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Denim, Rattlesnakes, and Evidence-Based Scouting

To the Editor:

In the recent publication "Denim Clothing Reduces Venom Expenditure by Rattlesnakes Striking Defensively at Model Human Limbs," [1] the investigators use a model to determine if denim clothing reduces venom expenditure during rattlesnake strike.

A significant shortcoming of this study is failure of the authors to describe the denim used. Denim is a cotton twill textile with a characteristic stitching pattern that includes diagonal as well as parallel and perpendicular fibers for added strength and durability.[2] The density and thickness of denim varies tremendously: for reference, the best selling denim jean produced by Levi-Strauss & Corporation, Levi's 501®, is a 13.5 ounce denim.[3] The most dense and thick denim jean currently commercially available, by Samurai Brand®, is 24 ounce denim, meaning its density exceeds that of Levi's 501® by 77%. Likewise, the weight of denim fabric can be considerably lighter. For the investigators to simply state they used "denim" without disclosing its specific qualities makes the results of this study minimally translatable. Aside from denim weight, additional qualities such as whether it was dry or raw denim, as opposed to washed denim which is softer and presumably less protective, were not disclosed.

For decades the Boy Scouts of America have recommended wearing long pants and boots when hiking, backpacking, or camping in outdoors areas where venomous snakes might be encountered.[4] The Boy Scout Manual and pamphlets for the Wilderness Survival Merit Badge, established in 1974, as well as the Camping Merit Badge, and the Backpacking Merit Badge all mention use of long pants and boots. Dr. Hayes' publications include reference to his work with Boy Scouts, [5]which is commendable.

If one considers these Boy Scout publications credible they might construe Herbert and Hayes' study unnecessary due to lack of equipoise about the study hypothesis. These authors chose to test the hypothesis as the notion that denim is protective is widely held but experimentally unproven.

Repeating this study using a leather boot to protect the model limb might be a next step. This might draw similar criticism as it is difficult to understand how there could be equipoise about the hypothesis that leather boots may decrease venom expenditure during a rattlesnake strike. It could, however, lend scientific credibility to the long-held practice of wearing leather boots to protect against snakebite. It would additionally complete testing the "long pants and boots" suggested as hiking attire by the Boy Scouts.

As an occasional outdoorsman, former Boy Scout, and medical toxicologist, I express thanks to Drs. Herbert and Hayes for their scientific endeavor. Perhaps their study will assist persons to "be prepared" for potential rattlesnake encounters.

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In reply:

We appreciate the interest expressed by Dr. Hoffman in our study of how denim clothing reduced venom expenditure by rattlesnakes striking defensively at model human limbs.

We certainly agree with Dr. Hoffman that denim varies considerably in density and thickness, and that providing specific details on the material we used would have been ideal. Unfortunately, we moved into a new lab after completing the study, and the denim samples, purchased from a local fabric store, were somehow misplaced in a large storage unit. Despite another recent search, we simply cannot locate the samples. However, we revisited the same retail store and found 2 candidate fabrics that closely matched (and one may well have been) the material we used. One fabric was 14 ounces (mass per square yard, the metric for fabrics), but neither the store nor the supplier could provide specifications for the other, which appeared to be very close to 14 ounces. For perspective, clothiers generally use denim in the range of 3.5-8.0 ounces to craft blouses, tops, and shirts, and denim in the range of 8.0-16.5 ounces to construct trousers, jeans, and jackets.[1] The material we used was not sold as "pre-washed," but we pre-rinsed the fabric in deionized water and dried it before use, as described in our article.

As we conceded in our paper, some fabrics and clothing designs undoubtedly provide more protection than others.[2] Numerous "snake-proof" products are marketed, including penetration-resistant pants, chaps, gaiters, and boots. Although we have no reason to question the claims of manufacturers, we agree with Dr. Hoffman that controlled testing should be undertaken and the results made available. As for ordinary

clothing, further tests could be conducted to determine whether significant variation in venom reduction by biting snakes exists with the normal range of thickness typically employed in denim material.

In our study, we sought to test whether ordinary clothing could measurably reduce venom injection during a bite. The results suggested that ordinary clothing, such as that used in "blue jeans," could reduce by more than 50%, on average, the amount of venom injected into a model human limb (a saline solution-filled latex glove) by one species of rattlesnake (*Crotalus oreganus helleri*). In the light of our findings, the Boy Scouts of America has indeed offered good, commonsense advice for wearing boots and long clothing as snakebite protection, which Dr. Hoffman pointed out. However, we emphasize 4 important caveats to the conclusions from our study (we listed several others in the paper): 1) our models, although reasonable in design, differed from human limbs in several respects that could influence venom injection; 2) considerable variation in venom expenditure by snakes during defensive bites must be anticipated;[3,4] 3) numerous factors other than the amount of venom injected can influence snakebite severity;[5] and 4) substantial envenomation through clothing can still occur.[6] Wearing protective clothing should complement, but never substitute for, using good sense in avoiding a bite to begin with.

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False Positive Ethylene Glycol Determination by Spectrophotometry in the Presence of Severe Lactic Acidosis and Ketosis

To the Editor:

Severe metabolic acidosis with increased anion gap may be due to ethylene glycol poisoning. Two methods are available to quantify ethylene glycol in serum: the first non-specific method by spectrophotometry used for screening and the second one by gas chromatography coupled to mass-spectrometry used for confirmation. Nevertheless, gas chromatography is not available everywhere and requires technical expertise, challenging the definitive diagnosis of ethylene glycol poisoning in the emergency department (ED). The cross reaction between the enzyme L-lactate oxidase, used for the determination of lactate by many blood gas analyzers, and ethylene glycol metabolites (glycolate and oxalate) is now well known.[1] Futhermore, similarities in chemical structure exist between ethylene glycol and lactate and could alter the detection of ethylene glycol by spectrophotometry. Indeed, the enzymatic determination of ethylene glycol in serum uses glycerol dehydrogenase to oxidize ethylene glycol with concomitant production of nicotinamide adenine dinucleotide, which is detected by spectrophotometry. In critically ill patients with increased serum lactate, oxidation of lactate to pyruvate catalyzed by L-lactate dehydrogenase increases the production of nicotinamide adenine dinucleotide, which may cross-react with the ethylene glycol assay, causing false elevation of ethylene glycol.[2]

We report the case of a 58-year-old diabetic man who presented to the ED with abdominal pain. On admission, he had an arterial pH of 6.65, an increased anion gap (43 mEq/L), and a serum lactate concentration of 36 mmol/L. A spectrophotometric assay (PerkinElmer Lambda 25 UV/VIS, Waltham, MA) indicated an elevated serum ethylene glycol concentration (46.5 mg/dL). Salicylate and alcohol were not detectable. Urinalysis revealed ketones at 4 mmol/L. Abdominal computed tomography (CT) scan was normal. The patient developed hemodynamic shock (blood pressure was not measurable and heart rate was 140/min) associated with acute renal failure and he received intravenous fomepizole for presumed ethylene glycol poisoning. Intriguingly, serial serum ethylene glycol concentration assessed by spectrophotometry were steady (44 mg/dL) and arterial lactate (ABL 825, Radiometer, Copenhagen, Denmark) concentration remained elevated (25 mmol/L) despite continuous veno-venous hemodiafiltration for 20 hours.[3] Finally, severe lactic acidosis was likely related to a plasma metformin concentration of 8.60 mg/L (normal 0−1.34) revealed by high-performance liquid chromatography (Beckmann, Fullerton, CA). The persistent elevation of serum lactate interfering with the screening assay for ethylene glycol probably explains why blood ethylene glycol