

It's Not Always the Sea's Fault: Hydrocarbon Poisoning Killed Two Migrants in the Central Mediterranean

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Abstract

The Central Mediterranean migration route is as a vital yet perilous pathway for individuals attempting to reach Europe, particularly via Italy, from North African countries such as Libya and Tunisia. This journey, motivated by conflict, poverty, persecution, and the impacts of climate change, frequently involves treacherous sea crossings to destinations like Lampedusa and Sicily. Tragically, this route is the deadliest globally, with over 17,000 deaths and disappearances recorded since 2014. In the first quarter of 2024 alone, 367 confirmed fatalities were reported, predominantly due to drowning.

This case report explores the tragic deaths of two sub-Saharan African women, aged 19 and 33, who lost their lives while attempting to cross the Central Mediterranean on an overcrowded vessel. Recovered by a non-governmental search and rescue organization, the younger woman was found deceased aboard the boat, while the older woman, critically injured, succumbed shortly after rescue. Both victims exhibited characteristic chemical burns caused by fuel exposure on their skin (so called "fuel burns"). Although drowning was initially considered the cause of death, autopsy and toxicological findings identified acute hydrocarbon intoxication as the primary cause. Elevated hydrocarbon levels in their blood suggested severe pulmonary damage leading to cardiorespiratory arrest. These findings challenge the preliminary diagnosis and highlight the complexities of distinguishing between drowning and hydrocarbon intoxication. Accurate determination of causes of death in migration contexts is crucial for ensuring accountability and justice. This study underscores the indispensable role of forensic expertise in addressing the legal, political, and ethical dimensions of such tragedies. *Clin Ter* 2025; 176 (3):266-270 doi: 10.7417/CT.2025.5220

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Background

The International Organization for Migration (IOM) defines a migrant as "any person who is moving or has moved across an international border or within a State away from his/her habitual place of residence, regardless of: (1) the person's legal status; (2) whether the movement is voluntary or involuntary; (3) what the causes for the movement are; (4) what the length of the stay is" (IOM 2019).

The Central Mediterranean migration route, according to the International Organization of Migration, is a primary pathway for migrants seeking to reach Europe, primarily through Italy (Mediterranean Missing Migrants Project 2024). This route typically begins along the North African coast, particularly in Libya and Tunisia, and crosses the Mediterranean Sea to arrive in Italy, often on the islands of Lampedusa and Sicily (Mediterranean Missing Migrants Project 2024; MSF 2023; Steinhilper and Gruijters 2018). Migrants undertaking this perilous journey come from various African and Middle Eastern countries, driven by factors such as conflict, poverty, persecution, and climate change (Zamatto et al. 2017).

The Mediterranean Sea, particularly the Central Mediterranean route, has been identified as the deadliest migration corridor in the world, with over 17,000 recorded deaths and missing persons since 2014 (Mediterranean Missing Migrants Project 2024). Migrants face multiple risks, including drowning, hypothermia, dehydration, and exposure to toxic substances such as hydrocarbon inhalation, which can occur on overcrowded, precarious vessels not designed for long journeys on open seas (Mediterranean Missing Migrants Project 2024). The dangerous nature of this journey underscores the urgency for robust humanitarian responses and has led to the establishment of various search and rescue (SAR) operations.

Italy's Mare Nostrum (2013–2014), a proactive state-led SAR mission, was launched in response to rising fatalities and the tragic 2013 Lampedusa shipwreck that claimed 368 lives (UNHCR 2014). With a focus on rescuing migrants in distress close to the Libyan coast, Mare Nostrum saved over 150,000 lives (Carrera et al. 2015). However, due to its high cost (€ million per month) and lack of broader European support, the operation ended in 2014 (Cusumano 2019). The EU's Operation Triton (2014–2018), managed by Frontex, replaced Mare Nostrum, shifting the focus from humanitarian rescue to border security (European Commission 2014). This shift, alongside a reduction in rescue resources, contributed to a significant increase in mortality rates (UNHCR 2015). NGOs such as Médecins Sans Frontières (MSF) and SOS Méditerranée subsequently stepped in, deploying rescue operations in the Central Mediterranean,

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despite accusations of acting as a “pull factor” for migration (Zamatto et al. 2017). Subsequent studies have shown that SAR operations do not constitute a pull factor for migration phenomena (Rodríguez Sánchez et al. 2023).

Nevertheless, deaths continue at an alarming rate. Since 2014, the “Missing Migrants Project” has been proposed for collecting data on migrant deaths. This initiative, implemented by the IOM, aims to document fatalities and disappearances of individuals during their migration towards international destinations (Mediterranean Missing Migrants Project 2024). In the first three months of 2024 alone, 367 confirmed deaths and missing persons were reported, with the majority resulting from drowning (Mediterranean Missing Migrants Project 2024). These ongoing fatalities highlight the persistent risks of this journey and the need for continued SAR operations to prevent further loss of life.

Regarding the causes of migrant deaths, IOM data from the decade 2014–2023 indicate that nearly 60 percent of recorded deaths are due to drowning, with over 27,000 fatalities occurring in the Mediterranean alone. The report emphasizes the urgent need to enhance search and rescue operations to prevent these sea tragedies and highlights the crucial importance of working with governments to establish safer migration routes (Mediterranean Missing Migrants Project 2024).

It is important to note that this data covers migrant deaths due to transport accidents, shipwrecks, violent attacks, or medical complications during their journeys. These figures are derived from official records such as those from coast

guards and forensic experts, as well as from other sources including media reports, NGOs, surveys, and migrant interviews (Mediterranean Missing Migrants Project 2024). Given the variety of sources, the reliability of the data may be affected. Understanding the underlying causes of migrant deaths, including drowning and other less-recognized risks such as hydrocarbon inhalation, is crucial for shaping future policy and humanitarian responses to this crisis.

Case Presentation

Two young migrant women of sub-Saharan African origin, aged 19 (Subject A) and 33 (Subject B), tragically lost their lives while attempting to cross the Central Mediterranean Sea on a small boat. Their bodies were recovered by a non-governmental organization (NGO) vessel engaged in search and rescue operations. Subject A was found deceased on the small boat, while Subject B was discovered in critical condition aboard the NGO vessel; she unfortunately succumbed to her injuries within two hours.

Both bodies exhibited characteristic “fuel burns” on their skin. The authors conducted autopsies and toxicological investigations, concluding that the cause of death was consistent with cardiorespiratory arrest secondary to pulmonary edema resulting from acute hydrocarbon intoxication. Macroscopic examination of the lungs revealed congestion and edema (Fig. 1). Microscopic examination of lung samples, following a general staining procedure with hematoxylin

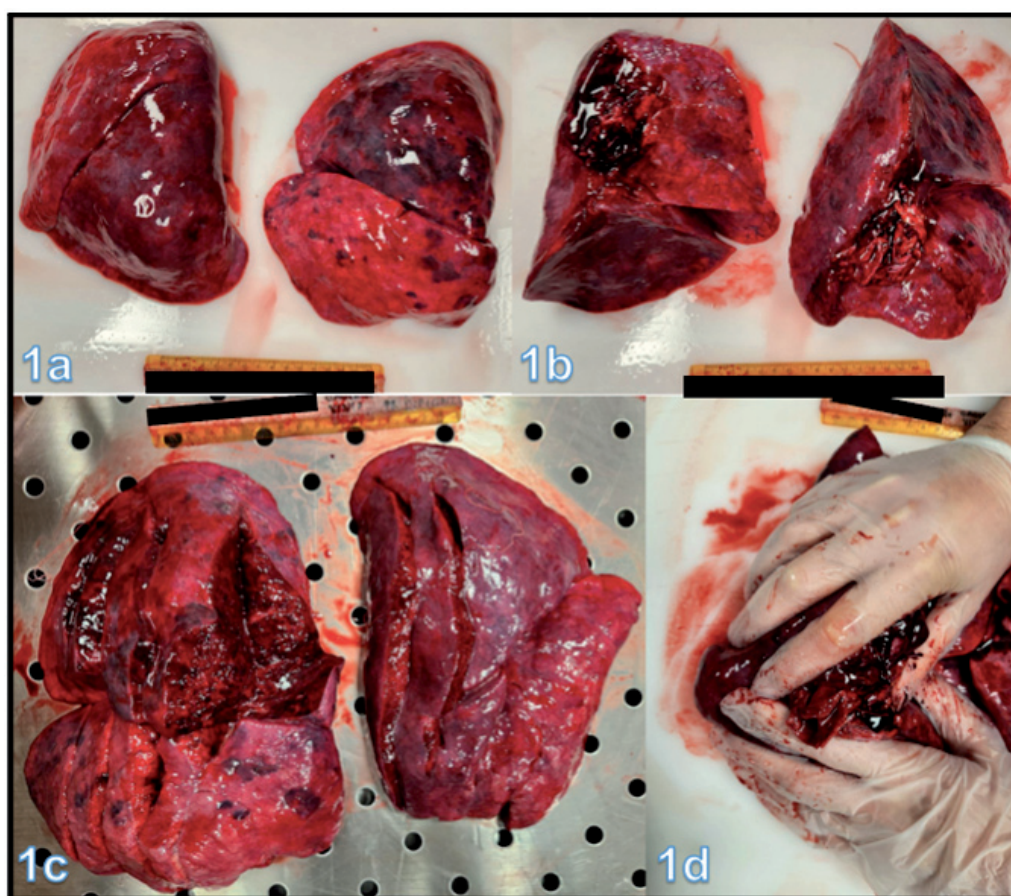


Fig. 1. Congested lungs with edema

Table 1. Substances analyzed

Substance	Subject A	Subject B	Unit of measurement	Normal range in blood	LD50 (mg/Kg)
Benzene	0,6	0,7	mg/L	<0,01	>2000
Ethylbenzene	0,6	0,4	mg/L	<0,01	>5460
Styrene	<0,01	<0,01	mg/L	<0,01	>1331
Toluene	2,2	2,4	mg/L	<0,01	>5580
a-xylene	0,5	0,6	mg/L	<0,01	>4300
m-p-xylene	1,2	1,3	mg/L	<0,01	>4300
Aromatic organic solvents	4,8	5,4	mg/L	<0,01	>5000
Hydrocarbon C<12	16,3	17,6	mg/L	<0,01	>3610

and eosin, revealed significant histopathological changes, including pronounced congestive phenomena, areas of edema, and hemorrhagic regions. Toxicological analysis was performed using gas chromatography with a flame ionization detector (FID) in the headspace mode on blood samples collected during the autopsy. The results indicated levels of hydrocarbons that significantly exceeded normal ranges, as detailed in Table 1.

Conclusions

The findings of our investigation contradict the cause of death registered by the ship's doctor, which attributed the deaths of the two women to "drowning". However, distinguishing between acute hydrocarbon intoxication and drowning syndrome is very difficult and requires specialized expertise in pathology and forensic toxicology.

Drowning is predominantly characterized by asphyxia resulting from fluid aspiration, leading to overdistended, waterlogged lungs with a marked increase in weight (Armstrong et al. 2023). A key diagnostic feature is the presence of fine, proteinaceous, white froth at the mouth and nostrils, frequently extending into the trachea and bronchi. Histological examination of drowning cases commonly reveals alveolar overdistension, intra-alveolar hemorrhage, and surfactant disruption. (Tyr et al. 2024) Additional findings may include the presence of fluid in the stomach, which, in freshwater drowning, can be associated with Paltauf's hemorrhages. In some cases, diatoms may be identified within internal organs, particularly in the bone marrow or brain, though their diagnostic value remains debated (Badu et al. 2014). Gastric hemorrhagic erosions, such as Wischniewski spots, have been reported but are generally considered non-specific. (Erksine et al. 2011) Externally, prolonged immersion often results in cutaneous maceration and so-called washerwoman changes. Furthermore, contraction of the arrector pili muscles due to rigor mortis can produce a characteristic gooseflesh appearance. In some instances, evidence of struggle, such as sand or vegetation under the fingernails, may suggest a vital reaction (Armstrong et al. 2023). The primary elements distinguishing hydrocarbon poisoning from drowning lie in pulmonary pathology, toxicological findings, and associated systemic effects. While chemical pneumonitis, myocardial sensitization, and the

direct detection of hydrocarbons are defining features of hydrocarbon toxicity, lung overdistension, proteinaceous froth, and electrolyte disturbances are more indicative of drowning. Furthermore, externally visible manifestations differ, with hydrocarbon exposure often causing skin irritation and chemical burns (Marrone et al. 2024), whereas prolonged immersion in water is more commonly associated with cutaneous maceration (Armstrong et al. 2023).

Acute intoxication by hydrocarbons occurs when migrants are forced to breathe air contaminated by fuel gas, which can accumulate rapidly in enclosed spaces due to fuel spills or leaks (Brown and Armstrong 2024). Gasoline is often stored in improvised and unsafe containers on these vessels, and fuel spills can create a toxic environment inside the boat, especially in enclosed spaces where hydrocarbon gas accumulates rapidly. Migrants, confined in overcrowded and poorly ventilated spaces, are forced to inhale air contaminated with fuel vapours. The mixture of saltwater with fuel that is often spilled inside the boats and stays attached to the clothing and body can cause deep burns (Fig. 2) due to prolonged skin contact, so called "fuel burns" (Marrone et al. 2024). The lack of adequate ventilation in the holds of vessels increases the risk of inhaling hydrocarbons. Acute symptoms of hydrocarbon inhalation include nausea, dizziness, headache, and irritation of the respiratory tract. In more severe cases, it can lead to fainting, convulsions, and damage to the central nervous system (Tormoehlen et al. 2014; Vitale and Gutovitz 2024). Prolonged exposure can cause rashes, chronic headaches, peripheral neuropathy (due to demyelization) or cognitive impairment. It can cause also chemical pneumonitis, an inflammation of the lungs caused by inhalation of toxic chemicals. Massive and prolonged exposure can lead to respiratory and cardiac collapse, due to pulmonary edema, resulting in death (Brown and Armstrong 2024).

Accurately identifying the cause of death is crucial because of the legal, political, and ethical implications. Forensic analysis strongly suggests that the deaths of the two women resulted from exposure to toxic volatile hydrocarbons. This finding has significant implications for civil and criminal liability profiles, as well as deeper ethical and political reflections. The role of the forensic medical doctor is crucial in cases of violent death that occur in the context of transnational migrations, particularly along the Mediterranean route, as their specialized knowledge and skills are

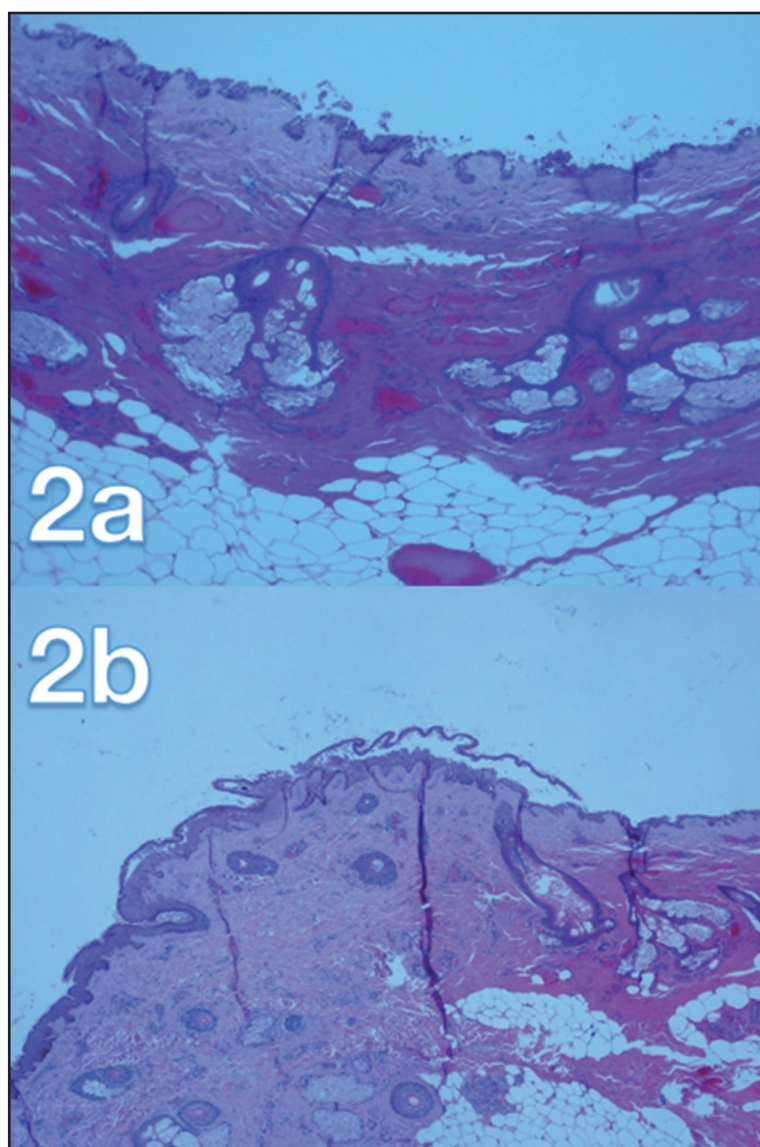


Fig. 2 Skin "fuel burns" microscopic findings

essential for verifying and defining the cause of death and facilitating the administration of justice by the judiciary.

List of abbreviations

IOM: International Organization for Migration; NGO: Non-Governmental Organization; FID: Flame Ionization Detector.

Ethical Approval and Consent

We obtained approval and consent for publication from the Ethical Committee of our Section/Institution. Informed consent was obtained from the next of kin for one of deceased individual, and from the legal representative of Ethiopian community in Southern Italy for the other one. Anyway personal data of the two deceased individuals are not mentioned in the paper and to identify them from photographs is not possible.

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