

Case Report

Copper wire theft and high voltage electrical burns

Eamon C Francis, Odhran P Shelley

National Burns Unit, Department of Plastic, Reconstructive and Aesthetic Surgery, St James Hospital, Dublin 8, Ireland

Received August 12, 2014; Accepted September 8, 2014; Epub October 26, 2014; Published October 30, 2014

Abstract: High voltage electrical burns are uncommon. However in the midst of our economic recession we are noticing an increasing number of these injuries. Copper wire is a valuable commodity with physical properties as an excellent conductor of electricity making it both ubiquitous in society and prized on the black market. We present two consecutive cases referred to the National Burns Unit who sustained life threatening injuries from the alleged theft of high voltage copper wire and its omnipresence on an international scale.

Keywords: Copper wire, theft, electrical, burns, high voltage

Introduction

As the difficult socio-economic climate continues in our country we are noticing an increasing number of referrals to our institution from alleged theft of high voltage copper wire.

Copper is an important and valuable commodity in society today. In the midst of a global recession in the developed world and rapid expansion in the developing world its demand and value are soaring. Its commercial price tripled alone in 2006 [1]. This has been a persistent stimulus for the theft of copper wire from electrical utilities and consequently high voltage electrical burns.

High voltage electrical burns are often dramatic resulting in severe and sometimes fatal injuries. It is estimated that in the United States alone, one thousand people die annually secondary to high voltage electrical burns and they represent between 3-5% of Burn Unit admissions [2, 3]. Survivors may lose one or more limbs and have extensive damage to adjacent or distant tissues requiring complex reconstructions.

Case series

The first patient was unemployed male in his late twenties who had been on remand from prison. He had reported climbing up an electri-

cal pylon in an electrical supply station while involved in the alleged theft of copper wire, when he sustained a high voltage electrocution > 20,000 volts.

He sustained a 3.5% mixed partial and full thickness burns to both hands and feet and a fractured left clavicle. He required admission to the Coronary Care Unit for telemetry due to a sinus bradycardia and serial cardiac enzyme monitoring. There was a markedly elevated creatinine kinase level > 10,000 μ /L and myoglobinuria, which required intravenous fluid therapy, calcium and bicarbonate infusions.

Upon transfer to our unit underwent debridement and split thickness grafting of his burns combined with a propeller flap reconstruction based on his dorsal metatarsal perforator for a significant left foot wound. He made a full recovery and was discharged with outpatient follow up after an eight week admission.

The second patient was a right hand dominant unemployed male in his late twenties who had been scavenging for copper wire on an industrial estate. He reported picking up copper wire attached to an electrical generator which was live consequently sustaining 2% full thickness burns to his right hand, forearm and axilla. He had an associated deep exit wound on his left praecordium.

Copper wire theft and high voltage electrical burns

This resulted in a compartment syndrome of his right forearm requiring a fasciotomy and an escharotomy. His index finger was non-viable and was amputated at the level of the MCPJ. He was admitted to ICU post operatively for monitoring of his cardiac rhythm and enzymes and as was his creatinine kinase level > 21,000 μ /L. He was successfully treated with intravenous fluid therapy only.

After a delayed transfer it was noted he had volkmann's contractures of his remaining digits and their blood supply was severely compromised. He was brought to theatre where there was found to be long segments of thrombosis in his radial and ulnar arteries. This required bilateral thrombectomies with inter-positional vein grafting to re-anastomose both vessels and perfuse his hand.

However the re-vascularization was not successful and the patient required a formal amputation at the level of his distal forearm at a later date with debridement and split thickness grafting of his exit wound. He was discharged well with outpatient follow up after four week admission.

Discussion

This study is the first in Ireland that highlights the increasing trend of patients being treated with high voltage electrical injuries and their consequences due to the theft of copper wire.

High voltage electrical injuries are conventionally > 1000 volts and can result devastating injuries with significant morbidity and possible mortality [4]. For every reported death, there are two serious injuries and thirty six reported electrical injuries. Fatal injury most often occurs in young males.

The mechanism of a high voltage burn injury is due to electroporation which denatures proteins causing significant skeletal muscle necrosis. This may manifest with disproportionately corresponding external wounds and potential progressive internal damage [5]. The current passes through low-resistance tissues preferentially - blood vessels, nerves, muscle, skin, tendon, and fat are affected first and then bone [6]. In extremities the current path is narrow so the heat produced is concentrated and tissue injury is more extensive. Vascular damage in particular is proportional to the current, voltage

and resistance [7]. Skin resistance is affected by moisture, so the current can be transferred to deeper structures causing significant damage with overlying spared skin [3].

In combination to potentially fatal electrical conductance disturbances there are fatal metabolic changes such as rhabdomyolysis, hyperkalemia, hypocalcaemia and metabolic acidosis. Significant skeletal tissue damage may cause elevated myoglobin and creatinine kinase levels. Monitoring with serial serum and urinary levels is essential. Certain patients may require intravenous fluids to prevent myoglobinuric induced renal failure [6].

There has been a consistent increase worldwide in the price of copper wire particularly fuelled by China's staggering economic growth which has correlated with an increase in copper wire thefts [8]. In the United Kingdom alone the price of copper wire has tripled from £1700 to £4500/per tonne [9]. While our cases highlight small scale opportunistic theft, this practice is being predominantly carried out by organised crime syndicates.

There are published case series from Italy show organized crime targeting electrical and railway industries, leading to severe compromise of these services [10]. The same is true in South Africa where organized crime groups are stealing significant sums of copper wire again from rail and electrical companies costing construction companies more on security than the value of their contracts [11].

This "Red Gold" rush has been well described in the United Kingdom, who have since introduced recommendations to increase security around electricity substations and railway lines [12] and recently in Ireland the national telephone carrier stated there were 200 incidents of metal theft; with 60,000 meters of cable valued at €240,000 taken [13]. In a statement the company said these thefts do result in loss of service to customers. They urged anyone with information about them to contact police [13].

Conclusion

Electrical burns due to the theft of copper wire are a worrying trend that is increasing in our society. It is most commonly in young males. These injuries can result in life changing morbidities and possible mortality. This is at

Copper wire theft and high voltage electrical burns

great cost to both the patient and to society. These injuries are best managed in specialist centre after initial stabilization. Electricity providers and copper wire merchants should enforce stricter precautions both to its access and to its sale and be proactive in reporting suspect thefts. Consideration for the introduction of a formal prevention strategy should be debated to prevent further injury and death.

Disclosure of conflict of interest

Note.

Address correspondence to: Eamon C Francis, National Burns Unit, Department of Plastic, Reconstructive and Aesthetic Surgery, St James Hospital, Dublin 8, Ireland. E-mail: eamonfrancis@rcsi.ie

References

- [1] Report from the Italian Institute of Copper: <http://www.iir.it/rame/statistiche/asp#Prezzi>; http://www.iir.it/rame/caratteristiche_chimico_fisiche.asp; accessed September 4, 2008.
- [2] Spies C, Trohman RG. Narrative review: Electrocution and life-threatening electrical injuries. *Ann Intern Med* 2006; 145: 531-7.
- [3] Koumbourlis AC. Electrical injuries. *Crit Care Med* 2002; 30 Suppl: S424-30.
- [4] DiVincenti FC, Moncrief JA, Pruitt BA Jr. Electrical Injuries: a review of 65 cases. *J Trauma* 1969; 328: 1427-1429.
- [5] Block TA, Aarsvold JN, Matthews KL 2nd, Mintzer RA, River LP, Capelli-Schellpfeffer M, Wollmann RL, Tripathi S, Chen CT, Lee RC. The 1995 Lindberg Award. Nonthermally mediated muscle injury and necrosis in electrical trauma. *J Burn Care Rehabil* 1995; 16: 581-8.
- [6] Baxter CR. Present concepts in the management of major electrical injuries. *Surg Clin North Am* 1970; 20: 1401-18.
- [7] Lee RC. Injury by electrical forces: pathophysiology, manifestations and management. *Curr Probl Surg* 1997; 34: 684.
- [8] Moylan J. The soaring cost of copper thefts. BBC news 05/12/06. http://news.bbc.co.uk/go/pr/fr/-2/hi/uk_news/6207410.stm.
- [9] Organised gangs are thought to be behind the theft of copper cable from construction site of the Channel Tunnel Tail Link (CTRL) in Kent. BBC news 06/12/06. <http://news.bbc.co.uk/go/pr/fr/-2/hi/uknews/England/kent/5088-222.stm>.
- [10] Curinga G, Pietramaggiori G, Scherer SS, Masellis A, Gherardini G, Brancato R, Conte F, Bistoni G. Electrical injuries due to the theft of copper. *J Burn Care Res* 2010; 31: 341-6.
- [11] Report from the Energy Bulletin, 21st November 2006. <http://www.energybulletin.net./22790/html>.
- [12] Baker PA, Al-Benna S, Thompson R, Watson JD. The "redgold" rush and severe electrical burns. *Burns* 2008; 34: 885-7.
- [13] Theft of copper wire an issue for Eircom. <http://www.rte.ie/news/2014/0529/6203-18-train-service-disrupted/>.