Tidsskriftet Tidsskrift for Den norske legeforening

Patients with low-voltage electric shock referred to an Emergency Department

SHORT REPORT

TRUDE BEATHE SVENDSEN*

Faculty of Medicine and Health Sciences
Norwegian University of Science and Technology
She has contributed to data collection, analysis and interpretation, drafting of the manuscript and approval of the submitted version of the manuscript.
Trude Beathe Svendsen, specialty registrar in the Department of Dermatology and Venereology, University Hospital of North Norway, Tromsø. She graduated from the Norwegian University of Science and Technology and undertook foundation year 1 training in the Emergency Departments at St Olav's Hospital, Trondheim University Hospital, Helgeland Hospital Trust, Sandnessjøen and University Hospital of North Norway, Harstad.
The author has completed the ICMJE form and declares no conflicts of interest.

DINA BÆRHEIM*

Faculty of Medicine and Health Sciences
Norwegian University of Science and Technology
She has contributed to data collection, analysis and interpretation, drafting of the manuscript and approval of the submitted version of the manuscript.
Dina Bærheim graduated from the Norwegian University of Science and Technology, completed her foundation training at Stavanger University Hospital and is now a trainee in general practice.
The author has completed the ICMJE form and declares no conflicts of interest.

JOSTEIN DALE

Specialist Department of Emergency Medicine

Division of Emergency Medicine and Prehospital Care
St Olav's Hospital, Trondheim University Hospital
He has contributed to the idea and project design, data interpretation, drafting of the manuscript and approval of the submitted version of the manuscript.
Jostein Dale, senior consultant and director of the Specialist Department of Emergency Medicine.
The author has completed the ICMJE form and declares no conflicts of interest.

LARS OLE GOFFENG

Norwegian National Institute of Occupational Health
He has contributed to data interpretation, specialist expertise and input, drafting of the manuscript and approval of the submitted version of the manuscript.
Lars Ole Goffeng, PhD (Occupational Medicine), psychologist and researcher. He has extensive experience of issues related to electrical accidents.
The author has completed the ICMJE form and declares no conflicts of interest.

SVEND PEDER VESTERFJELL

Emergency Department
Division of Emergency Medicine and Prehospital Care
St Olav's Hospital, Trondheim University Hospital
He has contributed to data interpretation, specialist expertise and input, drafting of the manuscript and approval of the submitted version of the manuscript.
Svend Peder Vesterfjell, senior consultant.
The author has completed the ICMJE form and declares no conflicts of interest.

EIRIK HUGAAS OFSTAD

Emergency Department and Observation Unit
Nordland Hospital Trust
and
University of Tromsø – The Arctic University of Norway
He has contributed to data interpretation, specialist expertise and input, drafting of the manuscript and approval of the submitted version of the manuscript.
Eirik Hugaas Ofstad PhD, specialist in emergency medicine and prehospital care and specialist in general internal medicine, senior consultant and associate professor.

The author has completed the ICMJE form and declares no conflicts of interest.

LARS EIDE NÆSS-PLEYM

Specialist Department of Emergency Medicine
Division of Emergency Medicine and Prehospital Care
St Olav's Hospital, Trondheim University Hospital
and
Norwegian University of Science and Technology
He has contributed to the idea and project design, data analysis and interpretation, drafting of the manuscript and approval of the submitted version of the manuscript.
Lars Eide Næss-Pleym, ICT adviser and doctoral research fellow.
The author has completed the ICMJE form and declares no conflicts of interest.

LARS PETTER BJØRNSEN

lars.p.b.w.bjornsen@ntnu.no
Emergency Department
Division of Emergency Medicine and Prehospital Care
St Olav's Hospital, Trondheim University Hospital
and
Department of Circulation and Medical Imaging
Norwegian University of Science and Technology
He has contributed to the idea and project design, data analysis and interpretation, drafting of the manuscript and approval of the submitted version of the manuscript. He has been chiefly responsible for progression of the work.
Lars Petter Bjørnsen, specialist in emergency medicine, senior consultant and associate professor.
The author has completed the ICMJE form and declares no conflicts of interest.

* Trude Beathe Svendsen and Dina Bærheim contributed equally to this article.

BACKGROUND

Patients exposed to electricity are often referred to the Emergency Department, but guidelines differ as to how they should be managed. In this article, we describe patients with low-voltage electric shock in the Emergency Department at St Olav's Hospital, Trondheim University Hospital.

MATERIAL AND METHOD
Retrospective data from patients referred to the Emergency Department following low-voltage electric shock (< 1,000 V) in the period 1.1.2012–31.12.2017 (N = 210) were included.

RESULTS
The median age was 26 years and 186/210 (89 %) were men. Out of the 210 patients, 165 (79 %) had symptoms following electric shock. Localised pain and chest discomfort occurred in 84/165 (51 %) and 57/165 (35 %) of patients respectively. ECG findings were normal in 168/209 (80 %), and no patients had arrhythmias requiring treatment or elevated troponin T or creatine kinase. No patients had serious complications or died.

INTERPRETATION
Low-voltage electric shock did not cause serious arrhythmias or elevated levels of troponin T or creatine kinase. It should be possible to manage asymptomatic patients with normal findings on clinical examination and ECG in a prehospital setting without reducing patient safety.

Main findings

Out of 210 patients attending the Emergency Department following low-voltage electric shock, 186 (89 %) were young healthy men.

A total of 158 of the 210 patients (75 %) were tradespeople exposed to electric currents at work.

Low-voltage electric shock did not cause serious arrhythmias or elevated levels of troponin T or creatine kinase in any of the patients.

Low-voltage electric shock (< 1,000 V) (1, 2) is more common than high-voltage electric shock (3). Most cases involve young men at work, and many are referred to the Emergency Department (1). There are national and international guidelines for the management of electric shock, but clinical practice varies (2, 4, 5). This study is a survey of patients who were referred to the Emergency Department following low-voltage electric shock.

Material and method

Retrospective data were obtained from patients (N = 210) referred to the Emergency Department at St Olav's Hospital –Trondheim University Hospital, following low-voltage electric shock in the period 1.1.2012–31.12.2017. Patients were included based on the contact reason 'electrical injury' (Emergency Signs and Symptoms (ESS) code *35 Electrical injury* in the Rapid Emergency Triage and Treatment System (RETTS)) (6) in combination with a free text search in

the Emergency Department's database using the following search terms: 'electric current', 'volts' or 'shock' (Figure 1). The collected data included gender, age, occupation, voltage, symptoms, electrocardiography (ECG) findings, levels of troponin T and creatine kinase (CK), as well as 30-day mortality. The study was approved by the data protection officer at St Olav's Hospital, Trondheim University Hospital (ESA 16/9114), and the Regional Committee for Medical and Health Research Ethics (REK) in 2016 (2016/474/REK Midt).

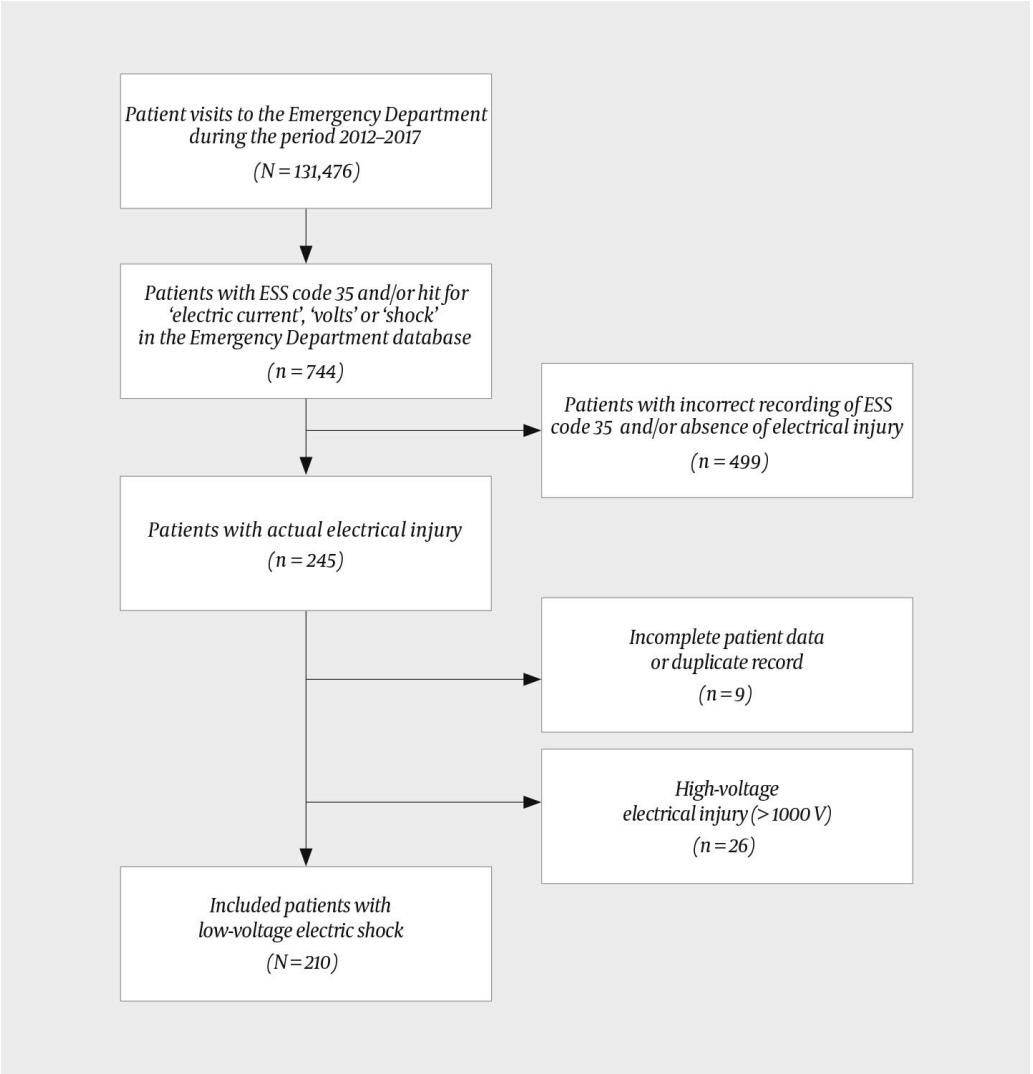

Figure 1 Patient inclusion. Patients were included based on the chief complaint 'electrical injury' (Emergency Signs and Symptoms (ESS) code 35) in the Rapid Emergency Triage and Treatment System (RETTS) (6). This includes electrical accident, lightning strike, inhalation injury, burns, caustic injury, chemical injury, localised cold injury and radiation injury.

Results

Patient characteristics

In the period 1.1.2012–31.12.2017, a total of 245 patients attended the Emergency Department following electric shock. Out of the 245 patients, 210 (89 %) had been exposed to low voltage (< 1000 V). The median age was 26

years (interquartile range 34–22 = 12 years), and 186/210 (89 %) were men. A total of 158/210 (75 %) had been exposed at work, of whom 132/158 (84 %) worked in the electrical or construction trade.

Symptoms

On arrival in the Emergency Department, 45/210 (21 %) of patients were asymptomatic. The most common symptoms are presented in Table 1.

Table 1

Symptoms reported in the Emergency Department following low-voltage electric shock categorised by treatment level, i.e. management in the Emergency Department or admission to the Observation Unit or to a ward. Some patients had multiple symptoms.

Reported symptoms N (%)	All (N = 210)	Discharged from the Emergency Department (n = 103)	Admission (n = 107)
No symptoms	45 (21)	26 (25)	19 (18)
Localised symptoms	84 (40)	37 (36)	47 (44)
Chest discomfort	57 (27)	27 (26)	30 (28)
Malaise	52 (24)	20 (19)	32 (30)
Entrance wounds/burns	24 (11)	9 (8)	15 (14)
Muscular symptoms	12 (6)	7 (7)	5 (5)
Headache and dizziness	26 (12)	9 (9)	17 (16)
Other	10 (5)	3 (3)	7 (7)

Blood tests

Troponin T was measured in 193/210 (94 %) of patients. All test results were within the normal range (< 14 ng/L), apart from 2 cases with slightly elevated levels (16 ng/L and 18 ng/L), which had returned to normal when second tests were taken after 6 hours. Creatine kinase was measured in 88/210 (42 %) of cases, with 5 patients having slightly elevated levels, 1,600–2,528 U/L (normal range 50–400 U/L).

ECG findings

Almost all patients underwent a 12-lead ECG (209/210). All were in sinus rhythm, but 41/209 (20 %) of the ECGs were interpreted as abnormal. Of those with abnormal ECG findings, 30/41 (73 %) underwent a repeat ECG during their care. The following persistent abnormalities were detected: right bundle branch block, juvenile ST elevations, T-wave changes and second-degree AV block (Mobitz type 1/Wenckebach). In 10/30 (33 %) of those whose subsequent ECG returned to normal, the abnormality was T-wave changes or ventricular extrasystole.

Treatment level, repeat contact and mortality

Out of the 210 patients, 103 (49 %) were investigated and managed in the Emergency Department, while the remaining patients were observed in hospital. None of these patients required treatment. No patients died within 30 days, but 5 patients were in subsequent contact with the specialist health service. Repeated observation and cardiac investigation with ECG, troponin T measurement and echocardiography in these patients revealed no abnormalities.

Discussion

In the study, we looked at patients referred to an Emergency Department following low-voltage electric shock. The majority were healthy young men exposed to electrical current in the course of their work. This is consistent with previous studies (1, 2). The proportion of asymptomatic patients was higher in our study than in a study from Germany and Austria (21 % versus 8 %) (1). One reason may be the fact that as many as 67 % of patients in the foreign study were exposed to voltages higher than domestic current (220–230 V), as well as the fact that abnormal blood test results are classed as symptoms.

Abnormal ECG findings were reported in 41/209 (20 %) of the patients. This is slightly higher than in another Norwegian study (17 %) and in a European study (14 %) (1, 2). The difference from the foreign study is that in Norway many patients with minimal symptoms and normal ECG findings would be managed by the urgent care service. Ventricular extrasystole and non-specific ST-T changes are not uncommon in healthy young individuals (1, 3, 4), but since no previous electrocardiograms were available for comparison, it is not possible to say whether the abnormalities in our study were due to electric shock (7). One asymptomatic patient was diagnosed with Mobitz type I. These types of disorders have been described in patients exposed to low-voltage electric current (8), but can also occur in healthy young athletes with no underlying heart disease due to increased parasympathetic activity (9, 10). All the abnormalities were considered to have a good prognosis and did not require further investigation or treatment. As in previous studies, our findings provide evidence that normal or unchanged ECG findings at an early stage predict the absence of arrhythmias (1, 2, 11). Nevertheless, a resolution of some ECG abnormalities may indicate that there may be a short-term non-clinically significant cardiac impact in some patients.

Troponin T has been regarded as a marker of myocardial injury following electrical accidents (3). We found slightly elevated levels of troponin T in 2/193 (1 %) of patients, which is consistent with another Norwegian study (2). Creatine kinase findings were also comparable with this study. Creatine kinase is a marker of muscle damage, not a cardiac marker, and any increase is primarily associated with muscle necrosis following high-voltage electrical injury in particular (12). The study provides no evidence that low-voltage electrical shock results in a clinically significant release of troponin T or

creatine kinase. Troponin T and creatine kinase should mainly be analysed in patients with abnormal findings on clinical examination or ECG following low-voltage electric shock (1).

Limitations

The limitation of the study is that the retrospective data collection was carried out from just one Emergency Department. Information from other parts of the health service was not available, and the follow-up of patients within 30 days was limited to just the specialist health service of the regional health authority. The study does not reveal situation-specific factors in the exposure to electric current that may have affected the severity.

Conclusion

Our study shows that patients attending the Emergency Department following low-voltage electric shock did not have elevated troponin T, elevated creatine kinase or arrhythmias requiring treatment. We believe that most patients could be effectively managed based on patient history, a clinical examination and ECG. Asymptomatic patients with normal findings on clinical examination can be handled in a prehospital setting or in the primary healthcare service without referral to hospital.

The article has been peer-reviewed.

LITERATURE

1. Warenits AM, Aman M, Zanon C et al. International Multi-Center Analysis of In-hospital Morbidity and Mortality of Low-Voltage Electrical Injuries. Front Med (Lausanne) 2020; 7: 590758. [CrossRef]

2. Ahmed J, Stenkula C, Omar S et al. Patient outcomes after electrical injury - a retrospective study. Scand J Trauma Resusc Emerg Med 2021; 29: 114. [CrossRef]

3. Waldmann V, Narayanan K, Combes N et al. Electrical cardiac injuries: current concepts and management. Eur Heart J 2018; 39: 1459–65. [CrossRef]

4. Veiersted KB, Goffeng LO, Moian R et al. Akutte og kroniske skader etter strømulykker. Tidsskr Nor Lægeforen 2003; 123: 2453–6.

5. Arnoldo BD, Purdue GF. The diagnosis and management of electrical injuries. Hand Clin 2009; 25: 469–79. [CrossRef]

6. Widgren BR, Jourak M. Medical Emergency Triage and Treatment System (METTS): a new protocol in primary triage and secondary priority decision in emergency medicine. J Emerg Med 2011; 40: 623–8. [CrossRef]

7. Krämer C, Pfister R, Boekels T et al. Cardiac monitoring always required after electrical injuries? Med Klin Intensivmed Notf Med 2016; 111: 708–14.

[CrossRef]

8. Robinson NM, Chamberlain DA. Electrical injury to the heart may cause long-term damage to conducting tissue: a hypothesis and review of the literature. Int J Cardiol 1996; 53: 273–7. [CrossRef]

9. Drezner JA, Sharma S, Baggish A et al. International criteria for electrocardiographic interpretation in athletes: Consensus statement. Br J Sports Med 2017; 51: 704–31. [CrossRef]

10. Zehender M, Meinertz T, Keul J et al. ECG variants and cardiac arrhythmias in athletes: clinical relevance and prognostic importance. Am Heart J 1990; 119: 1378–91. [CrossRef]

11. Bailey B, Gaudreault P, Thivierge RL. Cardiac monitoring of high-risk patients after an electrical injury: a prospective multicentre study. Emerg Med J 2007; 24: 348–52. [CrossRef]

12. Aygün D, Gönüllü H. The myopathic effects of electrical injury. Ulus Travma Acil Cerrahi Derg 2010; 16: 225–8.

Publisert: 6 January 2022. Tidsskr Nor Legeforen. DOI: 10.4045/tidsskr.21.0415
Received 15.5.2021, first revision submitted 19.9.2021, accepted 1.11.2021.