CASE REPORT

Clinical management of electrical burns in the developing world: a case of electrical burn injury left untreated leading to amputation

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SUMMARY

We discuss the case of a 26-year-old male patient from Northern Samar, the Philippines who was left without essential health services after the amputation of all four limbs following a high voltage (20 000 volts) injury in Metro Manila in 2011. Local health services in the developing world are faced with enormous challenges in providing first-line care for burn patients. The cost of maintaining a burn unit, finding suitable qualified staff, and appropriate referral mechanisms are only some of the challenges faced. Once a patient is discharged from hospital they face more obstacles in obtaining artificial limbs, physiotherapy and access to mental health services. Disability pensions are non-existent thus patients place a considerable lifelong burden on their families.

CASE PRESENTATION

While conducting a clinical infectious disease trial in the province of Northern Samar we encountered a 26-year-old male Filipino quadriplegic patient, who was living with his mother in the remote village of Simora Palapag. On examination of the patient's four limbs, it was found that amputations had been performed below the olecranon of both upper limbs with the removal of the left axillary posterior trunk, and distal to the patella of both lower limbs. The patient had dark pigmentation of both axillae from burns received during the electrical accident. Figure 1 depicts the percentage body area the patient suffered from his electrical burn on hospital admission. The patient's current health status is shown in figure 2.

The electrical accident occurred at 08:30 on the 7th of April, 2011, at a construction site in Metro Manila. The patient was employed as a metal and glass welder. The victim was preparing to weld an iron bar when the bar touched a 20 000 volt electrical overhanging wire. For a few seconds (1–3 s) the electricity coursed through his body, into his arms and exited his axillae and feet, before a large electrical spark pushed him onto the floor in a supine position. The accident caused electrical burns to 25% of his body (figure 1). During the first few seconds, the patient felt no pain but experienced intense heat throughout his body. The victim was conscious and witnessed the distal parts of his arms and legs turn completely black, with open wounds on both his wrists with a diameter matching the iron bar and the bone exposed. The patient sustained motor paralysis distal to the patellae but had conserved minimal motor activity within the phalanges. Within a minute the patient's limbs became inflamed.

For 30 min the patient lay on the floor with no help, as his coworkers were afraid of possible electrocution. At 09:00 local time he was transported in bed linen on the back of a pickup truck to Tondo General Hospital. The victim did not receive any medical treatment for 8 hours while waiting for transfer to the burn unit at the Jose Reyes Memorial Medical Centre in Metro Manila. During this period haematuria was observed. At 17:00 he was admitted to the emergency ward at Jose Reyes Hospital. The patient was administered an ECG, Intravenous therapy fluids (Ringer's lactate; Bicarbonate at 1–2 mEq/kg; Mannitol at 1 g/kg), pain medication (morphine) and an indwelling urinary catheter. A general blood test was taken which showed an abnormally high white cell count (WCC) at 19.89×10^9/L. The emergency room physician removed the patient's clothes and started fasciotomy, which made an incision into the blood vessels of his limbs in order to remove the accumulated blood clots. The patient's wounds were washed, debrided, disinfected and dressed before he was transferred to the burn ward. For the next 2 weeks his wounds were dressed twice daily and inspected for discolouration or haemorrhage. He was also administrated pain medication (tramadol), nutritional supplements and antibiotics daily (eg, silver nitrate (0.5% aqueous); silver sulfadiazine (1% miscible ointment)). Three days later another blood test revealed low haemoglobin levels at 80 g/L, a high WCC count at 12.13×10^9/L and a low platelet count at 79×10^9/L.

At the end of the second week a decision was made to amputate his legs distal to the knee, and at the end of the third week, his arms below the olecranon. The decision of where to amputate was made by ascertaining nerve and tissue viability. After the second amputation, on the 35th day, he was transferred to the orthopaedic ward. During his 55th day of stay, the patient received home medications (ciprofloxacin, caltrate plus, epsom, diovan forte, tramadol), as well as consultation with social workers and psychologists prior to discharge. A final blood test revealed WCC within normal range at 7.90×10^9/L. The patient was recommended for prosthetic limbs; however, further information on obtaining prostheses was not given. On discharge on the 31st of May, 2011, he was helped home by his mother. For the past

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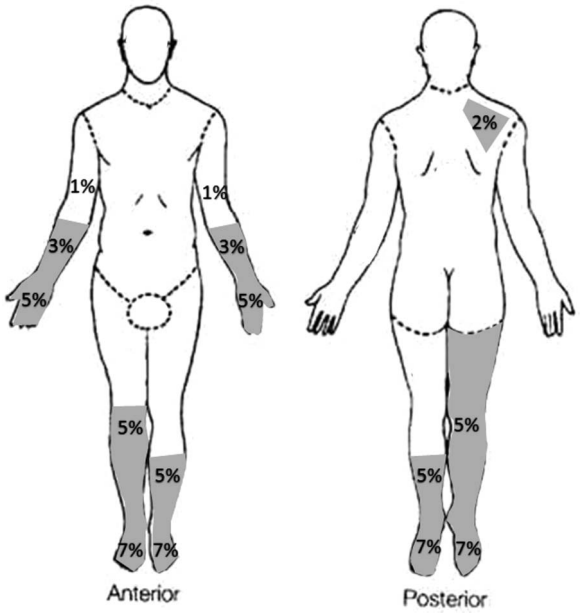

Figure 1 Anterior and posterior views of percentage areas burned (shaded) on the patient.

5 years the patient has received no help from the local government, the provincial government or from the national healthcare provider, PhilHealth, for disability support or for the acquisition of artificial limbs.

GLOBAL HEALTH PROBLEM LIST

- How should burn patients, including those with high voltage electrical burns, be diagnosed and treated in the developing world where there is a scarcity of medical resources?
- How can burn patients receive immediate emergency treatment to prevent last resort amputation of necrotic tissues?
- What workplace health and safety regulations need to be created by developing nations to prevent burn injury?
- How can healthcare services in the developing world be made affordable for patients from low-income earning backgrounds?

GLOBAL HEALTH PROBLEM ANALYSIS

Electrical burns make up 32% of the burns cases in the Philippines.[1] A fact sheet issued by WHO in 2014 indicated that 265 000 deaths occur annually from burn injuries,[2] of which most of the deaths originated from developing countries within the South-East Asia region. In low income and middle income countries (LMIC) government authorities should recognise that there is a need to introduce preventative measures for potential burn victims. As indicated in 2008, in a WHO plan for burn prevention and care, these measures can be implemented with legislation that introduces work place health and safety regulations, as well as improving the treatment within hospitals through techniques such as skin grafts.[3]

In 1999, a survey which was published on electrical burn patients by the Philippine General Hospitals, revealed that the prevalence of electrical burns was only second to flame burns. This was instigated by the growing industrial development of the country and the limited knowledge of health and safety regulations with respect to electrical equipment. The survey revealed that only one patient of the 28 surveyed was wearing shoes at the time of the accident. The rest were wearing rubber flip-flops which did not provide insulation from the electrical current.[1] Most workers from the labour-intense workforce either do not wear any safety equipment or have only very poor protection equipment for their occupation. About 57% of the electrical burn accidents surveyed were from rooftops, similar to

Figure 2 Anterior view of the patient's (A) right axillary region (B) whole body (C) left axillary region (D) right brachium to antebrachium region (E) left brachium to antebrachium region (F) left crus amputation (G) right crus amputation.

this patient, who had his accident on the third floor of a construction building near overhanging commercial power lines.[1]

The immediate treatment of electrical burn injuries is vital. Depending on how high or low the voltage of the electrical source is will determine the diagnostic and treatment procedures. The diagnosis of burns can be graded on a four point grading scale, which includes the traditional three degree grading system for skin destruction, with the last grade being the complete destruction of the skin layer and subcutaneous tissue layer, fat tissue, muscle and nerve down to the bone. Burns can be further divided into two groups based on how the electricity either entered through the body or as a result of a flash burn.[4] A low-voltage (eg, 110–220 V) burn would be treated as if it was a superficial thermal injury while a high voltage (eg, >1000 V) would require a variety of different treatment modalities.[5] The main concern of a high voltage electrical burn wound is the exposure of internal tissues (eg, bones, cartilage and tendons). To minimise the risk of infection, skin grafts or artificial dermis sources need to be used to cover internal tissues after the necrotic tissue has been removed. With regard to the patient, neither of these standard techniques was deployed to save his distal limbs and prevent further amputation.

A practice known to benefit burn patients is to implement patient care within the golden hour. In this case what should have been done was the immediate transportation of the patient to a hospital with a specialist centre for burn injuries, instead of waiting hours (8) for an ambulance for transfer. The golden hour of treatment is largely non-existent in the developing world. The standard protocol for treating electrical burn injuries is vital; this patient should have been treated as trauma case because of the nature of his electrical burn injuries. On admission to the emergency ward, the patient should have received a primary assessment and general burn care treatment such as a tetanus immunisation and other preventative sepsis measures, since this patient's injury occurred at a construction site. Fluid resuscitation (using an isotonic balanced saline solution) and cardiac monitoring was needed due to the high-voltage electrical burn injury. Surgical intervention, blood transfusion, fasciotomy and skin grafting should have been used to save more of the patient's limbs. The operation would have provided better skin coverage and blood circulation to preserve vital structures damaged in the accident.[6] Care of the wound should have included assessment for any exudate daily and included the redressing of the wounds on the limbs. The dressing should have been soaked in antibacterial solution to avert the development of future sepsis and other possible hospital-acquired infections. The inadequate care this patient received needs to be addressed by the Department of Health in view of the high rate of injuries among Filipino construction workers.

National healthcare systems in a developing country do not provide medical insurance or assistance for the long-term consequences of electrical injuries. This includes disability support as amputation leads to long-term unemployment, which creates a considerable lifelong burden on the families.[7] In the Philippines major burns units are found in only four hospitals (ie, Philippine General Hospital; Jose Reyes Memorial Medical Center in Manila; East Avenue Medical Center in Quezon City; and Davao Medical Center in Davao City) that serve a population of over 100 million.[8 9] Access to care is a growing concern in the Philippines. After discharge, the sequelae of electrical injuries can result in neurological and psychological incapacities. These include cerebral injury, transverse myelitis as well as central and peripheral motor nerve injuries.[7] For this patient, in addition to his initial injuries, this resulted in the onset of a delayed electrical injury after discharge (1–5 years later), of a physical, neurological and psychological nature.[10] The patient was lost to follow-up and received no further medical services after discharge. The patient lacked the support of rehabilitation services which past research has shown to have a detrimental effect on an electrical injured patient in the long term.[11] The family sought assistance from their local, provincial and national governments but were told nothing could be done for them. The only financial assistance came from the patient's employer. In this case it was his uncle. The employer funded the surgeries performed on the patient by selling the company's pick-up truck.

The overall protection of the patient by his employer comes under the Labour Standards Enforcement Framework which covers general labour standards and is managed by the Bureau of Working Conditions within the Department of Labour and Employment according to the International Labour Organization.[12–14] These organisations cover the Filipino Law of The Labor Code (Presidential Decree number 442 of 1974) of which one part enacts labour inspections of all workplace environments.[13] However, these inspections are voluntary self-assessments on preventive measures which may not have been ratified in the patient's workplace. Additional regulations, including inspection and mandatory safety equipment, are needed in order to provide better working conditions and safety for construction workers in LMICs.

The death rate due to injuries has increased by 24% in the period from 1990 to 2010.[15] Moreover, the burden of injuries is expected to increase exponentially over the next two decades in LMICs and decrease in developed nations over the same time frame. Emergency services in the Philippines are currently not able to meet the needs of their population of over 100 million. Moreover, PhilHealth is not able to meet the chronic health needs of the population. Clearly these health policy issues need to be addressed if accidental death and injuries are to be prevented. This would require legislation by the government such as implementing stricter health and safety laws for the work place and having stringent regulations for new construction projects adjacent to high voltage electrical supplies.

Learning points

- Electrical burns need immediate attention in order to prevent the loss of viable tissues and prevent disability as a result of amputation.
- Local hospitals need prompt referral mechanisms in place in order to transfer burn patients to tertiary hospitals with established burn units.
- Healthcare policy needs to be created in LMICS. to ensure that essential emergency services are met and long-term care is provided for those with special needs and disability;
- Health and safety standards in many LMICs are lacking, thus there is an urgent need to establish basic international standards.

Contributors The case report was written and conceived by MC and AR. MC and JRG interviewed the patient. DC was involved in data collection and interpretation of the findings.

Competing interests None declared.

Patient consent Obtained.

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REFERENCES

1 Acosta AS, Azarcon-Lim J, Ramirez AT. Survey of electrical burns in Philippine General Hospital. *Ann N Y Acad Sci* 1999;888:12–18.
2 World Health Organization. World Health Organization Fact sheets. 2014. http://www.who.int/mediacentre/factsheets/fs365/en/
3 World Health Organization. World Health Organization. 2008. http://apps.who.int/iris/bitstream/10665/97852/1/9789241596299_eng.pdf
4 Aghakhani K, Heidari M, Tabatabaee SM, *et al*. Effect of current pathway on mortality and morbidity in electrical burn patients. *Burns* 2015;41:172–6.
5 Kym D, Seo DK, Hur GY, *et al*. Epidemiology of electrical injury: differences between low- and high-voltage electrical injuries during a 7-year study period in South Korea. *Scand J Surg* 2015;104:108–14.
6 Snell JA, Loh NH, Mahambrey T, *et al*. Clinical review: the critical care management of the burn patient. *Crit Care* 2013;17:241.
7 Karimi H, Momeni M, Vasigh M. Long term outcome and follow-up of electrical injury. *J Acute Dis* 2015;4:107–11.
8 Philippine General Hospital. Philippine General Hospital history Alfredo T. Ramirez Burn Unit. 2001. http://www.pgh.gov.ph/en/
9 Philippines Department of Health. Dr. Jose R. Reyes Memorial Medical Center. 2015. http://www.doh.gov.ph/node/3372
10 Wesner ML, Hickie J. Long-term sequelae of electrical injury. *Can Fam Physician* 2013;59:935–9.
11 Shih J, Shahrokhi S, Jeschke M. Review of adult electrical burn injury outcomes worldwide. *J Burn Care Res* 2017;38:e293–8.
12 Occupational safety and health country profile: the Philippines (Occupational Safety and Health). Ilo.org. 2017. http://www.ilo.org/safework/countries/asia/philippines/lang--en/index.htm (accessed 18 Jan 2017).
13 Occupational Safety and Health Center Philippines—Rules and Regulations Implementing Executive Order No. 307. Oshc.dole.gov.ph. 2017. http://www.oshc.dole.gov.ph/122/ (accessed 18 Jan 2017).
14 Conditions B. DOLE-Bureau of Working Conditions. Bwc.dole.gov.ph. 2017. http://www.bwc.dole.gov.ph/ (accessed 18 Jan 2017).
15 Norton R, Kobusingye O. Injuries. *N Engl J Med* 2013;368:1723–30.