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ORIGINAL PAPER



Arrhythmias and laboratory abnormalities after an electrical accident: a single-center, retrospective study of 333 cases

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Východisko studie



- ročně stovky případů úrazu el. proudem v ČR
(ve FN Plzeň průměrně 18 případů/rok)
- absence doporučených postupů a odborných stanovisek
- hospitalizace a blokování monitorovaného lůžka
v případech, které to nevyžadují

Retrospektivní studie ve FN Plzeň



- retrospektivní analýza dat v období **2000 - 2020**
- **333** případů úrazu elektrickým proudem
- **kritéria:** příjmová/aktuální/závěrečná diagnóza **T754** (úraz elektrickým proudem)
- **zkoumané charakteristiky:**
 1. pohlaví, věk, komorbidita
 2. napětí el. proudu
 3. doba hospitalizace, doba EKG monitorace
 4. provedená laboratorní vyšetření a jejich výsledky
 5. důsledky úrazu el. proudem: úmrtí, arytmie, poruchy vedení, porucha vědomí, popáleniny, iontové dysbalance, ad.

Charakteristika populace a okolnosti úrazu el. proudem



	All patients (n = 333)	Adult patients (n = 229)	Pediatric patients (n = 104)
Age (years, mean $\pm$ SD)	25.96 $\pm$ 17.61	34.87 $\pm$ 13.5	6.33 $\pm$ 5.55
Age groups			
15–18 years	–	–	13 (12.50%)
10–15 years	–	–	22 (21.15%)
5–10 years	–	–	8 (7.69%)
1–5 years	–	–	58 (55.77%)
< 1 year	–	–	3 (2.88%)
Male/female	222/111 (66.67/33.33%)	155/74 (67.69/32.31%)	67/37 (64.42/35.58%)
Actual pregnancy	5 (1.50%)	5 (1.50%)	–
Medical history			
Structural heart disease	9 (2.70%)	6 (2.62%)	3 (2.88%)
Coronary heart disease	6 (1.80%)	6 (2.62%)	–
Heart failure	3 (0.90%)	3 (1.31%)	–
Cardiac surgery	3 (0.90%)	2 (0.87%)	1 (0.96%)
Arrhythmias	11 (3.30%)	10 (4.37%)	1 (0.96%)
Bundle branch blocks	8 (2.40%)	6 (2.62%)	2 (1.92%)
Atrioventricular blocks	3 (0.90%)	3 (1.31%)	–
History of palpitations	3 (0.90%)	3 (1.31%)	–
Pacemakers, ICDs	5 (1.50%)	5 (2.18%)	–
Arterial hypertension	28 (8.41%)	28 (12.23%)	–
Diabetes mellitus	7 (2.10%)	7 (3.06%)	–
Hyperlipidemia	29 (8.71%)	29 (12.66%)	–
Kidney disease	6 (1.80%)	3 (1.31%)	3 (2.88%)
Bronchial asthma/COPD	13 (3.90%)	10 (4.37%)	3 (2.88%)
Thyroid gland disease	8 (2.40%)	7 (3.06%)	1 (0.96%)
Malignancy	5 (1.50%)	5 (2.18%)	–
Stroke	1 (0.30%)	1 (0.44%)	–

	All patients (n = 333)	Adult patients (n = 229)	Pediatric patients (n = 104)
Voltage of the source			
Small (< 50 V)	2 (0.60%)	1 (0.44%)	1 (0.96%)
Low (50–1000 V)	303 (90.99%)	203 (88.65%)	100 (96.15%)
High (1000–52 000 V)	16 (4.80%)	13 (5.68%)	3 (2.88%)
Unknown	12 (3.60%)	12 (5.24%)	–
Lightning	1 (0.30%)	1 (0.44%)	–
Direct current	6 (1.80%)	6 (2.62%)	–
Suicide attempt	2 (0.60%)	2 (0.87%)	–
Workplace accident	49 (14.71%)	48 (20.96%)	1 (0.96%)

Hospitalizace a EKG monitorace



	All patients (<i>n</i> = 333)	Adult population (<i>n</i> = 229)	Pediatric population (<i>n</i> = 104)
Hospitalization	326 (97.90%)	227 (99.13%)	99 (95.19%)
Refusal of hospitalization	4 (1.20%)	4 (1.75%)	–
Continuous ECG monitoring	258 (77.48%)	196 (85.59%)	62 (59.62%)
Duration of hospitalization (days, mean)	3.53	3.74	2.95
Without those longer than 30 days	1.55	1.64	1.34
Without those longer than 7 days	1.14	1.10	1.21
Discharge	310 (93.09%)	215 (93.89%)	95 (91.35%)
Transfer to another department	16 (4.80%)	14 (6.11%)	2 (1.92%)
Transfer to another hospital	13 (3.90%)	10 (4.37%)	3 (2.88%)
30-day mortality	2 (0.60%)	1 (0.44%)	1 (0.96%)
1-year mortality	4 (1.20%)	3 (1.31%)	1 (0.96%)

Výskyt arytmií

	All patients (n = 333)	Adult patients (n = 229)	Pediatric patients (n = 104)
Arrhythmias/dysrhythmias	39 (11.71%)	36 (15.72%)	3 (2.88%)
<u>Ventricular fibrillation</u>	8 (2.40%)	7 (3.06%)	1 (0.96%)
Sinus tachycardia	14 (4.20%)	14 (6.11%)	–
Sinus bradycardia	11 (3.30%)	9 (3.93%)	2 (1.92%)
Sinus arrhythmia	2 (0.60%)	2 (0.87%)	–
Atrial fibrillation	4 (1.20%)	4 (1.75%)	–
SVT	1 (0.30%)	1 (0.44%)	–
Unspecified tachycardia	1 (0.30%)	1 (0.44%)	–
Premature complexes	10 (3.00%)	8 (3.49%)	2 (1.92%)
Supraventricular	4 (1.20%)	4 (1.75%)	–
Ventricular	5 (1.50%)	4 (1.75%)	1 (0.96%)
Unknown	1 (0.30%)	–	1 (0.96%)
Cardiac conduction abnormalities	26 (7.81%)	26 (11.35%)	–
LAH	2 (0.60%)	2 (0.87%)	–
IRBBB/ intermit. iRBBB	21 (6.31%)/2 (0.60%)	21 (9.17%)/2 (0.87%)	normal finding
RBBB/ intermit. RBBB	1 (0.30%)/1 (0.30%)	1 (0.44%)/1 (0.44%)	–
SAB (second degree)	1 (0.30%)	1 (0.44%)	–
AVB (first degree)	1 (0.30%)	1 (0.44%)	–
ECG changes of ST/T	10 (3.00%)	9 (3.93%)	1 (0.96%)
ST elevation	2 (0.60%)	1 (0.44%)	1 (0.96%)
ST depression	5 (1.50%)	5 (2.18%)	–
Negative T wave	3 (0.90%)	3 (1.31%)	normal finding
Cardiac decompensation	1 (0.30%)	1 (0.44%)	–
Newly dg. systolic dysfunction	5 (1.50%)	3 (1.31%)	2 (1.92%)

SVT supraventricular tachycardia, iRBBB incomplete right bundle branch block, RBBB complete right bundle branch block, intermit. intermitent, SAB sinoatrial block, AVB atrioventricular block, dg. diagnosed



Maligní arytmie

- 8 případů během 20 let
- nebyl nalezen jasný predisponující faktor

muži

Age	Sex	Voltage	Year	Medical history	Trauma	Burns	Death
16	M	Low	2002	–	No	No	Yes
24	M	Unknown	2004	–	No	No	Yes
39	M	High	2000	paroxysmal atrial fibrillation, tick-borne encephalitis at age 38	Yes	3°	No
43	F	Low	2002	–	No	No	No
44	M	High	2005	rib fractures at age 19	No	3°	No
47	M	Low	2011	–	No	3°	No
50	M	Low	2012	–	No	No	No
58	M	Low	2013	concomitant subacute MI	No	No	Yes

mortalita 37,5%

nízké napětí

Opožděné maligní arytmie

- žádný výskyt
ve shodě s dalšími
obdobnými studiemi
- publikovány 2002 - 2019

Pilecky D, Vamos M, Bogyi P et al (2019) Risk of cardiac arrhythmias after electrical accident: a single-center study of 480 patients. Clin Res Cardiol 108(8):901–908

Akkaş M, Hocagil H, Ay D, Erbil B, Kunt MM, Ozmen MM (2012) Cardiac monitoring in patients with electrocution injury. Ulus Travma Acil Cerrahi Derg 18(4):301–305

Bailey B, Gaudreault P, Thivierge RL (2007) Cardiac monitoring of high-risk patients after an electrical injury: a prospective multicentre study. Emerg Med J 24:348–352

Pawlik AM, Lampart A, Stephan FP, Bingisser R, Ummenhofer W, Nickel CH (2016) Outcomes of electrical injuries in the emergency department: a 10-year retrospective study. Eur J Emerg Med 23(6):448–454

Blackwell N, Hayllar J (2002) A three year prospective audit of 212 presentations to the emergency department after electrical injury with a management protocol. Postgrad Med J 78:283–285

Krämer C, Pfister R, Boekels T, Michels G (2016) Cardiac monitoring always required after electrical injuries? Medizinische Klin 111(8):708–714

Bailey B, Gaudreault P, Thivierge RL (2007) Cardiac monitoring of high-risk patients after an electrical injury: a prospective multicentre study. Emerg Med J 24:348–352



Laboratorní vyšetření

- myoglobin, CK - neužitečné
- cTn - diskutabilní, nejeví se jako vhodné pro rutinní použití
- iontogram !

	All patients (n = 333)	Adult popula- tion (n = 229)	Pediatric population (n = 104)
Total	67 (20.12%)	58 (25.33%)	9 (8.65%)
Hypokalemia	60 (18.02%)	55 (24.02%)	5 (4.81%)
Hypocalcemia	11 (3.30%)	8 (3.49%)	3 (2.88%)
Hypomagnesaemia	8 (2.40%)	6 (2.62%)	2 (1.92%)
Hypophosphatemia	5 (1.50%)	5 (2.18%)	–
Hyponatremia	4 (1.20%)	4 (1.75%)	–
Hyperkalemia	4 (1.20%)	3 (1.31%)	1 (0.96%)
Hypercalcemia	3 (0.90%)	2 (0.87%)	1 (0.96%)
Hypermagnesemia	1 (0.30%)	1 (0.44%)	–
Hyperphosphatemia	1 (0.30%)	1 (0.44%)	–

Laboratorní vyšetření

- statisticky významně vyšší výskyt arytmii a poruch vedení u pacientů s iontovou dysbalancí

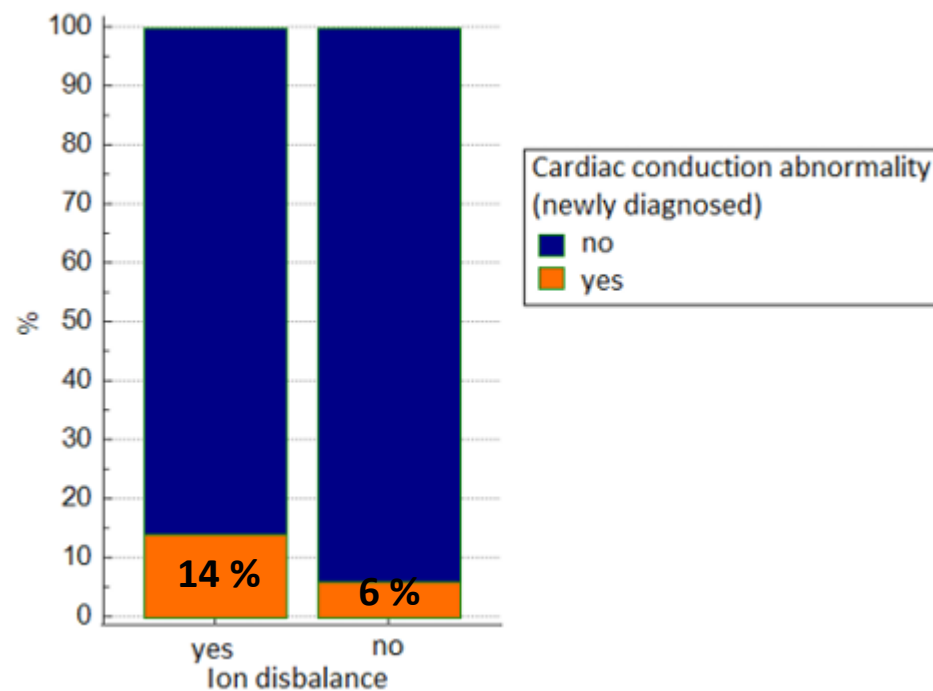
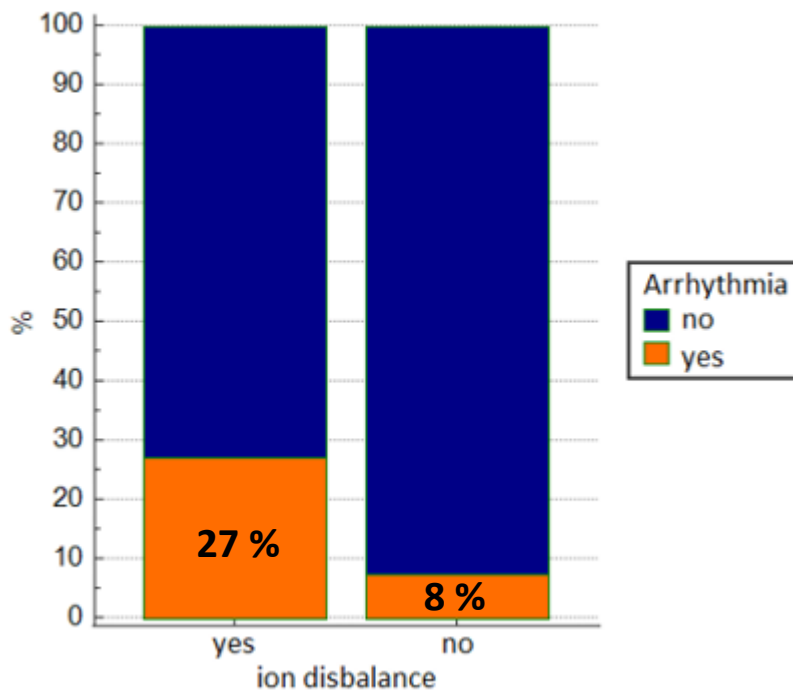
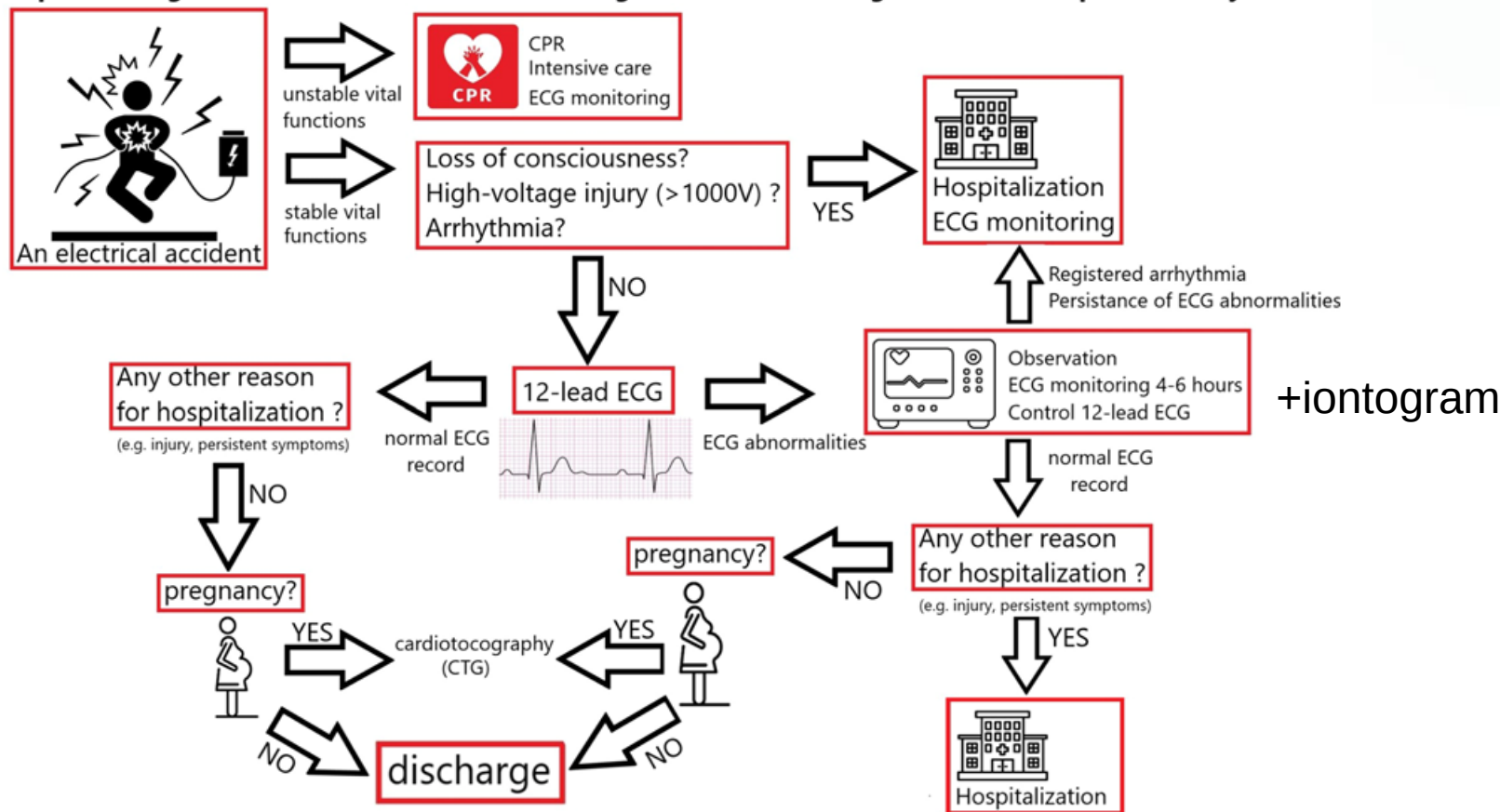


Schéma vytvořené na základě výsledků studie a nyní používané ve FN Plzeň

A possible algorithm for electrical accident management based on single-center retrospective study

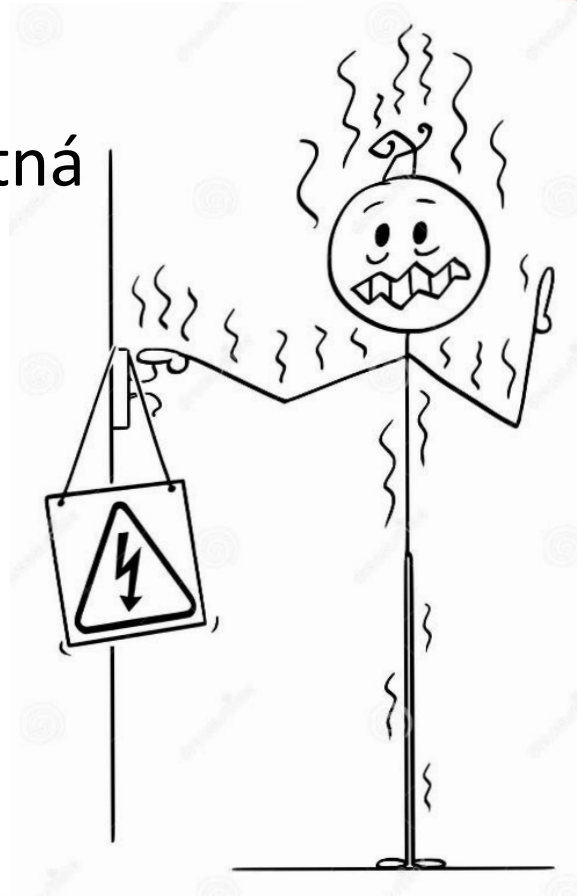


Úraz elektrickým proudem - závěry

Hospitalizace ve většině případů není nutná

Vhodná metaanalýza provedených studií

Doporučené postupy

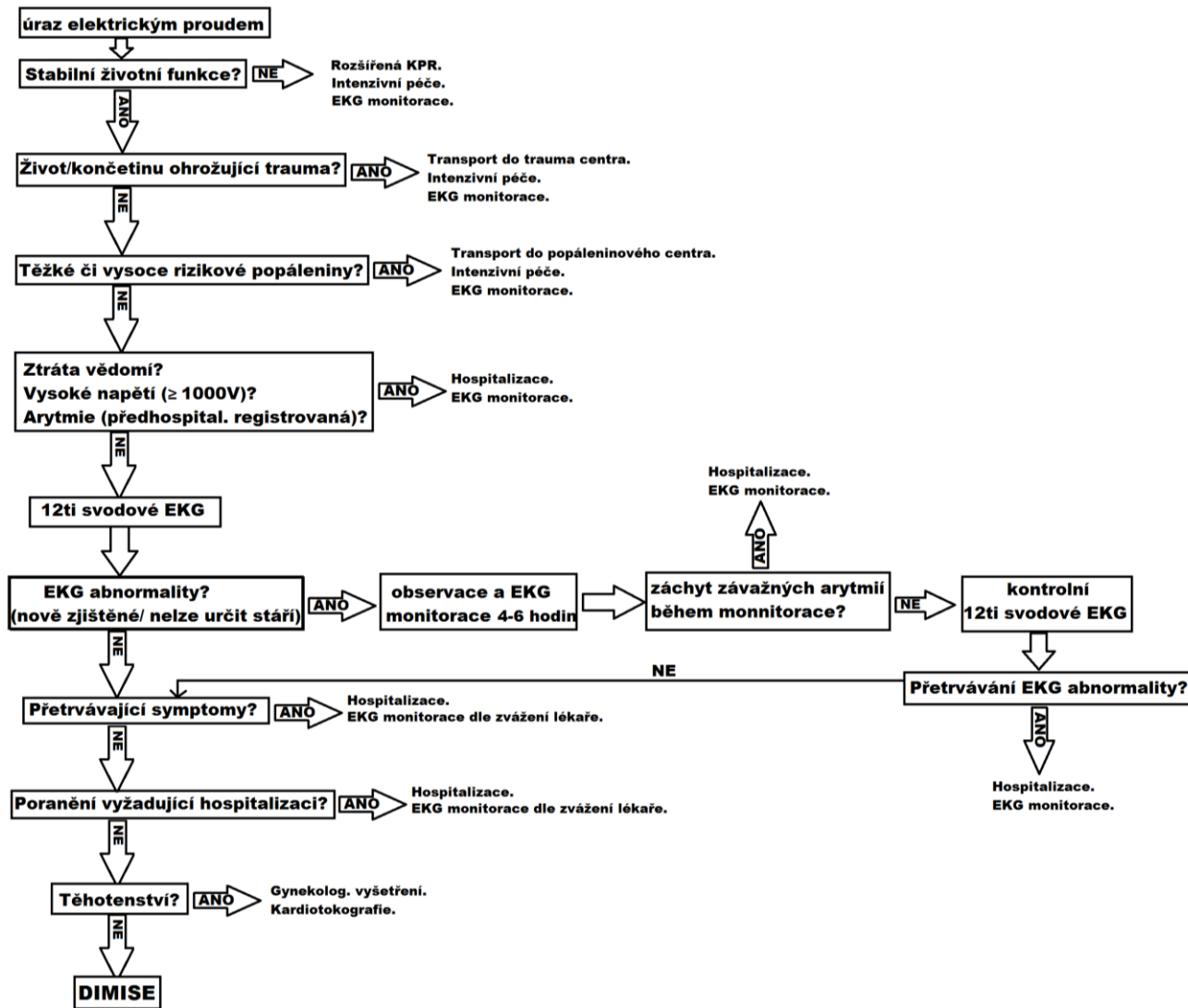


Další důsledky úrazu el. proudem



	All patients (n = 333)	Adult population (n = 229)	Pediatric population (n = 104)			
Death	4 (1.20%)	3 (1.31%)	1 (0.96%)			
Death due to electrocution	3 (0.90%)	2 (0.87%)	1 (0.96%)			
Cardiopulmonary resuscitation	11 (3.30%)	10 (4.37%)	Concomitant traumatic injuries	41 (12.31%)	28 (12.23%)	13 (12.50%)
Respiratory arrest/disorder	2 (0.60%)	1 (0.44%)	Fractures	14 (4.20%)	10 (4.37%)	4 (3.85%)
Loss of consciousness	31 (9.31%)	26 (11.35%)	(Sub)luxations	3 (0.90%)	2 (0.87%)	1 (0.96%)
Skin burns	101 (30.33%)	49 (21.40%)	Lacerated/incised wounds	6 (1.80%)	5 (2.18%)	1 (0.96%)
1st degree	11 (3.30%)	4 (1.75%)	Traumatic brain injury	11 (3.30%)	7 (3.06%)	4 (3.85%)
1st–2nd degree	6 (1.80%)	3 (1.31%)	Lung contusion	4 (1.20%)	2 (0.87%)	2 (1.92%)
2nd degree	46 (13.81%)	16 (6.99%)	Pneumothorax	1 (0.30%)	1 (0.44%)	–
2nd–3rd degree	6 (1.80%)	2 (0.87%)	Kidney fissure	1 (0.30%)	1 (0.44%)	–
3rd degree	20 (6.01%)	14 (6.11%)	Spleen damage	1 (0.30%)	–	1 (0.96%)
4th degree	1 (0.30%)	1 (0.44%)	Rhabdomyolysis	5 (1.50%)	4 (1.75%)	1 (0.96%)
Unknown	8 (2.40%)	6 (2.62%)	Acute kidney injury	4 (1.20%)	3 (1.31%)	1 (0.96%)
Small electricity-related marks	50 (15.02%)	27 (11.79%)	Neurological abnormalities			
			Paresthesia	50 (15.02%)	40 (17.47%)	10 (9.62%)
			Hypoesthesia/anesthesia	2 (0.60%)	1 (0.44%)	1 (0.96%)
			Convulsion/spasm/fasciculation	9 (2.70%)	8 (3.49%)	1 (0.96%)
			Autonomic dysfunction	1 (0.30%)	–	1 (0.96%)
			Speech disorder	1 (0.30%)	1 (0.44%)	–
			Post-hypoxic encephalopathy	3 (0.90%)	2 (0.87%)	1 (0.96%)
			Brain edema			
			Vegetative state	3 (0.90%)	2 (0.87%)	1 (0.96%)

Managment dospělých pacientů po úrazu elektrickým proudem ve FN Plzeň





**Arrhythmias and
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