Appreciable Blood-Ethanol Concentration after Washing Abrased and Lacerated Skin with Surgical Spirit

To the Editor:

The question of whether appreciable amounts of ethanol can become absorbed into the bloodstream through intact skin arises from time to time in connection with drunk-driving litigation (1). However, to produce an elevated blood-ethanol concentration (BEC), the amounts of alcohol taken up through the skin must exceed the amounts eliminated by metabolism in the liver and excretion in the breath and urine. The average rate of disposal of ethanol in man is between 5 and 8 g/h by oxidation with class I isoenzymes of hepatic alcohol dehydrogenase (2).

Bowers et al. (3) reported a controlled study to assess the likelihood of ethanol being absorbed through intact skin and producing a measurable BEC in experiments involving four children (7-9 years of age) and one adult. The legs of the subjects were wrapped in cotton from above the knees to the feet, and the wrappings were subsequently soaked with 200 mL of 95% (v/v) ethanol. Although the ethanol-soaked cotton was kept covering the skin with rubber sheeting and adhesive tapes for 4-9 h, no ethanol was measurable in the blood (3). Absorption of ethanol through skin damaged with abrasions or lacerations seems more likely to generate a measurable BEC, but this notion is not well documented in the scientific literature.

During routine postmortem examination of a 56-year-old woman who was knocked from her bicycle and run over by a bus, the medical examiner took vitreous humor and blood from a femoral vein for toxicological analysis. The concentration of ethanol in these specimens was determined by a well-established gas chromatographic method at an accredited laboratory (4). Two different stationary phases were used for chromatography, and the BEC was 0.047 g/100 mL and 0.045 g/100 mL for duplicate determinations. The chromatogram showed well-resolved peaks for ethanol and the internal standard (t-butanol), and the calibration control checks and blank specimens satisfied quality control requirements. However, the concentration of ethanol in vitreous humor was zero, and no other drugs were present in body fluids except ketamin, which was administered as an anesthetic agent in preparation for surgery.

The finding of a significant BEC (0.046 g/100 mL) and absence of ethanol in vitreous humor is very difficult to explain, and such a result should immediately be considered suspect. Postmortem synthesis of ethanol is one likely explanation for finding low concentrations of ethanol in blood without any measurable amounts being detected in the vitreous humor or urine (5). However, in this case, the corpse was fresh and well preserved without signs of putrefaction, and the gas chromatogram did not indicate the presence of other volatiles, which speaks against the notion of any microbial synthesis of ethanol.

The victim's relatives testified to the fact that she rarely drank any alcohol and only in very moderate amounts, so how can the toxicological results be explained? Trauma patients are sometimes treated with mannitol, an osmotic diuretic, to reduce swelling and blood clots in the brain. A previous case report suggested that this sugar alcohol (mannitol) may, under some circumstances, serve as a substrate for microbial synthesis of ethanol (6). However, the hospital records in this case showed that the woman received various analgesic and anesthetic agents in addition to plasma substitutes including 6 L of ringer acetate solution, but mannitol had not been given. None of the substances administered antemortem seemed likely to explain the appearance of ethanol in postmortem blood. A more detailed scrutiny of the hospital procedures, including questioning of the surgical staff, revealed that a nurse working in the operating theater had cleaned the woman's damaged skin, covering roughly 33% of total body surface, with surgical spirits (70%, v/v, ethanol). Apparently this was a standard pre-operative procedure if the skin was damaged with cuts or abrasions because ethanol is widely considered an antiseptic agent. Although exact details of the amounts of ethanol used to clean the skin were not available, the solution was probably applied liberally without considering the risk of elevating the patient's BEC.

A BEC of 0.046 g/100 mL for a woman with a body weight of 72 kg corresponds to 17 g (21 mL) of pure ethanol or 30 mL of a 70% (v/v) solution absorbed and distributed in all body fluids. The patient died of internal injuries before the operation started, but the exact time between washing the skin with ethanol and the time of death was unfortunately not recorded. If the patient had survived a few hours longer, even the vitreous humor might have contained a measurable amount of ethanol by transport with the blood circulation. This would have created a dilemma for the medical examiner and toxicologist who might have been more inclined to conclude that the woman had been drinking before the accident. Although a BEC of 0.045 g/100 mL is a fairly low concentration compared with statutory alcohol limits in the U.S. (0.08 or...
0.10 g/100 mL), the legal limit for driving in Sweden is presently set at 0.02 g/100 mL and at 0.05 or 0.08 g/100 mL in other European countries (7).

We are reporting this case to warn others about the risk of ethanol being absorbed into the bloodstream if damaged skin is washed with surgical spirits. A BEC of 0.046 g/100mL might have ramifications in civil litigation when responsibility for the accident is investigated and insurance claims are made. This case report also underscores the need to routinely take several different body fluids for analysis of alcohol in postmortem toxicology (e.g. blood, vitreous humor, and urine). The danger of contaminating body fluids taken at autopsy with externally applied solvents (methyl ethyl ketone and methanol) and the problem this causes when interpreting results were recently discussed by Caughlin (8).

Some recent work with the aid of a novel microdialysis technique showed that percutaneous absorption of organic solvents, including low molecular weight alcohols, can occur through intact skin. However, the small amounts of ethanol passing through the skin are rapidly cleared by metabolism; therefore, accumulation in the body leading to a measurable BEC is not very likely (9). The situation appears to be different if the skin surfaces are abraded or lacerated as indicated by the present forensic case report. Percutaneous absorption of ethanol resulting in clinical manifestations of intoxication has been reported in a 1-month-old infant (10) and in a 2-year-old child (11). Bandages soaked in ethanol were applied to areas of damaged skin, which facilitated absorption into the blood, and the low body weights of the subjects meant that an appreciable BEC developed.

A.W. Jones
Department of Forensic Toxicology
University Hospital
581 85 Linköping
Sweden

J. Rajs
Department of Forensic Medicine
Karolinska Institute
104 01 Stockholm
Sweden

References