection control guidelines propose sterilization of nasopharyngeal temperature probes[2] The majority of theatre complex sterilization techniques call for the application of heat. These include processes such as autoclaving, gassing or steaming equipment.

Concern exists regarding the malfunction of temperature probes when exposed to high temperature sterilization methods. This sentiment is shared amongst temperature probe manufacturers. Many manufacturers advocate for single use of these devices.

The nasopharyngeal temperature probe is considered a semi-critical device as it is a device that comes into contact with mucosal membranes. International literature regarding semi-critical devices advocates for high-level disinfection processes.

These ideals and recommendations put forward by the various bodies have proven to be a difficult benchmark in resource-constrained environments. Non-compliance to national and international infection control guidelines[2,15,18], the lack of institutional decontamination protocols and miseducation[13] has led to the use of non-standardized and non-recommended cleaning practices for used nasopharyngeal temperature probes. This research investigated these practices and sought to ascertain evidence-based recommendations for the decontamination process of nasopharyngeal temperature probes.

The results presented confirms the inefficiency of current cleaning practices and the confirmation that the nasopharyngeal

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temperature probe is indeed a pathogen vector. In the data set, the cleaning methods commonly in use were assessed with logistic regression analysis. Statistically significant data depicts current decontamination protocols as being ineffective. Dry Wipe and Water-wash techniques are performed particularly poorly, with decontamination success at 16 and 33% respectively.

Hibitane® obtained decontamination success of 75%, not surprisingly outperformed by CIDEX® with 91.7% decontamination success.

In light of potential probe malfunction with heat sterilization and rapid patient turnover, developing countries view high-level disinfection is an attractive alternative in decontamination of these potentially infective probes. Summation of the tested methods indicates the usefulness of Hibitane® and CIDEX®, as high-level disinfection practices.

As far back as 1977, Hibitane® was observed as a super-cleaner specifying multiple mechanisms for its perceived efficacy.[19] It is currently believed that Hibitane® is not full proof. An aptly named editorial by Wang et al describes Hibitane® as a "useful tool, not a panacea"[20].In that document Wang reviews Hibitane®, giving credence to the disinfectants anti-gram positive effect and heralds its long residual activity against gram positive organisms yet reports an inferior action against gram-negatives and other organisms. These features could account for the presence of Candida albicans cultured in the Hibitane® group. Despite its reported effectivity on gram-positive organisms, Coagulase negative Staphylococcus Epidermidis was cultured on more than one occasion.

The CIDEX® group had 1 positive culture.

The single contaminated probe was discovered to be due to an ineffective first stage of high-level disinfection. In the case of this contaminant, the temperature probe placed in CIDEX® with nasopharyngeal blood and residue. The stages of high-level disinfection includes firstly cleaning instrument of any visible contamination, followed by immersion in CIDEX® and then removal of disinfectant.

In contrast to Hibitane®,CIDEX® provides a wide spectrum efficacy against bacteria, viruses and fungi. In addition CIDEX® has a proven potent action against Mycobacterium Tuberculosis[21].CIDEX has been linked to skin and mucosal irritation, as well as allergenic processes including asthma and bronchitis[22]. Experts advise a thorough rinse of the device after disinfection.

Researchers have demonstrated that the distinction between sterilization techniques and high-level disinfection may be theoretical. Muscarella, in Journal of Infection Control, reviewed these techniques in light of semi-critical instruments and surmised that high-level disinfection was not associated with higher infection rate than that of sterilization[23].

The nasopharyngeal temperature probe as potential pathogen vector has not previously been explored.

Historically literature focusing on anaesthesia equipment[6,7,24–28] has neglected the nasopharyngeal temperature probe, with greater focus being placed on laryngoscopes and endoscopic equipment as well as the anaesthesia workstation. These devices are proven cross-contaminators to both patient and staff.

There is no doubt that ineffective practice poses a great financial burden, but as clinicians the more pertinent question is that of patient welfare. In 2006 a Pseudomonas aeruginosa outbreak in a neonatal intensive care unit was directly linked to the deaths of 2 infants. A team of experts traced the outbreak back to the institutes theatre complex, where the inadequate decontamination processes of laryngoscopes were found to be colonized with strains of pathogens identical to the strains found in the neonatal unit[29].

In the current research the Chi-Square analysis indicates that the nasopharyngeal temperature probe hosts a multitude of pathogenic microbes, as such the probe is a cross-contaminant. The ongoing use of non-recommended practices may therefore be linked to postoperative complications.

Assessment of postoperative complications was not the objective of this study, however the rate and number of pathogens cultured raised concern. This concern is heightened when one considers the incidence of immune impairment amongst the population serviced in Southern Africa, coupled with the immunosuppressive effects of surgery and anaesthesia independent of host immunity.[30–33]HIV/AIDS, diabetes mellitus and various oncological and autoimmune compromised patients are particularly at risk with this ineffective cleaning processes.[34]

The microbiologists involved in this study reported on aerobic microbial growth, with the deliberate exclusion of respiratory flora. 42% of all probes showed contamination, particularly in the Water-wash and Dry-wipe groups. Organisms cultured in order of prevalence range from forms of coagulase negative staphylococci, Bacillus Cerulli, Staphylococcus Aureus, Pseudomonas Aeruginosa, Klebsiella Pneumonia and others.

With the exception of Bacillus Cerulli, all the cultured organisms pose infectious risk. Particular emphasis is placed on the Staphylococcus Aureus, Pseudomonas Aeruginosa and Klebsiella species. Australian authors in the Journal of Clinical Microbiology in 2015 reported Staphylococcus Aureus as the leading cause for bacteraemia, infective endocarditis, pulmonary and dermatological infections worldwide. The authors make special mention of device-related infections and health care-associated infections and the growing incidence of Methicillin Resistant Staphylococci.[35]

Pseudomonas Aeruginosa is a gram-negative bacterium, presenting an array of severe infections, of particular concern to immune compromised patients.

This organism demonstrates a host of evasive mechanisms, as a result a 2017 article by Moradali et al ranked Pseudomonas Aeruginosa as one of the deadliest microbes to date.[36]

American researcher, Dr Martin, published Colonization, Infection, and the Accessory Genome of Klebsiella pneumonia in 2018[37]. In this article the author tables the hypervirulent,

drug-resistance patterns of the opportunistic gram-negative pathogen.

The investigation aimed to identify non-commensal microbial pathogens.

Fungal growths did not fall into the identified aims, but the shear presence and load of the fungi was highlighted by the laboratory, with the culture of Candida Albicans species. This discovery denotes that in the light of certain inferior decontamination practices the presence of cross-contaminants may be vast, although the authors focused on aerobic microbes the potential pathogens may include viruses, fungi and non-aerobes.

The present research highlights the nasopharyngeal temperature probe as a cross-contaminant, a matter compounded by poor decontamination practices.

The author thus recommends high-level disinfection protocol of nasopharyngeal temperature probes in all theatre complexes, with subsequent training and evaluation of all relevant staff. This proposed protocol would eliminate wasteful usage of non-recommended substances and potentially save on theatre costs, as the recommended high-level disinfectants are commonplace in many institutions.

LIMITATIONS

The impact of this contextual study is limited by the sample size.

The sample number was limited by financial constraints, which led to the authors focus on microbe pathology in a qualitative manner.

Quantifying bacterial load, presence of non-microbial pathogens as well virulence testing would strengthen the data and are suggested variables to incorporate in future research.

CONCLUSION

A high theatre demand, heavy patient burden and financial constraints are important considerations when reviewing the non-compliance to infection control guidelines. These factors have led to application of non-recommended cleaning techniques which pose threat to patient health and safety.

The data shows that the nasopharyngeal temperature probe is indeed a source of cross-contamination. It goes on to highlight the issue of pathogenic spread due to inadequate decontamination of these temperature probes.

This study demonstrates a greater than 90% decontamination rate following the use of CIDEX®, a practice in keeping with international literature which supports high-level disinfection for these semi-critical devices. The author therefore recommends high-level disinfection of nasopharyngeal temperature probes as well as the generation and implementation of protocols detailing adequate decontamination and the correct training of staff regarding said protocol in all units utilizing and reusing nasopharyngeal temperature probes.

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