Associate Editor
Cameron Wright

Senior Editor
Shahzma Merani
Mabel Leow

Proofreader
Nadiah Binte Mohamad Shariff

Senior Proofreader
Emily Feng-Gu

Date of submission: 20 April 2020
Date of acceptance: 2 November 2020
Date of online publication: 5 November 2020

Case Report

When trauma meets infection in a lower income country

Dr. Brittany Weir
Doctor of Medicine
Four-year degree, written as a fourth-year medical student
University of Wollongong
Currently working as an Intern at Sunshine Coast University Hospital

Brittany is an intern at Sunshine Coast University Hospital, graduating in 2019 with a Doctor of Medicine from the University of Wollongong. She also previously completed a Bachelor degree in Physiotherapy at the University of Queensland and has worked as a physiotherapist since 2012. Brittany is interested in trauma surgery, orthopaedics, and critical care.

Corresponding author
Brittany Weir
Email address: brittany.weir@health.qld.gov.au

Source of submission: case report assignment, prepared specifically for AMSJ

160 Character summary of article: A case of a 23-year-old polytrauma patient in Zambia reveals the devastating outcomes of lack of resources, healthcare-associated infections, and delayed treatment in a low- and middle-income country.

Keywords: trauma, healthcare-associated infections, low- and middle-income country

Table/Figures: 1 Table, 1 Figure

Word count: 1566

Learning points

1. Deficient resources in low- and middle-income countries (LMIC) negatively influence health care and patient related outcomes.
2. Infection prevention and control (IPC) is crucial in healthcare to slow the spread of antibiotic resistance and reduce patient morbidity and mortality.
3. Early anatomical reduction of fractures reduces complications and improves long term function.

Abstract

Introduction: Healthcare-associated infections (HAI) are particularly prevalent in low- and middle-income countries (LMICs). HAIs cause a serious threat to patient wellbeing and have been associated with increased patient morbidity and mortality, longer hospital admission times, increased risk of antibiotic resistance, and higher healthcare costs.
Case: A case of a 23-year-old polytrauma patient in Zambia reveals the devastating outcomes of lack of resources, HAIs, and delayed treatment in LMICs.
Discussion: Research demonstrates the negative influence of LMIC status on health care and patient related outcomes. This report, in conjunction with the literature, emphasises the importance of prompt trauma management and strict infection control. The critical need for more knowledge around infection prevention and control (IPC) and resources to implement IPC processes in LMICs are highlighted.

Introduction

Healthcare-associated infections (HAI) are a major health challenge worldwide, and instances are particularly prevalent in low- and middle-income countries (LMICs) [1-3]. LMICs face many challenges contributing to decreased HAI control including lack of resources, reduced health literacy, and massive overcrowding [2,3]. HAIs pose a serious threat to patient wellbeing and literature shows that HAIs have been associated with increased patient morbidity and mortality, longer hospital admission times, increased risk of antibiotic resistance, and higher healthcare costs [2,3,6].

Surgical site infections (SSI) are among the most common cause of HAIs, alongside central line-associated infections, catheter-related infections, and hospital-acquired pneumonia [2,4,5]. Factors such as inadequate hand hygiene, inappropriate antibiotic use, and emergency surgery increase the risk of infection [2,4,5]. Evidence-based practice to prevent SSIs includes preoperative antibiotics and strict perioperative infection control regimes such as hand hygiene and barrier protective equipment [4].

Hand hygiene has been proven to be an effective and critical strategy in reducing all HAIs, in particular the use of alcohol-based hand gel. However, this simple resource is often scarce in LMICs [2,3].

Case

A 23-year-old female presented to the emergency department of a local hospital in Zambia, in haemorrhagic shock with polytrauma following a motor vehicle accident (MVA). She was admitted to the hospital with extensive lower limb crush injuries from the MVA. She had no previous medical or surgical history, was single, lived nearby in one of the local villages with her mother, denied alcohol use, and was a non-smoker. Initial management included a primary survey and resuscitation requiring a blood transfusion. Following a secondary survey, she was diagnosed with bilateral closed displaced femoral shaft fractures, a right distal leg traumatic amputation, a left distal fibula fracture, degloving wounds to her left leg and foot, and a deep laceration to her right upper limb, as well as multiple minor skin lacerations. Further management included a guillotine transtibial below knee amputation (BKA) to her right leg, subsequent debridement, and wound dressings. She was commenced on benzylpenicillin, gentamicin, metronidazole, pethidine, and paracetamol.

On day six of her admission she was showing signs of residual anaemia (Haemoglobin (Hb) 76 g/L), necrosis of her leg wounds, and sepsis. Following another blood transfusion, she taken to theatre for evaluation under spinal anaesthesia, wound debridement and bilateral Steinmann transtibial pin insertions to assist with distraction of her bilateral femur fractures. There was no air conditioning or HEPA filters in the theatre and exterior windows were open to obtain air flow in the heat. During the procedure, wound cultures were unable to be obtained as the hospital had no supplies of sterile swabs. She was afebrile and haemodynamically stable post-surgery and her Hb levels had improved to 106 g/L. Skeletal traction was commenced for fracture reduction using a rope and pulley system attached to large water bottles which hung off the end of the bed.

On day 21, she was taken back to theatre for wound debridement, split-thickness skin graft and stump closure. Daily wound care involved bedside wound dressing removal, normal saline wash, application of gauze soaked in honey, and crepe bandage. She had daily routine bloods as well as chest and limb physiotherapy. Her daily medications included ceftriaxone, analgesia, folic acid and ferrous sulphate.

Throughout this patient's hospital stay she developed multiple wound infections requiring frequent surgeries (Table 1). A major complication was the development of wet gangrene in her right BKA stump wound requiring a transfemoral above knee amputation (AKA). Unfortunately, one week later her AKA stump had also become gangrenous requiring further debridement in theatre. Despite this debridement, four weeks later her AKA stump developed osteomyelitis and she returned to theatre for debridement and sequestrectomy of her AKA stump.

Approximately five months' post injury, the patient was taken to theatre for the tenth time for an open reduction internal fixation of her left femoral shaft fracture. Given the time lapse since injury and unsuccessful attempts at reduction, the fracture had started to heal in the displaced position with callous formation evident on a plain radiograph (Figure 1).

The patient was given a spinal anaesthesia with minimal sedation. The procedure was complicated by debridement of extensive fibrous tissue at the fracture site due to a significant overlap of fragments of approximately 10 cm. The fragments were shortened approximately four centimetres, the fracture was reduced, and an interlocking nail was placed in the femoral shaft. She lost a substantial amount of blood during the surgery and was hypotensive (blood pressure 75/40 mmHg) and tachycardic (pulse rate 145 beats per minute). While blood products were necessary for adequate resuscitation, there was only one bag of blood available for transfusion. The patient required tranexamic acid, two litres of normal saline and multiple boluses of adrenaline in addition to the bag of packed red blood cells. Her blood pressure had stabilised to 110/70 mmHg in recovery.

The hospital had an inconsistent and limited supply of antibiotics. The common antibiotics available were penicillin, gentamicin, metronidazole, ceftriaxone, and cefotaxime. Occasionally the hospital stocked cefoxitin, ciprofloxacin, linezolid, co-trimoxazole, nitrofurantoin, and piperacillin-tazobactam. Ceftriaxone was given in this case, justified as the only intravenous antibiotic available at the time, and while the intention may have been to give this antibiotic preoperatively, it was only administered on completion of the surgery. Sterile equipment such as gowns, gloves and surgical instruments were scarce within the hospital, and the limited supply meant that surgeries were delayed until equipment could be re-sterilised. The wards were overcrowded and hand hygiene throughout this patient's care was negligible, with finite supply of alcohol-based hand gel, hand washing facilities, and gloves.

After five months in hospital, this patient was discharged home in a wheelchair to follow up in outpatient clinics for wound and fracture care. Unfortunately, given the extent of damage caused to surrounding soft tissue during the fracture repair, her functional prognosis was poor with a high risk of fracture non-union and avascular necrosis.

Discussion

This case was significant as it combined severe polytrauma, multiple SSIs, and complex fracture management with resource-limited health care and infection control. Infection control is vital to all aspects of health care, and the devastating outcomes of poor infection control are emphasised by this case. While prevention of infection is key, early recognition of wound infections is crucial to prevent both limb-threatening gangrene and life-threatening sepsis [7,8].

LMIC status negatively influences healthcare and patient-related outcomes [1-3]. This case highlights the lack of resources available in LMICs like Zambia, and the impact on patient outcomes. Basic infection control measures such as hand hygiene and barrier protection proved to be difficult with deficient supplies of alcohol gel, soap, gloves, bacterial swabs, and sterile equipment. Without HEPA filters in theatres, open exterior windows further increased the risk of infection. While hospitals like this in Zambia are extremely resourceful with their equipment, research shows that HAI rates in lower income countries is at least 2-fold higher than in high income countries [1-3].

Infection prevention and control (IPC) is crucial in healthcare to reduce complications and improve health outcomes. Poor IPC in this case contributed to the complications associated with this patient's wounds including gangrene, frequent surgeries, limb loss, and prolonged hospital stay, all factors which further increase the risk of additional HAIs [2-5]. Evidence-based practice recommends the use of prophylactic preoperative antibiotics to significantly decrease the risk of SSIs [4-5]. Unfortunately, in this case, antibiotics were only given postoperatively. The presence of infected, necrotic tissue is an indication for extensive debridement which may include lower limb amputation and is necessary to prevent life-threatening sepsis [7-10]. Complications following amputation include medical complications, wound infection, and the need for re-amputation, all of which occurred in this case [9,12]. Approximately 10-20% of below-knee amputations entail a re-amputation at the transfemoral level, with this rate substantially increased in lower income countries due to poor infection control [9-11].

Moreover, evidence suggests a strong relationship between HAIs and antibiotic resistance, a growing global health burden [6]. Drug-resistant organisms cause the majority of HAIs worldwide, placing poor infection control among the drivers of antibiotic resistance [6,12]. Prolonged hospitalisation, recent surgery, and prior antibiotic use – particularly the use of third-generation cephalosporins (e.g. ceftriaxone) – all of which were present in this case, are independent risk factors for a drug-resistant infection [12,13]. Therapeutic guidelines [14] recommend a first-generation cephalosporin, for example, cefazolin, as first line antibiotic prophylaxis for open fractures, although these were not available in this Zambian hospital. Zambia is just one of many countries worldwide contributing to the trend of increasing antibacterial drug resistance [15]. Antibiotic resistant microorganisms such as *Staphylococcus aureus*, *Klebsiella pneumonia* and *Escherichia coli* have been isolated in Zambia, and there is a high prevalence of resistance to gentamicin, penicillin, ciprofloxacin, and ceftriaxone [16-18]. The limited supply of sterile swabs, microbiology laboratory equipment, and effective second- and third-line antibiotic therapies in LMICs further

increase the risk of morbidity and mortality associated with antibiotic resistance [6,12,13].

Finally, the importance of early anatomical reduction in the management of displaced fractures was highlighted by this case. The five-month delay to fracture fixation as a result of multiple HAIs lead to a complicated surgical procedure and a poor functional outcome. Early anatomical reduction, surgical repair and functional rehabilitation of femur fractures reduces complications and improves long term function [19,20].

Conclusion

The consequences of HAIs can be devastating, with these poor outcomes skyrocketing in a resource-limited LMIC hospital. HAIs are preventable presentations which can lead to significant morbidity and mortality. This case demonstrates the importance of adequate resources on IPC and highlights the vital need for more health awareness and funding in Zambia and, by extension, other LMICs.

Consent Declaration

Written informed consent was obtained from the patient for publication of this case report and accompanying figures.

Acknowledgements

The author would like to acknowledge the Research and Critical Analysis team at the University of Wollongong for their invaluable support and guidance, and continual enthusiasm towards research and the education of medical students.

Furthermore, a special mention to the orthopaedic doctors at the University Teaching Hospital in Lusaka for their acceptance and enthusiasm towards teaching International medical students.

Conflicts of Interest

None declared.

References

[1] Allegranzi B, Nejad SB, Combescure C, Graafmans W, Attar H, Donaldson L, et al. Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. Lancet. 2011;377(9761):228-41. doi:10.1016/S0140-6736(10)61458-4

[2] Ayed HB, Yaich S, Trigui M, Jemaa MB, Hmida MB, Karray R, et al. Prevalence and risk factors of health care–associated infections in a limited resources country: a cross-sectional study. Am J Infect Control. 2019; 47(8):945-50. doi:10.1016/j.ajic.2019.01.008

[3] Loftus MJ, Guitart C, Tartari E, Stewardson AJ, Amer F, Bellissimo-Rodrigues F, et al. Hand hygiene in low-and middle-income countries: a position paper of the International Society for Infectious Diseases. Int J Infect Dis. 2019;86:25-30. doi:10.1016/j.ijid.2019.06.002

[4] Ban KA, Minei JP, Laronga C, Harbrecht BG, Jensen EH, Fry DE, et al. American College of Surgeons and Surgical Infection Society: surgical site infection guidelines, 2016 update. J Am Coll Surg. 2017;224(1):59-74. doi:10.1016/j.jamcollsurg.2016.10.029

[5] Shafer CW, Allison JR, Hogue AL, Huntington MK. Infectious disease: health care-associated infections. FP Essent. 2019;476:30-42.

[6] Lakoh S, Li L, Sevalie S, Guo X, Adekanmbi O, Yang G, et al. Antibiotic resistance in patients with clinical features of healthcare-associated infections in an urban tertiary hospital in Sierra Leone: a cross-sectional study. Antimicrob Resist Infect Control. 2020;9(1):1-0. doi:10.1186/s13756-020-0701-5

[7] Akinyoola AL, Ojo OD, Oginni LM. Microbiology of amputation wound infection in a Nigerian setting. J Wound Care. 2008;17(5):202-6. doi:10.12968/jowc.2008.17.5.29150

[8] Bonne SL, Kadri SS. Evaluation and management of necrotizing soft tissue infections. Infect Dis Clin North Am. 2017;31(3):497-511. doi:10.1016/j.idc.2017.05.011

[9] Chalya PL, Mabula JB, Dass RM, Ngayomela IH, Chandika AB, Mbelenge N, et al. Major limb amputations: a tertiary hospital experience in northwestern Tanzania. J Orthop Surg Res. 2012;7(1):18. doi:10.1186/1749-799X-7-18

[10] Grudziak J. Etiology of major limb amputations at a tertiary care centre in Malawi. Malawi Med J. 2019;31(4):244-8. doi:10.4314/mmj.v31i4.5

[11] Belmont Jr PJ, Davey S, Orr JD, Ochoa LM, Bader JO, Schoenfeld AJ. Risk factors for 30-day postoperative complications and mortality after below-knee amputation: a study of 2,911 patients from the national surgical quality improvement program. J Am Coll Surg. 2011;213(3):370-8. doi:10.1016/j.jamcollsurg.2011.05.019

[12] Rodrigues R, Fonseca RP, Gomes O, Castro R. Risk factors, length of stay and in-hospital mortality of methicillin-resistant staphylococcus aureus infections: a case-control study. Acta Med Port. 2020;33(3):174-82. doi:10.20344/amp.10952

[13] van Staa TP, Palin V, Li Y, Welfare W, Felton TW, Dark P, et al. The effectiveness of frequent antibiotic use in reducing the risk of infection-related hospital admissions: results from two large population-based cohorts. BMC Med. 2020;18(1):1-1. doi:10.1186/s12916-020-1504-5

[14] Therapeutic Guidelines Limited. eTG complete. [Internet]. 2020. [updated 2020; cited 2020 July 21]. Available from: https://www.tg.org.au

[15] World Health Organization. Antimicrobial resistance: global report on surveillance. World Health Organization; 2014.

[16] Kabwe M, Tembo J, Chilukutu L, Chilufya M, Ngulube F, Lukwesa C, et al. Etiology, antibiotic resistance and risk factors for neonatal sepsis in a large referral center in Zambia. Pediatr Infect Dis J. 2016;35(7):e191-8. doi:10.1097/INF.0000000000001154
[17] Mwamungule S, Chimana HM, Malama S, Mainda G, Kwenda G, Muma JB. Contamination of health care workers' coats at the University Teaching Hospital in Lusaka, Zambia: the nosocomial risk. J Occup Med Toxicol. 2015;10(1):34. doi:10.1186/s12995-015-0077-2
[18] Nagelkerke MM, Sikwewa K, Makowa D, de Vries I, Chisi S, Dorigo-Zetsma JW. Prevalence of antimicrobial drug resistant bacteria carried by in-and outpatients attending a secondary care hospital in Zambia. BMC Res Notes. 2017;10(1):378. doi:10.1186/s13104-017-2710-x
[19] Blair JA, Kusnezov N, Fisher T, Prabhakar G, Bader JO, Belmont PJ. Early stabilization of femur fractures in the setting of polytrauma is associated with decreased risk of pulmonary complications and mortality. J Surg Orthop Adv. 2019;28(2):137-43.
[20] Gangavalli AK, Nwachuku CO. Management of distal femur fractures in adults: an overview of options. Orthop Clin North Am. 2016;47(1):85-96. doi:10.1016/j.ocl.2015.08.011