

**Original Article****Open Access****Nasopharyngeal temperature probes: is South Africa's current decontamination process adequate?**

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*Correspondence to: ryand@sun.ac.za**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 unstandardized decontamination processes. This study sought to investigate nasopharyngeal temperature probes as possible source for cross-contamination, and assess the efficacy of current disinfection practices for these probes.

Methodology: This was an analytical double-blind randomized study of 4 different disinfection protocols for 48 nasopharyngeal temperature probes. The probes were randomized to disinfection protocols that included water wash, dry wipe, hibitane® and cidex® wash. After decontamination by the respective protocol, the probes were aseptically placed in nutrient broths, manually agitated and removed, and the broths were then inoculated onto blood agar plates. After 48 hours of aerobic culture incubation at 37°C, plates were examined for growth and bacteria identified using automated bioMérieux Vitek-2 microbial identification system. Chi square and logistic regression analyses were used to assess bacterial contamination rates of the disinfected probes, in order to infer the efficacy of the decontamination processes.

Results: Of the 48 nasopharyngeal temperature probes disinfected by the different protocols, 22 (45.8%) had bacterial contamination, with frequency of isolation for coagulase negative staphylococci (44%), *Bacillus cereus* (20%), *Staphylococcus aureus* (10%), *Enterobacter cloaca* (7%), *Pseudomonas aeruginosa* (4%), *Pseudomonas fluorescens* (3%), *Acinetobacter baumannii* (3%), amongst other bacterial species. Dry wipe, and water and soap methods, had statistically significant higher contamination rates of 83.3% and 66.7% than hibitane® and cidex®, with 25.0% and 8.3% respectively ($X^2=17.69$, $p<0.0001$). The odds of contamination when water-wipe was used as a cleaning method was 6 times (OR=6.000; 95% CI=1.018-35.374, $p=0.048$) that of hibitane® method while the odds for dry-wipe was 15 times (OR=15.000, 95% CI=2.024-111.174, $p=0.008$). No statistically significant difference was observed in the contamination rates between cidex® and hibitane® disinfection methods (OR=0.273, 95% CI=0.024-3.093, $p=0.294$).

Conclusion: These data shows that nasopharyngeal temperature probes are possible source of cross-contamination and pathogen transmission due to inadequacy of the decontamination processes for these temperature probes.

Keywords: nasopharyngeal probe; cross-contamination; decontamination; hibitane®; cidex®; infection control

Received Sept 19, 2021; Revised Oct 25, 2021; Accepted Oct 29, 2021; Published online Jan 18, 2022

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Sondes de température nasopharyngées: le processus de décontamination actuel en Afrique du Sud est-il adéquat?

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Contexte: La pratique standard dans de nombreux établissements incorpore des sondes nasopharyngées pour la surveillance de la température chez les patients subissant une anesthésie générale. Les directives de désinfection actuelles pour ces appareils ne sont pas claires et elles sont mal respectées. En Afrique du Sud, ces sondes de température sont réutilisées et soumises à des procédés de décontamination non standardisés. Cette

étude visait à étudier les sondes de température nasopharyngées comme source possible de contamination croisée et à évaluer l'efficacité des pratiques de désinfection actuelles pour ces sondes.

Méthodologie: Il s'agissait d'une étude analytique randomisée en double aveugle de 4 protocoles de désinfection différents pour 48 sondes de température nasopharyngées. Les sondes ont été randomisées dans des protocoles de désinfection comprenant un lavage à l'eau, un essuyage à sec, un lavage à l'hibitane® et au cidex®. Après décontamination par le protocole respectif, les sondes ont été placées de manière aseptique dans des bouillons nutritifs, agitées et retirées manuellement, et les bouillons ont ensuite été inoculés sur des plaques de gélose au sang. Après 48 heures d'incubation de culture aérobie à 37°C, les plaques ont été examinées pour la croissance et les bactéries identifiées à l'aide du système d'identification microbienne automatisé bioMérieux Vitek-2. Des analyses du chi carré et de régression logistique ont été utilisées pour évaluer les taux de contamination bactérienne des sondes désinfectées, afin de déduire l'efficacité des processus de décontamination.

Résultats: Sur les 48 sondes de température nasopharyngées désinfectées par les différents protocoles, 22 (45,8%) présentaient une contamination bactérienne, avec fréquence d'isolement pour les staphylocoques à coagulase négative (44%), *Bacillus cereus* (20%), *Staphylococcus aureus* (10%), *Enterobacter cloaca* (7%), *Pseudomonas aeruginosa* (4%), *Pseudomonas fluorescens* (3%), *Acinetobacter baumannii* (3%), parmi d'autres espèces bactériennes. Les méthodes d'essuyage sec et d'eau et de savon avaient des taux de contamination statistiquement plus élevés de 83,3 % et 66,7 % que l'hibitane® et le cidex®, avec respectivement 25,0% et 8,3% ($\chi^2=17,69$, $p<0,0001$). Le risque de contamination lorsque l'essuyage à l'eau était utilisé comme méthode de nettoyage était 6 fois (OR=6,000; IC à 95%=1,018-35,374, $p=0,048$) celui de la méthode hitane® tandis que le risque pour l'essuyage à sec était de 15 fois (OR=15,000, IC à 95%=2,024-111,174, $p=0,008$). Aucune différence statistiquement significative n'a été observée dans les taux de contamination entre les méthodes de désinfection cidex® et hitane® (OR=0,273, IC à 95 %=0,024-3,093, $p=0,294$).

Conclusion: Ces données montrent que les sondes de température nasopharyngées sont une source possible de contamination croisée et de transmission d'agents pathogènes en raison de l'insuffisance des processus de décontamination de ces sondes de température.

Mots-clés: sonde nasopharyngée; contamination croisée; décontamination; hitane®; cidex®; contrôle d'infection

Introduction:

The recommendation of the American Society of Anaesthesiologists for temperature monitoring is that "every patient receiving anaesthesia shall have temperature monitored when clinically significant changes in body temperature are intended, anticipated or suspected" (1). As a 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. The international infection control guidelines recommend high-level disinfection for these semi-critical devices (2). 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 source of cross-contamination 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 (3–8). The nasopharyngeal probe has not previously been investigated as a vehicle for pathogen. In contrast to the laryngoscope, another proven source of cross-contamination with minimal contact time with mucosal surface, the nasopharyngeal temperature probe remains in situ

for the duration of the procedure. The risk to patient health and safety with nasopharyngeal temperature probe 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. Samuel et al., (9) reported in their study that recommended infection control practices were not strictly adhered to in South Africa, and identified the current decontamination practices for nasopharyngeal temperature probes to include; (i) washing with soap and water; (ii) dry wipe; (iii) washing with water then bathing in 4% chlorhexidine (hibitane®), and (iv) washing with water followed by bathing in 2.4% glutaraldehyde (cidex®). None of these methods align with the national guidelines, however cidex® decontamination aligns with international high-level disinfection method.

The potential of anaesthesia devices to serve as vehicle for pathogen transmission is well documented, however the nasopharyngeal temperature probe has not been previously investigated. Based on this fact and the knowledge of inappropriate decontamination processes, it is postulated that temperature probe may as act as a source of cross-contamination. We therefore sought to investigate the nasopharyngeal temperature probe as a vehicle for pathogen transfer, and assess the efficacy of the current decontamination practices in our hospital.

Materials and method:

Study setting and ethical approval

The study was conducted at the Tygerberg Hospital theatre complex, Cape Town, South Africa between February and June 2019. Ethical approval was obtained from Stellenbosch University Health Research and Ethics Committee (HREC S17/03/057). Microbiologist aides were enlisted for the study, and the research was conducted in accordance with the Helsinki Declaration.

Study design and protocol

This was an analytical double-blind study of 48 nasopharyngeal temperature probes used on adult patients at the theatre complex of the hospital, randomized into four decontamination procedures; group 1: washing with soap and water; group 2: dry wipe; group 3: alcohol-based decontamination by washing first with water followed by bathing in hibitane® for a period of 5 minutes; and group 4: washing first with water followed by bathing in cidex® for a period of 5 minutes. Randomization was performed by a computer-generated program, allowing for 12 probes in each group. Children and patients with nasal or oropharyngeal pathology were excluded from the study.

The used nasopharyngeal probes were decontaminated based on the randomization group. Theatres were assigned sealed instructions detailing the cleaning process to be followed, and anaesthesia assistants executed the assigned decontamination instructions as received in concealed envelope. The study was conducted between February and June, 2019.

Laboratory procedure

The nasopharyngeal probes were first cultured by immersing 5-8 cm of the probes in test tubes containing nutrient broth under sterile condition by a single data collector and immediately transferred to the laboratory. Each test tube was marked with a study number. No patient demographic details were collected, and both investigator and laboratory staff were blinded to the decontamination method.

In the laboratory, the nutrient broths containing the immersed probes were manually agitated, removed, and the broths inoculated onto a prepared blood agar plates in

Petri dishes. The plates were incubated aerobically at 37°C for 48 hours. Microbial identification was done using the automated Vitek-2 microbial identification system (bioMérieux, Marcy-l'Étoile, France). Contamination, in the context of this study, was reported as any isolate of microbial growth.

Statistical analysis of data

Contamination rates were calculated for each decontamination process. Logistic regression and Chi-square analyses were used to compare contamination rates between the decontamination procedures, and $p < 0.05$ was considered statistically significant.

Results:

As depicted in Table 1, of all the 48 nasopharyngeal temperature probes randomized into 4 decontamination procedures, 22 (45.8%) had bacterial contamination, with dry wipe and water and soap methods, having statistically significant higher contamination rates of 83.3% and 66.7% than hibitane® and cidex®, with 25.0% and 8.3% respectively ($\chi^2 = 17.69$, $p < 0.0001$).

Binary logistic regression model showed in Table 2, a statistically significant difference between water and dry-wipe methods in comparison to the hibitane® method, with these two methods having significantly higher contamination rates, and therefore inferior to hibitane® as decontamination methods. The odds of contamination when water-wipe was used as a cleaning method was 6 times (OR = 6.000; 95% CI = 1.018-35.374, $p = 0.048$) that of hibitane® method, while the odds for the dry-wipe was 15 times (OR = 15.000, 95% CI = 2.024-111.174, $p = 0.008$). No statistically significant difference was observed between the cidex® and hibitane® decontamination methods (OR = 0.273, 95% CI = 0.024-3.093, $p = 0.294$).

Fig. 1 shows the frequency distribution of bacterial isolates recovered from cultures of decontaminated probes and these include; coagulase negative staphylococci (44%), *Bacillus cereus* (20%), *Staphylococcus aureus* (10%), *Enterobacter cloaca* (7%), *Pseudomonas aeruginosa* (4%), *Pseudomonas fluorescens* (3%), *Acinetobacter baumannii* (3%), amongst other bacterial species.

Table 1: Contamination rates of nasopharyngeal temperature probes with respect to decontamination methods

Decontamination method of probe	Contamination rate		X ²	p value
	Not Contaminated (%)	Contaminated (%)		
Hibitane® (n=12)	9 (75.0)	3 (25.0)	17.79	<0.0001*
Water-wipe (n=12)	4 (33.3)	8 (66.7)		
Dry wipe (n=12)	2 (16.7)	10 (83.3)		
Cidex® (n=12)	11 (91.7)	1 (8.3)		
Total (n=48)	26 (54.2)	22 (45.8)		

* = statistically significant; X² = Chi square

Table 2: Logistic regression for the test of association between decontamination methods and contamination rates of nasopharyngeal probes

Decontaminants	Estimate	S. E.	Wald	df	p value	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		

S. E = standard error; OR = odds ratio; CI = confidence interval; ref = reference

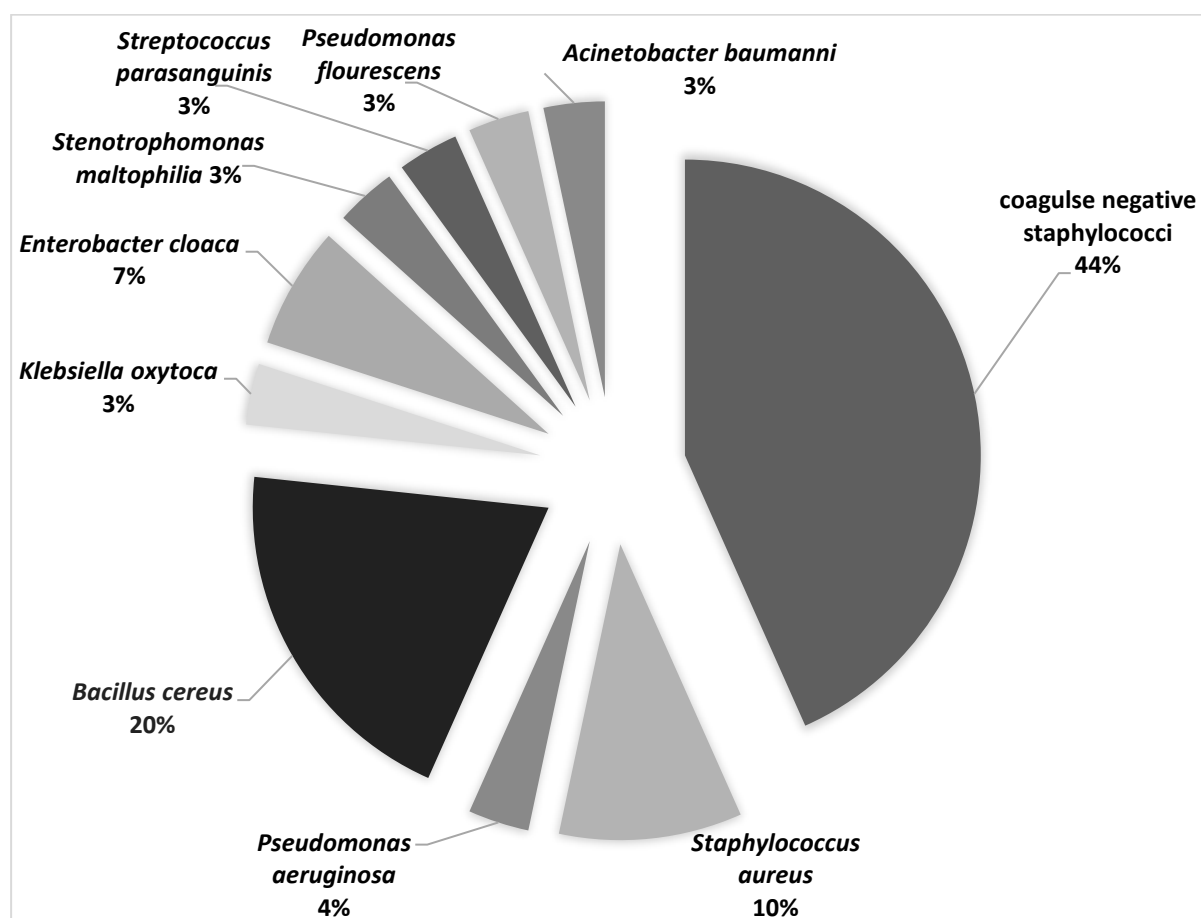


Fig 1: Frequency distribution of bacterial isolates from decontaminated nasopharyngeal temperature probe cultures

Discussion:

It is considered an international standard to monitor temperature in patients receiving anaesthesia. Perioperative thermoregulation and temperature monitoring are vital, as it alerts the anaesthesia practitioner to hypothermia or hyperthermia, because extremes of temperature are associated with grave systemic complications (10). Theatre complexes both locally and internationally have indicated that nasopharyngeal probes are the most commonly used perioperative temperature monitor (11).

The South African Society of Anaesthesiologists (SASA) published infection control guidelines in 2014 recommending sterilization of nasopharyngeal temperature probes, and multiple probes be available in each theatre (12). As the national infection control guidelines propose sterilization of nasopharyngeal temperature probes (12), majority of theatre complex call for the application of heat as sterilization techniques, including processes such as autoclaving (steam sterilization) and gas sterilization. However, concern exists regarding the malfunction of temperature probes when exposed to high temperature sterilization methods. This sentiment was shared amongst temperature probe manufacturers, and many of them advocated 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 (10,12,13), lack of institutional decontamination protocols and miseducation (9), have led to the use of non-standardized and non-recommended cleaning practices for nasopharyngeal temperature probes. Our study investigated these practices and sought to ascertain evidence-based recommendations for the decontamination process of nasopharyngeal temperature probes.

The results of our study confirmed the inefficiency of some current cleaning practices and confirmed that decontaminated nasopharyngeal temperature probes can indeed be a vehicle for pathogen transmission. Statistical analyses by Chi square and logistic regression of our data showed some current decontamination protocols as being ineffective. Dry wipe and water-wash techniques particularly performed poorly, with decontamination success rates of only 16% and 33% respectively. Hibitane achieved decontamination success

rate of 75% but not surprisingly, was outperformed by cidex® with 91.7% decontamination success rate.

In light of potential probe malfunction with heat sterilization and rapid patient turnover, developing countries view high-level disinfection as an attractive alternative in decontamination of these potentially contaminable probes. Summation of the tested methods indicates the usefulness of hibitane® and cidex®, as high-level disinfection practices. Cidex® provides particular benefit as it has a wide spectrum of activity against bacteria, viruses and fungi, in addition to proven potent action against *Mycobacterium tuberculosis* (14). Some researchers have reported that the distinction between sterilization and high-level disinfection may be theoretical. Muscarella (15), reviewed these techniques in light of semi-critical instruments and surmised that high-level disinfection was not associated with higher infection rate than sterilization (16).

Nasopharyngeal temperature probe as potential vehicle for pathogen transfer has not been previously explored. Historically, literatures focusing on anaesthesia equipment (4,5, 17-19) have apparently neglected nasopharyngeal temperature probe, with greater focus on laryngoscopes and endoscopic equipment as well as anaesthesia workstation. However, our study showed that these devices are proven cross-contaminators to both patient and staff. In a closely-related study of decontamination procedure for nasal endoscopes with water and soap, alcohol-based wash and cidex® immersion, only cidex® immersion strategy was effective against all inoculated organisms (8). The findings of this study are congruent with our current study.

Aerobic microbial growth in this study showed that 42% of all the probes were contaminated, particularly in the water-wash and dry-wipe groups. Bacteria isolated from contaminated probes in order of frequency were coagulase negative staphylococci (44%), *Bacillus cereus* (20%), *Staphylococcus aureus* (10%), *Enterobacter cloaca* (7%), *Pseudomonas aeruginosa* (4%), amongst others. With the exception of *Bacillus cereus*, all the cultured organisms pose significant infectious risk, contributing wholly or in part to certain postoperative morbidity and mortalities.

Assessment of postoperative complications was not the objective of this study, however the high contamination rates of the decontaminated probes and the types of pathogens cultured raise serious concern, especially when one considers the incidence of immune impairment amongst the population serviced in Africa, coupled with the immunosuppressive effects of surgery and anaesthesia on the host immune system (20-23). Patients

with HIV/AIDS, diabetes mellitus and various oncological and autoimmune conditions are particularly at risk of infection from the use of with these ineffective cleaning procedures (24). Although, limited by small sample size, the present study highlights nasopharyngeal temperature probes as possible source of cross-contamination, and cautions against the use of non-standardized decontamination processes.

Conclusion:

A high theatre demand, heavy patient burden and financial constraints are important considerations when reviewing the non-compliance with infection control guidelines. These factors have led to application of non-recommended cleaning techniques which pose significant threat to patient health and safety. The findings of our study show that decontaminated nasopharyngeal temperature probes can indeed be a source of cross-infection and pathogen transmission, due to inadequacy of the decontamination processes for these temperature probes. The 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.

Funding:

Authors received financial support for the research from the South African Society of Anaesthesiologists in form of Jan Pretorius Research Fund.

Conflict of interest:

Authors declare no conflict of interest

References:

- American Society of Anaesthesiologists. Standards for basic anaesthetic monitoring. 2015; 1-4.
- PIDAC. Best Practices for Cleaning, Disinfection and Sterilization of Medical Equipment/Devices in All Health Care Settings. Health Care. 2010.
- Negri De Sousa, A. C., Vilas Boas, V. A., Levy, C. E., and Pedreira De Freitas, M. I. Laryngoscopes: Evaluation of microbial load of blades. *Am J Infect Contr.* 2016; 44 (3): 294-298.
- Machan, M. D. Infection control practices of laryngoscope blades: A review of the literature. *AANA J.* 2012; 80: 274-278.
- Telang, R., Patil, V., Ranganathan, P., and Kelkar, R. Decontamination of laryngoscope blades: is our practice adequate? *J Postgrad Med.* 2010; 56 (4): 257-261.
- Choi, J. H., Cho, Y. S., Lee, J. W., Shin, H. B., and Lee, I. K. Bacterial contamination and disinfection status of laryngoscopes stored in emergency crash carts. *J Prev Med Publ Hlth.* 2017; 50 (3): 158-164.
- Petersen, B. T., Chennat, J., Cohen, J., et al. Multi-society guideline on reprocessing flexible gastrointestinal endoscopes: *Gastrointestinal Endoscopy.* 2011.
- Bradford, B. D. Disinfection of Rigid Nasal Endoscopes Following In Vitro Contamination. *JAMA Otolaryngol. Head Neck Surg.* 2013; 139 (6): 1.
- Samuel, R., Gopalan, P., Coovadia, Y., and Samuel R. Infection control in anaesthesia in regional, tertiary and central hospitals in KwaZulu-Natal. Part 2: Equipment contamination. *Southern Afr J Anaesth Analg.* 2013; 19 (3): 146-151.
- World Health Organization. WHO Guidelines for Safe Surgery 2009.
- Torossian, A. Thermoregulation in Europe Monitoring and Managing Patient Temperature (TEMMP) Study Group. Survey on intraoperative temperature management in Europe. *Eur J Anaesthesiol.* 2007 Aug; 24 (8): 668-75. doi: 10.1017/S0265021507000191.
- African South of Sahara. SASA Guidelines for Infection Control in Anaesthesia in South Africa 2014 SASA Guidelines for Infection Control 2014; 20 (3): 1-44.
- Gemmell, L., Birks, R., Radford, P., Jeffries, D., Ridgway, G., and McIvor, D. Infection control in anaesthesia. *Anaesthesia.* 2008.
- Best, M., Sattar, S. A., Springthorpe, V. S., Kennedy, M. E. Efficacies of selected disinfectants against *Mycobacterium tuberculosis.* *J Clin Microbiol.* 1990; 28 (10): 2234-2239. doi: 10.1128/jcm.28.10.2234-2239.1990.
- Muscarella, L. F. Reassessment of the risk of healthcare-acquired infection during rigid laryngoscopy. *J Hosp Infect.* 2008; 68 (2): 101-107.
- Freed Muscarella, L. High-Level Disinfection or "Sterilization" of Endoscopes? *Infect Contr Hosp Epidemiol.* 1996; 17: 183-187.
- Fourtounas, M. Microorganisms cultured from laryngoscope blades in an academic hospital following implementation of a new decontamination technique. 2015;
- Donskey, C. J. Does improving surface cleaning and disinfection reduce health care-associated infections? *Am J Infect Contr.* 2013; 41 (5): S12-S19.
- Bradford, B. D., Seiberling, K. A., Park, F. E., Hiebert, J. C., and Chang, D. F. Disinfection of rigid nasal endoscopes following in vitro contamination with *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Pseudomonas aeruginosa*, and *Haemophilus influenzae.* *JAMA Otolaryngol Head Neck Surg.* 2013; 139 (6): 574-578.
- Lee, Y. N. Effect of anaesthesia and surgery on immunity. *J Surg Oncol.* 1977; 9 (5): 425-430.
- Inada, T., Yamanouchi, Y., Jomura, S., et al. Effect of propofol and isoflurane anaesthesia on the immune response to surgery. *Anaesthesia.* 2004; 59 (10): 954-959.
- Koch, A., Zacharowski, P., Boehm, O., et al. Innate immunity, coagulation and surgery. *Front Biosci.* 2009; 14 (8): 2970-2982.
- Schneemilch, C. E., Schilling, T., and Bank, U. Effects of general anaesthesia on inflammation. *Best Pract Res Clin Anaesthesiol.* 2004; 18 (3): 493-507.
- HIV and AIDS in South Africa. AVERT.org 2016.