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Letter to the Editor

Safety of Cryogen Spray Cooling During Pulsed Laser Treatment of Selected Dermatoses

The novel method of achieving spatially selective photocoagulation with "dynamic" also known as cryogen spray cooling (CSC) is well established and is being used for the laser treatment of patients with selected dermatoses [1–6] and in laser surgery in general [7,8]. Recently, concerns have been raised at symposia and in commercially distributed literature with respect to possible adverse effects of using cryogens. In this letter, we address the general issue of safety of 1,1,1,2-tetrafluoroethane (HFC-134a; $C_2H_2F_4$; MW = 102 g/mol; DuPont, Wilmington, DE) as a cooling agent for cutaneous laser surgery.

We chose HFC-134a in our initial study of CSC [1] to comply with the Montreal Protocol and the US Food and Drug Administration (FDA) directive dealing with the replacement of chlorofluorocarbons as commercial refrigerants, which deplete atmospheric ozone and contribute to global heating [9]. HFC-134a is nonflammable at ambient temperature and atmospheric pressure, FDA approved for dermatologic use, and commercially available in a medical grade formulation.

As far as inherent toxicology is concerned, it has been abundantly proven in preclinical studies that HFC-134a is safe at very high multiples of likely human exposure [10,11]. In a study of 337 asthmatic patients receiving HFC-134a propelled albuterol from a metered dose inhaler over a 1-year period, only four subjects reported adverse symptoms consisting of diarrhea or dizziness [12]. A second concern has been frostbite, which is of minor importance for CSC because the liquid cryogen is in contact with human skin for less than 0.5 sec [1–8]. Another concern expressed is that HFC-134a will displace air and diminish the oxygen content in the room where it is released and, ultimately, cause suffocation. This displacement is more serious because the density of HFC-134a is 3.6 times higher than that of air. However, in this connection, the more important consideration is the relative quantity of released HFC-134a versus air. At the Beckman Laser Institute and Medical Clinic, University of California, Irvine, a canister (Candela Laser Corporation, Wayland, MA) of HFC-134a (net weight 450 g) is usually sufficient for 40 laser procedures. Thus, for each patient, approximately 450 g/40 = 11.25 g HFC-134a is released. This corresponds to 2.5 L of HFC-134a (11.25/102 = 0.11 mol = 2.5 L at room temperature), which is negligible (<70 ppm) when compared with the total volume of 36,000 L air in a mid-sized room (e.g., $3 \times 4 \times 3$ m^3). In fact, air expired by three persons (physician, nurse, and patient; 6 L/person/min, which contains 0.36% CO_2) contains 2 L CO_2 (assuming a treatment duration of 30 min), which is comparable to the amount of air displaced by HFC-134a. Even in a worst-case scenario, if the canister or its valve were damaged and the entire content (100 L HFC-134a) released inadvertently into a room with standard ventilation, exposure would not even approach the acceptable exposure limit of 1,000 ppm/12 hr for humans (Material Safety Data Sheet, DuPont). From these considerations, it may be concluded that HFC-134a is a safe cooling agent for cutaneous laser surgery.

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