

# *Current Awareness in Clinical Toxicology*

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## ***CURRENT AWARENESS PAPERS OF THE MONTH***

### **Cerebrovascular complications of methamphetamine abuse**

**Ho EL, Josephson SA, Lee HS, Smith WS. *Neurocrit Care* 2009; 10: 295-305.**

#### ***Objective***

Methamphetamine is a stimulant widely abused in the United States. The objective of this study was to demonstrate an association of methamphetamine use and ischemic stroke, subarachnoid hemorrhage, and intracerebral hemorrhage and to further reveal the underlying vascular pathology using neuroimaging and pathology.

#### ***Methods***

This was a retrospective study based on medical chart review of admissions to the neurovascular service of a tertiary care medical center from January 2003 to July 2007. Cases included patients who used methamphetamine as documented by history or urine toxicology screening.

#### ***Results***

From 1574 records, 30 cases were identified. The mean age of patients was 43 years and the discharge diagnoses included ischemic stroke, intracerebral hemorrhage, and subarachnoid hemorrhage. All subarachnoid hemorrhages were aneurysmal with the majority of the aneurysms located in the anterior circulation. The majority of strokes were located in the anterior circulation. In many cases, radiologic imaging confirmed arterial stenoses in the vascular distribution of the stroke. One patient who presented with ischemic stroke had severe atherosclerosis of bilateral common, internal, and external carotid arteries. On pathology, there was no evidence of inflammation or necrosis to suggest vasculitis as a possible etiology.

#### ***Conclusions***

Methamphetamine use is associated with ischemic stroke, intracerebral hemorrhage, and subarachnoid hemorrhage, especially among young patients. We showed no evidence that the ischemic stroke associated with methamphetamine use is due to an inflammatory etiology but may be due to a process of accelerated atherosclerosis.

### **Medication overdoses leading to emergency department visits among children**

**Schillie SF, Shehab N, Thomas KE, Budnitz DS. *Am J Prev Med* 2009; 37: 181-7.**

#### ***Background***

The high prevalence of medication use increases the potential for medication overdoses,

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especially among children.

### **Purpose**

This paper describes the burden of unintentional pediatric medication overdoses in order to target new prevention efforts.

### **Methods**

Data were analyzed in 2007 and 2008 from the National Electronic Injury Surveillance System, collected January 1, 2004, through December 31, 2005, to estimate the number of emergency department visits resulting from unintentional medication overdoses among children aged  $\leq 18$  years in the US. These data were analyzed by patient demographics, overdose cause, and implicated products, and compared to visits for nonpharmaceutical consumer product poisonings.

### **Results**

Based on 3034 cases, an estimated 71 224 emergency department visits for medication overdoses were made annually by children aged  $\leq 18$  years, representing 68.9% of emergency department visits for unintentional pediatric poisonings. The rate of unintentional poisonings from medications was twice the rate of those from nonpharmaceutical consumer products (9.2 visits per 10,000 individuals per year [95% CI=7.3, 11.0] vs 4.2 per 10 000 individuals per year [95% CI=3.3, 5.0]). Four fifths (82.2%) of visits for medication overdoses were from unsupervised ingestions (children accessing medications on their own); medication errors and misuse resulted in 14.3% of visits. Most visits (81.3%) involved children aged  $\leq 5$  years, and commonly available over-the-counter medications were implicated in one third (33.9%) of visits.

### **Conclusions**

Medication overdoses among children, notably unsupervised ingestions, represent a substantial burden in terms of emergency department visits and hospitalizations. New efforts to prevent pediatric medication overdoses are needed.

## **Adult metaxalone ingestions reported to Texas poison control centers, 2000-2006**

**Forrester MB. Hum Exp Toxicol 2009; online early: doi: 10.1177/0960327108098150: 1-8.**

### **Abstract**

Few data exist on potentially adverse metaxalone (Skelaxin®) ingestions in adults.

All metaxalone ingestions involving patients aged  $\geq 20$  years during 2000-2006 were retrieved from Texas poison control centers. Exclusion criteria were lack of follow-up or multiple substance ingestion. Cases were analyzed for selected demographic and clinical factors.

Of the 142 patients, 66.2% were female. Dose ingested was reported for 61 patients. Of those cases with a reported dose, distribution by management site was 29.5% on-site, 59.0% already at/en route to health care facility, and 11.5% referred to health care facility. Final medical outcome was 'no effect' for 50.8% cases, 'minor effect' for 31.1%, and 'moderate effect' for 18.0%. The more common adverse clinical effects reported were drowsiness (27.9%), tachycardia (6.6%), agitation (6.6%), nausea (4.9%), dizziness (4.9%), slurred speech (4.9%), and tremor (4.9%). A moderate medical outcome occurred in 13.6% of ingestions of  $\leq 2400$  mg and 20.5% of ingestions of  $>2400$  mg. Management involved a health care facility in 18.2% of ingestions of  $\leq 2400$  mg and 100.0% of ingestions of  $>2400$  mg.

This study found that adult ingestions of higher doses of metaxalone, particularly  $>2400$  mg, were associated with more serious medical outcomes and were managed at health care facilities. This study also proposes triage guidelines for when ingestions can be safely managed at home.

## Relationship between blood alcohol concentration on admission and outcome in dimethoate organophosphorus self-poisoning

Eddleston M, Gunnell D, Von Meyer L, Eyer P. *Br J Clin Pharmacol* 2009; online early: doi: 10.1111/j.1365-2125.2009.03533.x: 1-18.

### *Aims*

Many patients acutely poisoned with organophosphorus insecticides have co-ingested alcohol. While clinical experience suggests that this makes management more difficult, the relationship between plasma concentration of alcohol and insecticide is unknown. We aimed to determine whether acute intoxication results in ingestion of larger quantities of insecticide in dimethoate self-poisoning and a worse clinical outcome.

### *Methods*

We set up a prospective study of acute dimethoate self-poisoning in Sri Lankan district hospitals. An admission plasma sample was analysed to identify the ingested insecticide; in patients with detectable dimethoate, plasma alcohol was measured.

### *Results*

Plasma from 37 of 72 (51.4%) dimethoate poisoned patients had detectable alcohol (median concentration 1.10 g/L [110 mg/dL][IQR 0.78-1.65]) a median of 3 hrs post-ingestion. The median plasma dimethoate concentration was higher in patients who had ingested alcohol (479 $\mu$ mol/L [IQR 268-701] vs. 145 $\mu$ mol/L [IQR 25-337];  $P < 0.001$ ). Plasma dimethoate concentration was positively correlated with plasma alcohol (Spearman's  $\rho = 0.34$ ;  $p = 0.0032$ ). The median alcohol concentration was higher in the 21 patients who died compared to survivors (0.94 vs. 0.0 g/L,  $P = 0.018$ ). Risk of death was greater amongst individuals who consumed alcohol (OR 4.3, 95% CI 1.2-16.4); this risk was abolished by controlling for dimethoate concentration (OR 0.3, 0.0–8.8), indicating that deaths were not due to the direct toxic effects of alcohol.

### *Conclusions*

Alcohol co-ingestion is associated with higher plasma concentrations of dimethoate and increased risk of death. Larger studies are required to assess this finding's generalisability since efforts to reduce deaths from self-poisoning may benefit from concurrent efforts to reduce alcohol consumption.

## Cisplatin overdose: toxicities and management

Tsang RY, Al-Fayea T, Au HJ. *Drug Saf* 2009; 32: 1109-22.

### *Abstract*

Cisplatin is one of the most widely used antineoplastic agents in the treatment of solid tumour and haematological malignancies, including cancers of the testes, ovary, bladder, head and neck, oesophagus, stomach and lung, as well as lymphoma and osteosarcoma. Its non-specific targeting commonly results in adverse effects and toxicities affecting the gastrointestinal, renal, neurological and haematological systems even when administered at standard doses. Since cisplatin-related toxicities are dose-dependent, these may be more pronounced in the setting of a cisplatin overdose, resulting in significant morbidity and/or mortality. The incidence of cisplatin overdoses is unknown; however, early-phase clinical trials utilizing high-dose cisplatin, and case reports in the overdose setting have characterized the clinical features associated with cisplatin overdoses, highlighting some therapeutic strategies for consideration.

To date, no published guidelines exist for managing a cisplatin overdose. The major toxicities of a cisplatin overdose include nausea and vomiting, renal insufficiency, electrolyte abnormalities, myelosuppression, ototoxicity, peripheral neuropathy, hepatotoxicity and retinopathy. Diarrhoea, pancreatitis, seizures and respiratory failure have also been reported. No specific antidote for cisplatin exists. Key management principles and strategies to lessen toxicities include

renoprotection and enhancing drug elimination with aggressive intravenous hydration with or without the use of an osmotic diuretic, and avoidance of nephrotoxic medications. Sodium thiosulfate and plasmapheresis, with or without haemodialysis support, should be strongly considered. Close monitoring of clinical and laboratory parameters, and institution of supportive therapies, including antiemetics and haematopoietic colony stimulating factor support, are warranted. Based on the current literature, experimental therapies such as amifostine, dithiocarb sodium (diethyldithiocarbamate), acetylcysteine, fosfomycin and colestipol are of limited clinical effectiveness and remain investigational.

This review serves to highlight the clinical spectrum of toxicities resulting from a cisplatin overdose, to critically appraise the available literature and to present a suggested algorithmic approach for the initial management of a cisplatin overdose.

## **Intranasal naloxone is a viable alternative to intravenous naloxone for prehospital narcotic overdose**

**Robertson TM, Hendey GW, Stroh G, Shalit M. Prehosp Emerg Care 2009; 13: 512-5.**

### ***Objective***

To compare the prehospital time intervals from patient contact and medication administration to clinical response for intranasal (IN) versus intravenous (IV) naloxone in patients with suspected narcotic overdose.

### ***Methods***

This was a retrospective review of emergency medical services (EMS) and hospital records, before and after implementation of a protocol for administration of intranasal naloxone by the Central California EMS Agency. We included patients with suspected narcotic overdose treated in the prehospital setting over 17 months, between March 2003 and July 2004. Paramedics documented dose, route of administration, and positive response times using an electronic record. Clinical response was defined as an increase in respiratory rate (breaths/min) or Glasgow Coma Scale score of at least 6. Main outcome variables included time from medication to clinical response and time from patient contact to clinical response. Secondary variables included numbers of doses administered and rescue doses given by an alternate route. Between-group comparisons were accomplished using t-tests and chi-square tests as appropriate.

### ***Results***

One hundred fifty-four patients met the inclusion criteria, including 104 treated with IV and 50 treated with IN naloxone. Clinical response was noted in 33 (66%) and 58 (56%) of the IN and IV groups, respectively ( $p = 0.3$ ). The mean time between naloxone administration and clinical response was longer for the IN group (12.9 vs. 8.1 min,  $p = 0.02$ ). However, the mean times from patient contact to clinical response were not significantly different between the IN and IV groups (20.3 vs. 20.7 min,  $p = 0.9$ ). More patients in the IN group received two doses of naloxone (34% vs. 18%,  $p = 0.05$ ), and three patients in the IN group received a subsequent dose of IV or IM naloxone.

### ***Conclusions***

The time from dose administration to clinical response for naloxone was longer for the IN route, but the overall time from patient contact to response was the same for the IV and IN routes. Given the difficulty and potential hazards in obtaining IV access in many patients with narcotic overdose, IN naloxone appears to be a useful and potentially safer alternative.

## **Surgical approach to hydrocarbon injection in upper extremities: case series**

**Farahvash MR, Yegane R-A, Bashashati M, Ahmadi M, Tabrizi N. Int J Surg 2009; 7: 382-6.**

### ***Background***

Hydrocarbon injection, which mostly occurs in the upper extremity, is commonly seen in domestic and industrial accidents, or attempted suicide. Surgical approach to chemical cellulites and other complications in these patients is controversial.

### ***Method***

This survey has been carried out on 21 patients admitted to general surgery unit of Loqman Hakim hospital, Tehran, Iran with the complaint of hydrocarbon injection in 2001-2005.

### ***Results***

The most common injected material was petroleum (in 8 patients). Anterior forearm was the most common injection site (in 16 patients). All of the patients had inflammation, swelling, and localized tenderness. Leukocytosis was present in 18 of 21 patients. Compartment syndrome happened in 13 patients; 5 with necrotizing fasciitis. All of the patients with compartment syndrome underwent fasciotomy and debridement. Split thickness skin graft was done for 10 patients after 2 weeks of admission. There was no mortality or limb loss during the study period.

### ***Conclusions***

Prevention of the systemic complications, hospitalization, close monitoring and treatment of chemical cellulites are the main parts of the management of patients with hydrocarbon injection. Surgical intervention is recommended when compartment syndrome or other local complications occur.

## **Denim clothing reduces venom expenditure by rattlesnakes striking defensively at model human limbs**

**Herbert SS, Hayes WK. Ann Emerg Med 2009; 54: 830-6.**

### ***Study objective***

Venomous snakebites can be painful, costly, and potentially life threatening. We seek to learn whether ordinary clothing (denim material from blue jeans) interferes with the kinematics of venom delivery, thereby reducing the amount of venom injected by a representative viper into a human limb.

### ***Methods***

In a laboratory study, we used model human limbs (warm, saline solution-filled gloves) to elicit defensive strikes from small and large southern Pacific rattlesnakes (*Crotalus oreganus helleri*). Each snake was videotaped biting a bare glove and a denim-covered glove.

### ***Results***

The snakes injected significantly less venom into denim-covered gloves than bare gloves during defensive strikes, with a 60% reduction for small snakes and 66% for large snakes. Latency to bite, number of bites, and duration of fang contact during the bite were similar for the 2 glove types, suggesting that the 2 targets elicited similar defensive behaviors and strikes. Several findings suggested that denim interfered with venom delivery, including the high proportion of dry bites for denim-covered gloves and the large quantity of venom spilled harmlessly on the denim cover. Large rattlesnakes struck more readily, maintained longer fang contact during the bite, and delivered 26 to 41 times more venom into gloves than small snakes.

### ***Conclusion***

In our model, denim clothing proved effective at reducing venom injection by both small and large rattlesnakes. Wearing long denim pants as an alternative to shorts may provide a simple, low-cost means of reducing the severity of snakebites.

## **Clotting factor replacement and recovery from snake venom-induced consumptive coagulopathy**

**Brown SGA, Caruso N, Borland ML, McCoubrie DL, Celenza A, Isbister GK. Intensive Care Med 2009; 35: 1532-8.**

### ***Introduction***

Using clotting factors (fresh frozen plasma and/or cryoprecipitate) to treat snake venom-induced consumptive coagulopathy (VICC) is controversial. We aimed to determine if factor replacement after antivenom is associated with an earlier return of coagulation function.

### ***Methods***

We retrospectively analysed VICC cases due to brown snake (genus *Pseudonaja*), tiger snake (*Notechis*, *Tropidechis*, and *Hoplocephalus*), and taipan (*Oxyuranus*) envenoming. Recovery of international normalized ratio (INR)/prothrombin time (PT) was compared between patients who did not receive factor replacement and those who did, and between patients who received factor replacement  $\leq 4$  h of commencing antivenom and those who received factor replacement later or not at all.

### ***Results***

There was no significant difference between cases receiving clotting factors and cases that did not, however in 21 cases having factor replacement within 4 h, the median time to coagulation recovery was 4.6 h (interquartile range [IQR] 3.5-8.8), versus 9.5 h (IQR 7.3-13) in 106 cases who had clotting factors later or not at all ( $P < 0.001$ ). No serious adverse effects attributed to clotting factors were recorded. Recovery by 6 h after starting antivenom was also more likely in those who were younger, in tiger snake envenoming, and where the interval between bite and starting antivenom was longer. The initial dose of antivenom did not appear to influence the likelihood of recovery at 6 h.

### ***Conclusion***

Early factor replacement after antivenom is associated with earlier improvement of coagulation function. Randomised controlled clinical trials to determine the efficacy and safety of factor replacement for VICC after venom neutralisation are required.

## **Levosimendan as a rescue drug in experimental propranolol-induced myocardial depression: a randomized study**

**Leppikangas H, Ruokonen E, Rutanen J, Kiviniemi V, Lindgren L, Kurola J. Ann Emerg Med 2009; 54: 811-7.**

### ***Study objective***

Severe  $\beta$ -blocker intoxication remains a clinical challenge despite a variety of treatment options. Because of its unique mechanism of action, the new calcium sensitizer levosimendan may provide more prominent cardiac support compared with current medications used to reverse negative inotropy. We hypothesize that levosimendan could reverse propranolol-induced severe negative inotropy in a porcine model of  $\beta$ -blocker intoxication.

### ***Methods***

Twenty-four pigs were anesthetized and monitored. After severe propranolol intoxication was completed, animals were randomized into 3 groups. With a double-blind procedure, 9 animals received a 1.25-mg levosimendan bolus, followed by saline solution infusion, 9 animals received mean arterial pressure-targeted dobutamine infusion after saline solution bolus, and 6 animals received a saline solution bolus followed by saline solution infusion. Hemodynamic and laboratory data were collected during a follow-up period of 120 minutes.

### ***Results***

All 9 pigs in the levosimendan group survived. In contrast, 4 of 6 (67%) and 7 of 9 (78%) pigs

died during the experiment in the placebo and the dobutamine groups, respectively. The levosimendan group showed improved change in the maximum positive slope of the left ventricular pressure, cardiac output, stroke volume, and mean arterial pressure compared with the dobutamine and the placebo groups.

### **Conclusion**

Levosimendan improved hemodynamic function and survival in this animal model of severe propranolol intoxication. The potential clinical application of levosimendan in propranolol intoxication warrants further investigation.

## **Pharmacokinetics of acetaminophen-protein adducts in adults with acetaminophen overdose and acute liver failure**

**James LP, Letzig L, Simpson PM, Capparelli E, Roberts DW, Hinson JA, Davern TJ, Lee WM. Drug Metab Dispos 2009; 37: 1779-84.**

### **Abstract**

Acetaminophen (APAP)-induced liver toxicity occurs with formation of APAP-protein adducts. These adducts are formed by hepatic metabolism of APAP to N-acetyl-p-benzoquinone imine, which covalently binds to hepatic proteins as 3-(cystein-S-yl)-APAP adducts. Adducts are released into blood during hepatocyte lysis.

We previously showed that adducts could be quantified by high-performance liquid chromatography with electrochemical detection following proteolytic hydrolysis, and that the concentration of adducts in serum of overdose patients correlated with toxicity. The following study examined the pharmacokinetic profile and clinical associations of adducts in 53 adults with acute APAP overdose resulting in acute liver failure. A population pharmacokinetic analysis using nonlinear mixed effects (statistical regression type) models was conducted; individual empiric Bayesian estimates were determined for the elimination rate constant and elimination half-life. Correlations between clinical and laboratory data were examined relative to adduct concentrations using nonparametric statistical approaches.

Peak concentrations of APAP-protein adducts correlated with peak aminotransferase concentrations ( $r = 0.779$ ) in adults with APAP-related acute liver failure. Adducts did not correlate with bilirubin, creatinine, and APAP concentration at admission, international normalized ratio for prothrombin time, or reported APAP dose. After N-acetylcysteine therapy, adducts exhibited first-order disappearance. The mean elimination rate constant and elimination half-life were  $0.42 \pm 0.09$  days<sup>-1</sup> and  $1.72 \pm 0.34$  days, respectively, and estimates from the population model were in strong agreement with these data. Adducts were detected in some patient samples 12 days postingestion.

The persistence and specificity of APAP-protein adducts as correlates of toxicity support their use as specific biomarkers of APAP toxicity in patients with acute liver injury.

## **Comparative antidotal efficacy of benzylpenicillin, ceftazidime and rifamycin in cultured human hepatocytes intoxicated with $\alpha$ - amanitin**

**Magdalan J, Ostrowska A, Piotrowska A, Gomulkiewicz A, Szelag A, Dziegiel P. Arch Toxicol 2009; 83: 1091-6.**

### **Abstract**

The most often used antidote to treat poisoning caused by amanitin-containing mushrooms is benzylpenicillin (BPCN). However, a very few reports suggest that other antibiotics such as ceftazidime (CEFT) and rifamycin SV (RIFSV) show better antidote activity against amanitins than

BPCN. Given this, there is an ongoing debate as which of three antidotes is optimal for treatment of such poisonings.

In this study, the efficacy of BPCN was compared with those of CEFT and RIFSV in human hepatocyte model. The functional integrity and viability of cultured hepatocytes was evaluated using the MTT [3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl tetrazolium bromide] assay and by measurements of lactic dehydrogenase (LDH) activity.

In the first experimental layout, hepatocytes were simultaneously exposed to  $\alpha$ -AMA and tested antidotes, while in the second layout, the cells were exposed for the first 12 h to  $\alpha$ -AMA only, and then, the medium containing  $\alpha$ -AMA was exchanged to culture medium containing both  $\alpha$ -AMA and the antidotes tested. The results demonstrated that simultaneous administration of  $\alpha$ -AMA and each of tested antidotes (BPCN, CEFT, RIFSV) effectively protected human hepatocytes; however, in the group dosed with BPCN, the highest hepatocyte viability was observed. In cell cultures from experimental layout II, all tested antidotes were ineffective, which indicates that after the critical dose of  $\alpha$ -AMA had been taken up by hepatocytes, further suppression of this process does not protect the cells against injury. Thus, 12 h of exposure of incubated hepatocytes to  $\alpha$ -AMA is a sufficient time for such a cellular uptake of a critical dose of this toxin.

In summary, it can be concluded that easily accessible and low-cost BPCN should be widely used as an antidote against amanitins. However, the key to successful therapy is a quick implementation of an antidote in order to protect as large as possible portion of the liver parenchyma against the devastating uptake of a critical dose of amanitins.

## Hemodynamics after intraosseous administration of hydroxocobalamin or normal saline in a goat model

**Borron SW, Arias JC, Bauer CR, Sanchez M, Fernández M, Jung I. Am J Emerg Med 2009; 27: 1065-71.**

### *Study objective*

Hydroxocobalamin may be lifesaving in cyanide (CN) poisoning, but personal protective equipment (PPE) wear, rescue, and decontamination may delay intravenous administration. Intraosseous (IO) lines may be rapidly placed even when wearing PPE. We assessed the hemodynamics of hydroxocobalamin (OHCo) and normal saline (NS) by the IO route.

### *Methods*

Twelve anesthetized Spanish goats underwent arterial line catheterization. Operators in PPE placed IO lines. After placement confirmation by fluoroscopy, animals randomly received hydroxocobalamin 75 mg/kg (3 mL/kg) (n = 6) or normal saline (NS) 3 mL/kg (n = 6) IO over approximately 7.5 minutes. Blood pressures and heart rates were monitored for 240 minutes after infusion initiation.

### *Results*

In the OHCo group, mean systolic and diastolic pressures peaked at 120 minutes, with mean increases of 14% and 17%, respectively, relative to infusion start, returning to near preinfusion values at 240 minutes. Heart rate changes were virtually nil. In the NS group, mean systolic pressures peaked at 60 minutes, with a mean increase of 36%, whereas diastolic pressures peaked at about 110 minutes, increasing 42%, returning to near preinfusion values at 240 minutes. Heart rate changes were minimal.

### *Conclusion*

Hemodynamic effects of OHCo given by the IO route in non-CN-poisoned goats are mild and well tolerated. Increases in mean blood pressure at peak after baseline were greater in the NS group, but the mean values over time were not significantly different from those observed in the OHCo group. Hemodynamic effects would likely differ somewhat in a CN-poisoned goat. Intraosseous

## **Investigating pressure bandaging for snakebite in a simulated setting: bandage type, training and the effect of transport**

**Canale E, Isbister GK, Currie BJ. Emerg Med Australas 2009; 21: 184-90.**

### ***Background***

The clinical evidence base for the use of pressure bandaging in snakebite is limited. We aimed to investigate if pressure bandages (PB) generated and maintained presumptive optimal pressures in a simulated setting.

### ***Methods***

A total of 96 subjects were recruited, 78 health professionals and 18 from the general public. Participants were asked to apply PB with crepe and with an elasticized bandage without instruction. A paediatric blood pressure cuff attached to a pressure transducer was used to measure the pressure generated. PB application with elasticized bandages was repeated by 36 participants (18 general public and 18 health professionals) with feedback on pressures attained, and reassessment on the sixth subsequent attempt. Pressure was also measured under correctly applied bandages during an ambulance ride.

### ***Results***

The median pressure generated under crepe bandages was 28 mmHg (interquartile range [IQR]: 17-42 mmHg) compared with 47 mmHg (IQR 26-83 mmHg) with elasticized bandages, with most subgroups applying the elasticized bandage closer to the estimated optimal pressure (55-70 mmHg). Following training, the median pressure for the 36 participants was 65 mmHg (IQR 56-71 mmHg), closer to the optimal range than initial attempts. On initial bandaging, 5/36 (14%) participants achieved optimal pressure range with elasticized bandages, compared with 18/36 (50%) after training ( $P = 0.002$ ). Crepe bandages initially correctly applied did not maintain desired pressure during ambulance transport on urban roads over 30 min. Elasticized bandages maintained pressure.

### ***Conclusions***

PB was poorly done by the general public and health professionals. Crepe bandages rarely generated optimal pressures compared with elasticized bandages, but training did improve participants' ability to apply elasticized bandages. PB recommendations should be modified to specify appropriate bandage types

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