Tidsskriftet Tidsskrift for Den norske legeforening

Low-voltage electric shock – proposed new recommendations

OPINIONS

LARS PETTER BJØRNSEN

lars.p.b.w.bjornsen@ntnu.no
Lars Petter Bjørnsen, specialist in emergency medicine, senior consultant at the Division of Emergency Medicine and Prehospital Care, St Olav's Hospital, Trondheim University Hospital, and associate professor at the Norwegian University of Science and Technology.
The author has completed the ICMJE form and declares no conflicts of interest.

TRUDE BEATHE SVENDSEN

Trude Beathe Svendsen, specialty registrar in the Department of Dermatology and Venereology, University Hospital of North Norway, Tromsø.
The author has completed the ICMJE form and declares no conflicts of interest.

DINA BÆRHEIM

Dina Bærheim, specialty registrar in general practice, Hjelmeland municipality in Rogaland.
The author has completed the ICMJE form and declares no conflicts of interest.

JOSTEIN DALE

Jostein Dale, senior consultant and director of the Specialist Department of Emergency Medicine, St Olav's Hospital, Trondheim University Hospital.
The author has completed the ICMJE form and declares no conflicts of interest.

SVEND PEDER VESTERFJELL

Svend Peder Vesterfjell, specialist in emergency medicine and prehospital care, senior consultant at the Division of Emergency Medicine and Prehospital Care, St Olav's Hospital, Trondheim University Hospital.
The author has completed the ICMJE form and declares no conflicts of interest.

EIRIK HUGAAS OFSTAD

Eirik Hugaas Ofstad, PhD, specialist in emergency medicine and prehospital care and specialist in general internal medicine, senior consultant at the Emergency Department and Observation Unit, Nordland Hospital Trust, and associate professor at University of Tromsø – The Arctic University of Norway.
The author has completed the ICMJE form and declares no conflicts of interest.

LARS EIDE NÆSS-PLEYM

Lars Eide Næss-Pleym, ICT adviser at the Division of Emergency Medicine and Prehospital Care, St Olav's Hospital, Trondheim University Hospital, and doctoral research fellow at the Norwegian University of Science and Technology.
The author has completed the ICMJE form and declares no conflicts of interest.

LARS OLE GOFFENG

Lars Ole Goffeng, PhD (Occupational Medicine), psychologist and researcher at the Norwegian National Institute of Occupational Health. He has extensive experience of issues related to electrical accidents.
The author has completed the ICMJE form and declares no conflicts of interest.

We propose new recommendations for the emergency treatment of low-voltage electric injuries (<1 000 volts). A large proportion of these patients can be treated as outpatients.

Electricity can cause injuries of varying severity, from no health consequences to death (1). In the last 20 years, the number of reported electrical injuries in Norway has increased from 50 in 2000 to 500 in 2020 (2). The rise is attributed to increased reporting of minor accidents (2). The reported extent of injuries and type of exposure also vary more than previously.

Today, some patients exposed to low-voltage electricity are treated by the urgent care service, while others are referred to the Emergency Department. We believe that there is still great variation in the treatment of this patient

population, as described by Veiersted et al. in 2003 (3). There are currently a number of recommendations for treatment in the acute phase following an electric injury (3–8). Several either focus primarily on the risk of heart complications (7–9), or are very extensive (3). In general, earlier recommendations have addressed patients with severe symptoms and potential cardiac impact, and have been less differentiated in terms of the extent of injury and the level of treatment patients should receive. There is a dearth of recommendations that are based on recent Norwegian experiences and take into account the full range of injuries and the extent of exposure.

> ***«There is a dearth of recommendations that are based on recent Norwegian experiences and take into account the full range of injuries and the extent of exposure»***

A survey we conducted at St Olav's Hospital suggests that a large proportion of patients with low-voltage electric injuries can be examined and treated outside the hospital setting, without diminishing patient safety (10). Based on earlier recommendations, our clinical experiences and recent literature on the risk of sequelae following low-voltage accidents (11), we present a proposal for an algorithm for the urgent treatment of patients who have experienced a low-voltage electric shock (Figure 1).

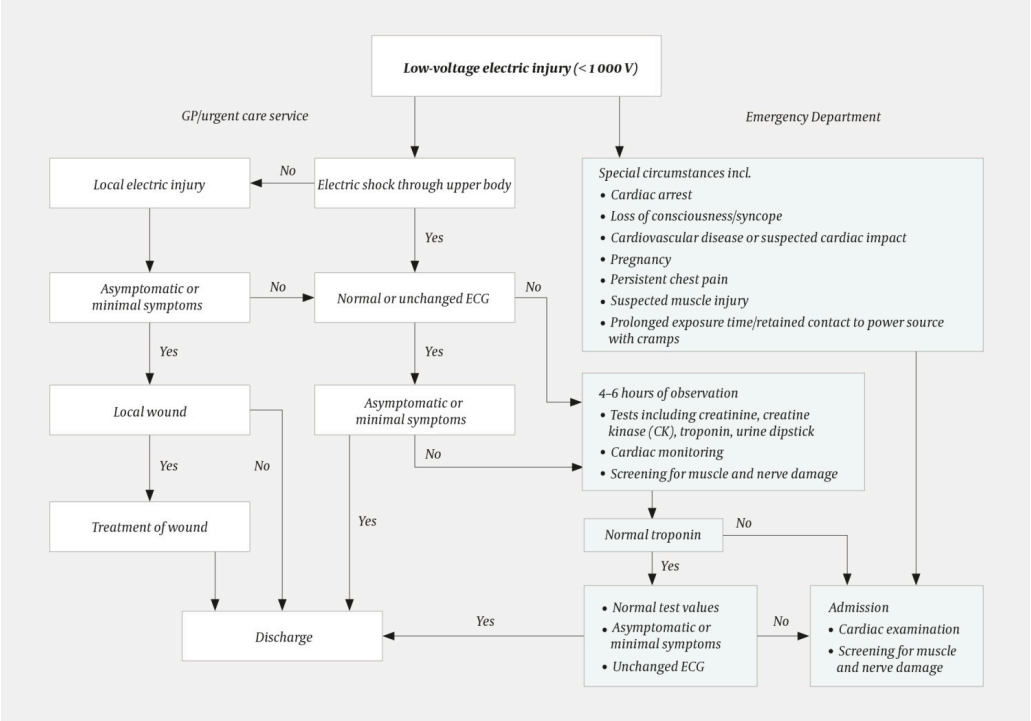

Figure 1 Proposed algorithm for the urgent treatment of patients following a low-voltage electric shock. Assessment components in the white area can be performed in the primary health service or in a prehospital setting, while components in the green area are dealt with in the Emergency Department. Minimal symptoms include local pain/tenderness, mild paraesthesia, redness of the skin and lethargy.

Proposal for new recommendations

Patients who are exposed to low-voltage currents without experiencing an electric shock in the upper body do not need further investigation if they have no or minimal symptoms and normal findings at a general clinical examination (12). Minimal symptoms are defined as, for example, local pain/tenderness, mild paraesthesia, redness of the skin, malaise and lethargy. These are considered to be a temporary reaction to electric shock and do not require interventions or further investigation in the acute phase. Following treatment for any local wounds, these patients can be sent home from the urgent care service, occupational health service or the Emergency Department (13). For more pronounced symptoms, an ECG should be performed.

If the current has passed through a patient's upper body, an ECG should be mandatory. Patients without symptoms or with only minimal symptoms who have no ECG changes do not require to be kept under observation, monitored or hospitalised (14). Troponin and creatine kinase isoenzyme MB (CKMB) are of limited value in the risk assessment of these patients (15). Initial assessment can be carried out by the urgent care service, or a GP or company doctor.

If new ECG changes are found and/or the patient has more than the minimum symptoms, blood sampling, a urine dipstick test, further monitoring and observation should be performed. After 4–6 hours of observation, asymptomatic patients with normal test results and unchanged ECG findings can be sent home (Figure 1) (13, 16). In the event of persistent abnormalities, development of dynamic ECG changes or symptoms that suggest cardiac impact, patients should be further monitored and undergo cardiological examination. In cases of anamnestic suspicion of severe cardiac impact, heart disease or other special circumstances (Figure 1), it is recommended that the patient be referred to hospital for observation, monitoring and possible further examination (17). Pregnant women should have an obstetric consultation (13).

> ***«It is important to document muscle and nerve effects in all patients. Such documentation can have implications for treatment, entitlement to welfare benefits and compensation»***

It is important to document muscle and nerve effects in all patients. Such documentation can have implications for treatment, entitlement to welfare benefits and compensation. Where there are obvious signs of nerve damage, such as paresis, a neurologist should be consulted in the acute phase. Some tingling and slight paraesthesia are common in the initial phase. Symptoms that last longer than a few days should be followed up by a GP (18). Sequelae may also occur after exposure.

The development of rhabdomyolysis has been described in cases of low-voltage electric shock (19), but other studies have not shown rhabdomyolysis that requires treatment (15). If muscle damage is suspected, the patient needs to be referred to the Emergency Department for further examination, including a

urine dipstick (haematuria) and CK test. The time of the accident must be recorded for this reason (19). Muscle damage and abnormalities in urine samples or blood tests (CK) are consistent with rhabdomyolysis.

A wider focus

In our proposal for a new emergency treatment algorithm for low-voltage electric shocks, the circumstances surrounding exposure to electricity and symptomatology guide the need for further investigation and observation. The main focus is on detecting cardiac or muscular complications. For example, when a patient has remained in contact with the power source, this will impact on the emergency follow-up as it prolongs their exposure time and increases the risk of tissue heating and damage.

The algorithm takes into account that the main observed late effects are not related to the risk of cardiac arrhythmias in the long term, but rather to the development of symptoms from the nervous system and musculoskeletal system as well as cognitive or post-traumatic symptoms, which are also assessed for sampling and other documentation in the acute phase. The proposal therefore bridges the gap between the primary focus on emergency medical treatment and knowledge about late effects following an electric shock, which is more relevant in rehabilitation and social insurance medicine.

Information to patients

Upon discharge, treated patients must be told to contact the urgent care service or their GP if they experience palpitations, chest pain, syncope, increasing muscle pain, paraesthesia or a rise in temperature (12). Since late effects can occur (1, 11, 20), patients should be encouraged to consult their GP if their symptoms persist. Patients should be informed about the possibility of experiencing chronic pain, numbness and mental impact, which should be followed up by a GP. Sequelae can also occur after exposure (11, 18).

Summary

Based on a review of earlier emergency treatment recommendations and six years of experience with emergency assessments of electric shock patients at St Olav's Hospital, we have described a new algorithmic approach based on appropriate treatment that is differentiated according to the acute clinical picture and exposure factors. We believe that this algorithm safeguards patient safety in the acute assessment of patients exposed to low-voltage electric injuries.

REFERENCES

1. Theman K, Singerman J, Gomez M et al. Return to work after low voltage electrical injury. J Burn Care Res 2008; 29: 959–64. [PubMed][CrossRef]

2. Direktoratet for sammfunnssikkerhet og beredskap. Elsikkerhet 93. Rapport nr. 1/2021. https://www.dsb.no/globalassets/dokumenter/elsikkerhet-els/elsikkerhet-magasinet/elsikkerhet-nr.-93.pdf Accessed 26.1.2022.

3. Veiersted KB, Goffeng LO, Moian R et al. Akutte og kroniske skader etter stromulykker. Tidsskr Nor Lægeforen 2003; 123: 2453–6. [PubMed]

4. Kobernick M. Electrical injuries: pathophysiology and emergency management. Ann Emerg Med 1982; 11: 633–8. [PubMed][CrossRef]

5. Lippestad C, Erikssen J, Vaagenes P et al. Strømskader. Patofysiologi og behandlingsprinsipper. Tidsskr Nor Lægeforen 1990; 110: 948–52. [PubMed]

6. Fish RM. Electric injury, part III: cardiac monitoring indications, the pregnant patient, and lightning. J Emerg Med 2000; 18: 181–7. [PubMed] [CrossRef]

7. Waldmann V, Narayanan K, Combes N et al. Electrical injury. BMJ 2017; 357: j1418. [PubMed][CrossRef]

8. 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. [PubMed][CrossRef]

9. Truhlář A, Deakin CD, Soar J et al. European Resuscitation Council Guidelines for Resuscitation 2015: Section 4. Cardiac arrest in special circumstances. Resuscitation 2015; 95: 148–201. [PubMed][CrossRef]

10. Svendsen TB, Bærheim D, Dale J et al. Pasienter med strømgjennomgang fra lavspenning henvist til et akuttmottak. Tidsskr Nor Legeforen 2021; 141. doi: 10.4045/tidsskr.21.0415. [PubMed][CrossRef]

11. Thomée S, Österberg K, Rådman L et al. Cognition and mental wellbeing after electrical accidents: a survey and a clinical study among Swedish male electricians. Int Arch Occup Environ Health 2020; 93: 683–96. [PubMed] [CrossRef]

12. Gentges J, Schieche C. Electrical injuries in the emergency department: an evidence-based review. Emerg Med Pract 2018; 20: 1–20.

13. Jain S, Bandi V. Electrical and lightning injuries. Crit Care Clin 1999; 15: 319–31. [PubMed][CrossRef]

14. Searle J, Slagman A, Maaß W et al. Cardiac monitoring in patients with electrical injuries. An analysis of 268 patients at the Charité Hospital. Dtsch Arztebl Int 2013; 110: 847–53. [PubMed]

15. Pilecky D, Vamos M, Bogyi P et al. Risk of cardiac arrhythmias after electrical accident: a single-center study of 480 patients. Clin Res Cardiol 2019; 108: 901–8. [PubMed][CrossRef]

16. Blackwell N, Hayllar J. A three year prospective audit of 212 presentations to the emergency department after electrical injury with a management protocol. Postgrad Med J 2002; 78: 283–5. [PubMed][CrossRef]

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

18. Tondel M, Blomqvist A, Jakobsson K et al. Elolyckor kan ge skador som visar sig efter lang tid. Lakartidningen 2016; 113:D7CL. https://lakartidningen.se/klinik-och-vetenskap-1/artiklar-1/klinisk-oversikt/2016/12/elolyckor-kan-ge-skador-som-visar-sig-efter-lang-tid/ Accessed 26.1.2022.

19. Goffeng LO, Stormoen DR, Veiersted KB. Elektrikerlærling skadet av strømgjennomgang. Tidsskr Nor Legeforen 2018; 138. doi: 10.4045/tidsskr.17.0613. [PubMed][CrossRef]

20. Hahn-Ketter AE, Whiteside DM, Pliskin N et al. Long-term consequences of electrical injury: neuropsychological predictors of adjustment. Clin Neuropsychol 2016; 30: 216–27. [PubMed][CrossRef]

Publisert: 28 February 2022. Tidsskr Nor Legeforen. DOI: 10.4045/tidsskr.21.0880
Received 10.12.2021, first revision submitted 24.1.2022, accepted 26.1.2022.