CORRESPONDENCE

Heat-Induced Brain Vitrification from the Vesuvius Eruption in C.E. 79

TO THE EDITOR: Cerebral tissues in human remains are rare archaeological discoveries.[1] These tissues are typically saponified, meaning that their triglycerides have been converted to glycerol and fatty acid salts, or soap. In C.E. 79, a volcanic hot ash avalanche rapidly killed the inhabitants of Pompeii and Herculaneum.[2] In the 1960s, at the *Collegium Augustalium* in Herculaneum, a human victim of the avalanche was found lying on a wooden bed, buried by volcanic ash (Fig. S1 in the Supplementary Appendix, available with the full text of this letter at NEJM.org). In this victim's skull, we discovered apparent brain remains that were vitrified instead of saponified (Fig. 1 and Fig. S2).

Vitrification refers to tissue that has been burned at high heat and turned into glass or a glaze. In this victim, these vitrified remains also encrusted the surface of the skull (Fig. S3). Glassy material was undetectable elsewhere in the skeleton or in the adjacent volcanic ash, and it was not found in other locations at the archaeological site. Intracranial mineral residues from victims who died from the eruption at the seashore, presumably at a site of different environmental conditions, showed high iron oxide contents from thermal degradation of heme proteins (indicating the vaporization of body fluids),[3] but no putative brain remains were found. A solidified spongy mass entrapped the chest bones in the victim at the *Collegium* (Fig. S4); this feature in victims of the Vesuvius eruption was unique among those at other archaeological sites, but it can be compared with features of victims of more contemporary events such as the firestorms in Dresden and Hamburg, Germany, during World War II.[4]

Proteomic investigation of the glassy material inside the skull identified several proteins that are highly expressed in human brain tissues (Table S1). Adipic and margaric fatty acids, components of human hair fat from sebum,[5] were detected exclusively in the glassy fragments (Table S2) but not in the adjacent ash or in charcoal from the archaeological site. Fatty acids that are typical of human brain triglycerides were also found in the putative brain material. These substances are common to animals and plants (Table S3); however, no evidence of plants or animals was found at the site from which the victim was recovered.

Features suggesting a maximum temperature of 520°C were detected on charred wood from the *Collegium* (Fig. S5). This suggests that extreme radiant heat was able to ignite body fat and vaporize soft tissues[3]; a rapid drop in temperature followed. The detection of glassy material from the victim's head, of proteins expressed in human

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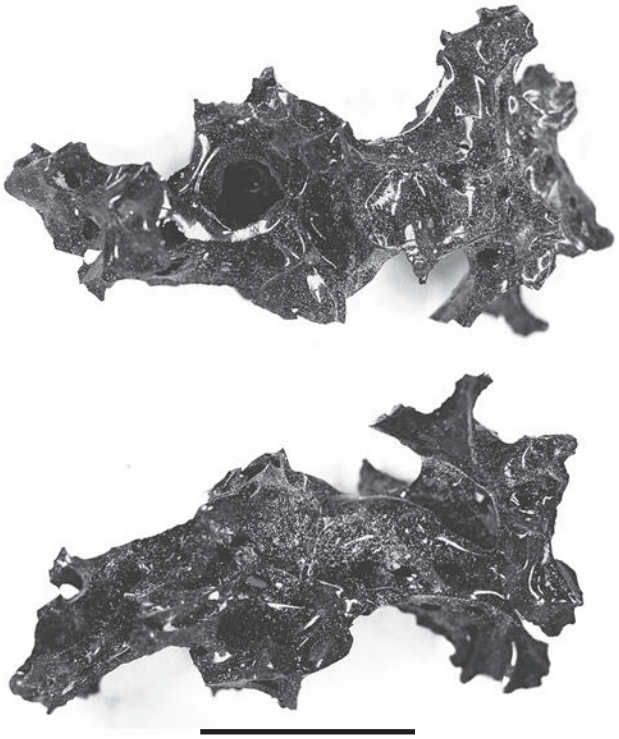

Figure 1. Fragment of Glassy Black Material Extracted from the Cranial Cavity of a Victim of the Volcanic Eruption at Herculaneum.

Shown are two views of a smooth, shiny, glassy surface shaped by subcircular large cavities and smaller pits formed by air bubbles, as seen with the use of a stereoscopic microscope. The scale bar represents 1 cm.

brain, and of fatty acids found in human hair indicates the thermally induced preservation of vitrified human brain tissue.

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Disclosure forms provided by the authors are available with the full text of this letter at NEJM.org.

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Pulmonary Illness Related to E-Cigarette Use

TO THE EDITOR: We have closely followed recent publications (including the letters by Maddock et al. [Oct. 10 issue][1] and Butt et al. [Oct. 31 issue][2]) on e-cigarette, or vaping, product use–associated lung injury (EVALI), particularly the role of bronchoscopy in the diagnostic workup of this condition. It has not yet been reported how severely "routine" flexible bronchoscopy and bronchoalveolar lavage (BAL) affect pulmonary function in these patients, resulting in a highly challenging perioperative course.

We reviewed records for nine of the first patients with EVALI identified at Children's Hospital of Wisconsin and included in the original case series described by Layden et al. (published September 6, 2019, at NEJM.org).[3] Preoperatively, most patients had only moderate oxygen requirements (Table 1). Intraoperatively and postopera-