

THE RATE OF CONJUNCTIVAL BLOOD SPLASH DURING INTRAMEDULLARY NAILING: A HOSPITAL BASED CROSS-SECTIONAL STUDY

B. T. Haonga, MD, **G. Njambilo**, MD, Muhimbili University of Health and Allied Sciences, Department of Orthopaedics and Traumatology and Muhimbili Orthopaedic Institute, P. O. Box 65474, Dar es Salaam, Tanzania, **N. Mbocha**, MD, Muhimbili University of Health and Allied Sciences, Department of Orthopaedics and Traumatology and **J. E. Makupa**, MPH, Ministry of Health Community Development Gender Elderly and Children, University of Dodoma, Faculty of Social Science in Community, Development Building No. 11 P.O. Box 743, 40478 Dodoma Tanzania

Correspondence to: Prof. Billy Haonga, P.O. Box 65001, Dar es Salaam, Tanzania. Email: bhaonga@gmail.com

ABSTRACT

Background: In the healthcare setting, much focus is directed at preventing bloodborne illness transmission by needlestick, but, despite the well-documented risk of disease transmission across mucous membranes, precautions against blood splashes to the eye are often not practiced. The risk of blood splash to the eye is especially high in orthopaedic procedures where the use of power tools can cause aerosolization and high velocity spray of contaminated fluids.

Objective: This study aimed to evaluate the risk of conjunctival contamination from blood and bodily fluid splash and the practice of using protective eyewear among theatre staff during intramedullary nailing for the treatment of long bone fractures at Muhimbili Orthopaedic Institute (MOI).

Methods: A hospital-based cross-sectional study was carried out at Muhimbili Orthopaedic Institute (MOI) in Dar es Salaam, Tanzania to determine the rate of conjunctival contamination during intramedullary nailing procedures. Protective goggles were provided to surgical staff during intramedullary nailing procedures and, after surgery, inspected for macroscopic splashes. The questionnaire was used to collect information about utilization of protective eyewear by surgical staff.

Results: Of the 491 goggles assessed, 92.46% were found to have evidence of macroscopic blood splash. The incidence of blood splashes during the operations was statistically significant ($p < 0.001$) at 89.06%- 94.11% C.I. of the 56 surgical staff included, 28.6% and 71.4% reported never or irregularly wearing protective eyewear, respectively.

Conclusion: Nine in every ten goggles were found to have blood splashes and the use of eye protective devices was low and inconsistent among surgical staff. This carries with it, the risk for transmission of blood borne pathogen such as HIV and Hepatitis B and C.

Key words: Bloodborne illnesses, Blood splash, Intramedullary nailing, Protective eyewear, Conjunctiva

INTRODUCTION

In healthcare settings, significant measures are taken to protect Healthcare Workers (HCWs) against occupational hazards including the transmission of bloodborne illnesses, especially in regions where prevalence of these diseases is high. The bloodborne pathogen transmission may occur by percutaneous (needlesticks or other sharp-related injuries) or mucosal (splashes) exposures (1). According to a United States

Occupational Safety and Health Administration (OSHA) regulation, masks and eye protective devices should be worn whenever "splashes, spray, spatter, or droplets of blood or other potentially infectious materials may be generated" (2). While much attention is paid to preventing needlestick-mediated transmission of bloodborne pathogens, conjunctival contamination from splashed debris receives less focus, even in surgical specialties where conjunctival contamination places surgical staff at risk for communicable diseases (3).

The incidence of blood splash is understandably more prevalent in some surgical specialties, such as orthopaedics where use of power tools for drilling, reaming and sawing can project blood at high velocities (2,4,5), causing up to seven-fold increased risk of blood splash (6) that can contaminate unprotected muco-cutaneous membranes. It has been demonstrated that HIV virus was found in the vapours produced by surgical power instruments (5). Further, the use of irrigation was a statistically significant risk factor for blood splash to the scrub nurse ($p=0.001$) (7,8). As such, concern has arisen that HIV and Hepatitis B and C viruses' transmission can occur through conjunctival blood splashes during surgery (4).

In order to address this risk, it has been shown that adherence to proper protective eyewear guidelines can reduce blood and bodily fluid-borne disease transmission and reduce the risk of hospital acquired infection during surgical procedures (9). Despite this evidence, it has also been shown that the knowledge, attitude and practice of healthcare workers towards standard precaution to prevent blood borne infection is insufficient (10,11) and there is reluctance to adhere with protective eyewear guidelines (7,12,13) with rates of surgical teams not using protective eyewear to range from 23% to over 56% (10,11,13,14) and up to 100% in elective knee and hip replacement (15,16). The most common reasons reported for non-adherence to protective eyewear guidelines include: discomfort, reduced visibility, fog formation, lack of availability, forgetting, and use of prescription glasses (2,11–13,17,18).

Though commonly reported as a form of "inadvertent" eye protection (7), prescription glasses were found to be inefficient against blood splash during surgical procedures (2). Further, aerosolized droplets of blood have been reported to travel considerable distances, creating an environmental hazard for members of the surgical team (19). When face shields, another form of splash protection, were examined macroscopically for splashes, 44% to 66% of eye shields were found to have blood spatter contamination (20), and the blood spatter was most commonly found on the protective equipment worn by lead surgeons, at 83.5%, followed by the first assistant, at 68.5%, and the scrub nurse at 46.0% (12).

The recent report on rate of transfusion transmitted infection among blood donors in Dar es Salaam showed an overall prevalence

of 8.4%, with Hepatitis B Virus (HBV) being the most prevalent infection (4.1%), HIV (1.7%) and Hepatitis C (1.0%) (21). Since there is a significant high burden of motor traffic crush injuries in Tanzania, Muhimbili Orthopaedic Institute (MOI) being the largest trauma center in the country receives the highest number of them, majority of whom require surgical fixation by intramedullary nailing; conjunctival contamination from blood and bodily fluid splash represents a significant risk of bloodborne pathogen transmission to surgical teams (14,22).

This study aimed to evaluate the risk of conjunctival contamination from blood and bodily fluid splash and the practice of using protective eyewear among theatre staff during intramedullary nailing for the treatment of long bone fractures at MOI.

The results of this study will increase awareness and encourage adherence to universal precautions against bloodborne pathogens, including protections against splash-related mucosal exposures. Additionally, it provides insight on the underlying factors associated with use and non-use of protective eyewear.

MATERIALS AND METHODS

A hospital-based cross-sectional study design was used to determine the risk of conjunctival contamination from blood and bodily fluid splash during intramedullary nailing from July to October 2017 and the practice of wearing protective eyewear among theatre staff at MOI during the same surgery.

Study participants: We included orthopaedic surgeons, assistant surgeons, residents and nurses who were involved during surgeries (Open reduction and internal fixation with intramedullary nailing for the fractures of tibia or femur). Informed consent was obtained from all study participants.

Blood and bodily fluid splash quantification: Protective eye goggles were provided to study participants to be worn for the entirety of the surgical procedures. Goggles were examined by the primary investigator after surgery as previously described by Ogendo *et al.* (23). Briefly, macroscopic splashes were quantified by inspecting the surface of each lens under a bright light using a magnification loop with a power of 20, against a white background divided into 1cm

squares. The splashes were graded as “small”, “medium”, “large” or “very large” if the number of the drops observed on the goggles were one to five drops, six to ten drops, eleven to fifteen drops or greater than fifteen drops, respectively. If blood and body fluid were observed to be running down the protective goggles, the splash was graded as “large”, irrespective of other splashes (23). The roles of operating team were recorded. We excluded participants who did not use goggles throughout the operation.

Awareness and practice survey: A questionnaire was provided to the study participants to assess their awareness and practice towards the use of protective eyewear as a precautionary means against blood borne infection.

Statistical analysis: Statistical Package on Social Science (SPSS) version 17 was used to analyze the quantitative data. Fisher’s exact test was used to

evaluate the statistical significance of the risk of conjunctival contamination during intramedullary nailing. A P-value of less than 0.05 was regarded statistically significant.

Ethical approvals: All study procedures were conducted under ethical clearance obtained from the Ethical Clearance Committee of Muhimbili University of Health and Allied Sciences (MUHAS). (Ref: HD/MUH/K16/2015)

RESULTS

Over a period of 6 months, a total of 500 goggles were provided to study participants for 188 intramedullary nailing procedures and 491 goggles (98.2% of total provided) were evaluated for blood and bodily fluid splashes after meeting the inclusion criteria. A total of 56 HCWs participated in the study. Table 1 describes the demographics of the HCWs who took part in the study.

Table 1

Demographic characteristics of the healthcare workers included in the study

Socio demographic characteristic		Number of health workers	(%)
No.		56	100
Age group (years)	32-39	39	69.6
	40-46	17	30.4
Gender	Male	34	60.7
	Female	22	39.3
Cadres	Specialists	11	19.6
	Residents	27	48.2
	Nurses	18	32.1

Incidence of blood and bodily fluid splashes: Out of 491 goggles examined, 454 (92.5%) goggles had blood and bodily fluid splashes. When graded, 226 (46.0%) goggles had 1-5 drops (small splash), 117 (28.8%) goggles had 6-10 drops (medium splash), 51 (10.4%) goggles had 11-15 drops (large splash) and 60 (12.22%) goggles had more than 15 drops (very large splash). (Table 2)

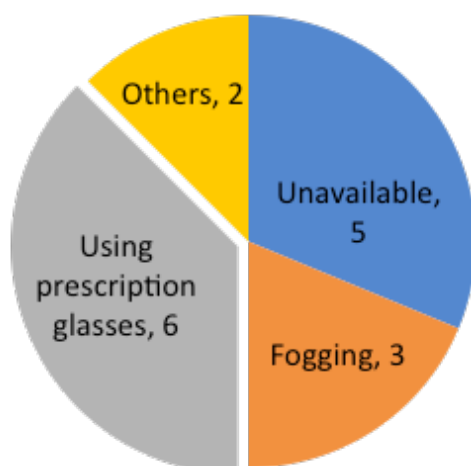
The mean number of drops per goggle was 7.43. The total number of blood drops counted during the study period was 3,373. The incidence of blood splashes during operations was found to be significant $P < 0.001$ at 89.1% to 94.1% confidence interval.

Table 2*Amount of blood in blood and bodily fluid splashes*

Splash category	Number of Goggles	(%)
Small (1-5 drops)	226	49.8
Medium (6-10 drops)	117	25.8
Large (10-15 drops)	51	11.2
Very large (15+ drops)	60	13.2
Total	454	100

Rate of protective eyewear use: All the study participants were aware of the use of eyewear as a protective means against blood borne infections; Of the 56 HCWs who completed the questionnaire, 16 (28.6%) reported never wearing protective eyewear. Among this group, the primary reasons reported for not using protective eyewear were: 5 (31.3%) protective eyewear was not available, 3 (18.8%) fogging, 6 (37.5%) use of prescription glasses, and 2 (12.5%) other reasons (Figure 1).

Of the 40 (71.4%) participants who reported wearing protective eyewear, 13 (32.5%) always wear the protective eyewear during surgery, and 27 (67.5%) only utilize the protective eyewear sometimes. Among this group who use the protective eyewear irregularly, the primary reasons for not always using protective eyewear included: 26 (46.2%) protective eyewear was not available, 13 (23.2%) spectacle fogging, 2 (3.6%) forgetting, and 1 (1.8%) other reason. The specialists reported using the protective eyewear most commonly (81%), followed by residents (77%). The nursing officers reported using the protective eyewear the least commonly (55%).

Figure 1*Reasons for not using protective eyewear*

DISCUSSION

Risk of conjunctiva contamination

In this study, we evaluated the conjunctival contamination that occurs from blood splashes during intramedullary nailing procedures at MOI which pose a risk of occupational blood borne infection among orthopaedic health care workers as we considered a significant rate of transfusion transmitted infection among blood donors (8.4%) in Dar es Salaam report, where Hepatitis B Virus (HBV) was found to be the most prevalent infection (4.1%), followed by HIV (1.7%) and Hepatitis C (1.0%) (21).

Our findings showed that blood splashes contaminate over 90% of goggles worn during intramedullary nailing procedures, with an average of 6-10 drops per pair of goggles observed. This observed incidence of blood and bodily fluid splash was similar to previously published studies that reported incidences ranging from 45% to 100% in orthopaedic surgeries (3,6,7,8,23). These findings underscore the significant risk of infection during orthopaedic procedures. In this study, the mean number of drops was observed to be 7.43 drops per person. This result is three times higher than previously published study which report 2.4 drops per procedure per principal surgeon (7). The discrepancy may be due to the fact that intramedullary nailing involves the use of power drill, reaming and large incisions during open reduction that is likely to spill more blood on air as compared to the operations that were studied by the other authors.

Practice of protective eyewear

We found that all study participants were aware of different methods of protection against blood borne infections including the use of eyewear; Despite that, there was a significant underutilization of eyewear during different orthopaedic procedures including intramedullary nailing. Our results showed that nearly 30% of study participants report never wearing protective eyewear and 48% report wearing protective eyewear only sometimes during intramedullary nailing procedures. This trend is similar in most of the developing countries including Kenya where authors reported less than 6% utilization rate of protective eyewear (7), this may be explained by the cultural similarities that people may underestimate the actual risk of infection via this route; furthermore, due to the limited

financial budget the protective eyewear may be unavailable.

The most common reasons for non-adherence to protective eyewear guidelines observed in this study were; the use of prescription glasses (37.5%), unavailability of protective eyewear (31.3%), and fogging (18.8%), 6 (37.5%) these mirrored previously published reports (2,11–13,17,18). The use of prescription glass reduces the risk of contamination, nevertheless they are less efficient in protection of bloodborne diseases in this context (24). Thus, operating team members with prescription glasses should wear protective goggles instead of prescription glasses or wear on top of them where necessary.

This also emphasizes the need for extra efforts to make eyewear more available to all theatre workers since lack of non-adherence with protective eyewear guidelines poses significant risks to HCWs for transmission of blood and bodily fluid-borne infections such as HIV and hepatitis B and C.

The data presented herein, suggest that there is a significant risk of bloodborne pathogen transmission through blood and bodily fluid splash during intramedullary nailing procedures done at MOI. This is especially important in Tanzania where HIV prevalence is 4.7% nationally and 10.1% in trauma patients treated at MOI (25). This risk to surgical staff will remain high unless occupational exposure is limited through the reliable use of protective eyewear.

We acknowledge the limitation that not all splashes that appeared and were quantified on the goggles would have necessarily landed in HCW conjunctiva, depending on their trajectory. Therefore, the results may overestimate the actual risk of exposure and contamination.

CONCLUSION

The incidence of blood and bodily fluid splashes on protective eyewear during intramedullary nailing procedures at MOI is high, presenting a significant occupational hazard to surgical staff if protective eyewear is not worn. Despite the known advantages of eye protection during orthopaedic procedures and increasing prevalence of blood borne viruses like HIV, HBV, CMV and HCV, many members of the surgical team do not consistently utilize protective eyewear. Thus, strategies for extra emphasis about the risks of HIV and other bloodborne pathogen transmission following

conjunctival blood exposure should be employed and improving the utilization rate of protective eyewear during intramedullary nailing procedures in Tanzania warrants further study and investment.

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REFERENCES

1. Beltrami, E.M., Williams, I.T., Shapiro, C.N. and Chamberland, M.E. Risk and management of blood-borne infections in health care workers. *Clin Microbiol Rev.* 2000; **13**(3):385–407.
2. Mansour, A.A., Even, J.L., Phillips, S. and Halpern, J.L. Eye protection in orthopaedic surgery. An in vitro study of various forms of eye protection and their effectiveness. *J Bone Joint Surg Am.* 2009; **91**(5):1050–54.
3. Davies, C., Khan, M., Ghauri, A. and Ranaboldo, C. Blood and body fluid splashes during surgery – The need for eye protection and masks. *Ann R Coll Surg Engl.* 2007; **89**(8):770–772.
4. Silva, R.D.E. Risk of blood splashes to the eye during surgery. *SAJS.* 2009; **47**(1):7–9.
5. Collins, D., Rice, J., Nicholson, P. and Barry, K. Quantification of facial contamination with blood during orthopaedic procedures. *J Hosp Inf.* 2000; **45**(1):73–75.
6. Hinton, A.E., Herdman, R.C. and Timms, M.S. Incidence and prevention of conjunctival contamination with blood during hazardous surgical procedures. *Ann R Coll Surg Engl.* 1991; **73**(4):239–241; discussion 241–242.
7. Ogendo, S.W.O., Awori, M.N., Omondi, M.A., Mulatya, E.M. and Mugo, P.W. Risk of conjunctival contamination from blood splashes during surgery at The Kenyatta National Hospital, Nairobi. *East Afr Med J.* 2008; **85**(9):432–437.
8. Patterson, P., Westacott, D., Scott, M., Sherrief, T. and Reid, M. The risk of eye blood splash contamination to staff in orthopaedic trauma surgery. *Injury Extra.* 2007; **38**(4):101.

9. Amoran, O. and Onwube, O. Infection control and practice of standard precautions among healthcare workers in northern Nigeria. *J Global Inf Dis.* 2013; **5**(4):156.
10. Sadoh, W.E., Fawole, A.O., Sadoh, A.E., Oladimeji, A.O. and Sotiloye, O.S. Practice of universal precautions among healthcare workers. *J Natl Med Assoc.* 2006; **98**(5):722–726.
11. Yakob, E. and Lamaro, T. Knowledge, attitude and practice towards infection control measures among Mizan-Aman General Hospital Workers, South West Ethiopia. *J Comm Med Health Educ* [Internet]. 2015 [cited 2019 Dec 3]; **05**(05). Available from: <https://www.omicsonline.org/open-access/knowledge-attitude-and-practice-towards-infection-control-measures-among-mizanaman-general-hospital-workers-south-west-ethiopia-2161-0711-1000370-.php?aid=61015>
12. Endo, S., Kanemitsu, K., Ishii, H., Narita, M., Nemoto, T., Yaginuma, G., *et al.* Risk of facial splashes in four major surgical specialties in a multicentre study. *J Hosp Infect.* 2007; **67**(1):56–61.
13. Singh, B.I., Nurein, H., Sinha, S., Singh, S. and Housden, P. Risk of conjunctival contamination in total joint arthroplasty. *J Hosp Inf.* 2006; **63**(3):275–280.
14. Mashoto, K.O., Mubyazi, G.M., Makundi, E., Mohamed, H. and Malebo, H.M. Estimated risk of HIV acquisition and practice for preventing occupational exposure: a study of healthcare workers at Tumbi and Dodoma Hospitals, Tanzania. *BMC Health Serv Res.* 2013; **13**:369.
15. Singh, V.K. and Kalairajah, Y. Splash in elective primary knee and hip replacement: are we adequately protected? *J Bone Jt Surg Br.* 2009; **91**(8):1074–77.
16. Alani, A., Modi, C., Almedghio, S. and Mackie, I. The risks of splash injury when using power tools during orthopaedic surgery: a prospective study. *Acta Orthop Belg.* 2008; **74**(5):678–682.
17. Collins, D., Rice, J., Nicholson, P. and Barry, K. Quantification of facial contamination with blood during orthopaedic procedures. *J Hosp Inf.* 2000; **45**(1):73–75.
18. Sangwan, B., Kotwal, A. and Verma, A. Occupational exposure to blood and body fluids amongst health care workers in a teaching hospital of the armed forces. *Med J Armed Forces India.* 2011; **67**(1):21–24.
19. Englehardt, R.K., Nowak, B.M., Seger, M.V. and Duperier, F.D. Contamination resulting from aerosolized fluid during laparoscopic surgery. *JSLS: Journal of the Society of Laparoendoscopic Surgeons / Society of Laparoendoscopic Surgeons.* 2014; **18**(3):4154434.
20. Marasco, S. and Woods, S. The risk of eye splash injuries in surgery. *Aust N Z J Surg.* 1998; **68**(11):785–787.
21. Mohamed, Z., Kim, J.U., Magesa, A., Kasubi, M., Feldman, S.F., Chevaliez, S., *et al.* High prevalence and poor linkage to care of transfusion-transmitted infections among blood donors in Dar-es-Salaam, Tanzania. *J Viral Hepat.* 2019; **26**(6):750–756.
22. Chalya, P.L., Seni, J., Mushi, M.F., Mirambo, M.M., Jaka, H., Mabula, J.B., *et al.* Needle-stick injuries and splash exposures among health-care workers at a tertiary care hospital in north-western Tanzania. *Tanzania J Health Res.* 2015; **17**(2):15.
23. Singh, V.K. and Kalairajah, Y. Splash in elective primary knee and hip replacement: are we adequately protected? *J Bone Joint Surg Br.* 2009; **91**(8):1074–77.
24. Chong, S.J., Smith, C., Bialostocki, A. and McEwan, C.N. Do modern spectacles endanger surgeons? The Waikato eye protection study. *Annals Surg.* 2007; **245**(3), 495–501. <https://doi.org/10.1097/01.sla.0000252406.94464.16>
25. Matoyo, H. Risk of occupational exposure to HIV infection at Muhimbili Orthopedic Institute Dar es Salaam Tanzania [Internet] [Thesis]. Muhimbili University of Health and Allied Sciences; 2007 [cited 2019 Dec 3]. Available from: <http://dspace.muhas.ac.tz:8080/xmlui/handle/123456789/1163>