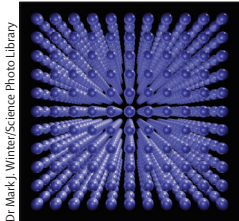




Improving forensic investigation for polonium poisoning

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Polonium crystal structure

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At the time of publication, the remains of Yasser Arafat have been exhumed and are being investigated for cause of death as a result of the findings of the case reported here.

On Nov 11, 2004, Arafat died at the age of 75 years of an unidentified illness in Percy Hospital, France. He presented with a medical history that began in Ramallah on Oct 12, 2004, with nausea, vomiting, abdominal pain, and diarrhoea. Shortly after, his general health deteriorated with continuing gastrointestinal symptoms, thrombocytopenia, apyrexia, but the absence of inflammation and myelosuppression. On Oct 29, he was admitted to Percy Hospital. He had diarrhoea, nausea, vomiting, and generalised abdominal pain with mild liver and kidney failure that was associated with disseminated intravascular coagulation syndrome. His condition worsened, with acute renal failure, aggravation of a cholestatic jaundice, and neurological coma. He was transferred to the intensive care unit, where he died of a cerebral haemorrhage. Despite numerous toxicological and clinical investigations, the cause of his illness remained unknown. There was no evidence of infectious, vascular, or cancerous disease and the treatment had been symptomatic only.¹ Poisoning was considered but never confirmed by toxicological analyses. After the death of Alexander Litvinenko in 2006,² ²¹⁰Polonium (²¹⁰Po) poisoning was considered as a possible cause of Arafat's death. Although the absence of myelosuppression and hair loss does not favour acute radiation syndrome, symptoms of nausea, vomiting, fatigue, diarrhoea, and anorexia, followed by hepatic and renal failures, might suggest radioactive poisoning. From a medico-legal perspective, this hypothesis is justified given the absence of a characterised cause of illness and the absence of toxicological evidence, including γ radiations, as well as the dearth of scientific literature in this topic.

In February, 2012, Arafat's widow made his medical records¹ and his late belongings available to us. DNA analysis (see appendix) confirmed that the belongings were Arafat's. Toxicological elemental analyses done on his hair were unremarkable. Further investigations on several belongings did not reveal any known poison. To assess the possibility of ²¹⁰Po ingestion, we focused our radiotoxicological analyses on visible body fluid stains from specific belongings (underwear, chapka, toothbrush, hospital cap, sportswear). We did ²¹⁰Po analyses on 75 samples, 38 of them taken from Arafat's belongings (see figure in appendix). The remaining 37 samples were references, which were not artificially contaminated with ²¹⁰Po. These included cotton items that had been kept for 10 years and protected from dust and products of radon decay in an attic (appendix). Several samples containing body fluid stains (blood and urine) contained higher unexplained ²¹⁰Po activities than the reference samples.

These findings support the possibility of Arafat's poisoning with ²¹⁰Po. According to biokinetic modelling (see appendix), the measured activities of ²¹⁰Po of several mBq per sample are compatible with a lethal ingestion of several GBq in 2004. Moreover, his clinical presentation could not rule out ²¹⁰Po poisoning. Although myelosuppression and hair loss are expected in acute radiation syndrome after whole-body external exposure, these symptoms are poorly documented in the case of internal exposure of ingested ²¹⁰Po. In radionuclide therapy, side-effects include nausea, vomiting, fatigue, and abdominal pain, with hair loss being less common. Toxicity can occur in bone marrow and, to a lesser extent, kidneys and liver.³ Myelosuppression varies greatly between patients. In Arafat's case, low marrow cellularity associated with ageing and non-bone-seeking biodistribution of ²¹⁰Po might have attenuated myelosuppression.⁴ Since ingested ²¹⁰Po is eliminated primarily through faeces, the gastrointestinal syndrome, associated with multiple organ failure, could be a predominant cause of death.⁵ The fact that around 20 half-lives had elapsed was clearly a challenge for measurement of ²¹⁰Po. However, on the basis of this forensic investigation, there was sufficient doubt to recommend the exhumation of his body in 2012. Three scientific teams are currently analysing body, shrine, and earth samples. Because of legal procedures, the date of publication of the detailed results of the exhumation analyses is unknown. An autopsy would have been useful in this case because although potential polonium poisoning might not have been identified during that procedure, body samples could have been kept and tested afterwards. The international medical community should continue to consider toxicological analyses of body samples in cases presenting with unknown cause of death.

Contributors

Radioanalysis was undertaken by the Institute of Radiation Physics, and toxicological, DNA, and medical analyses by the University Centre of Legal Medicine team. The authors thank Prof Gérard Waeber, Department of Internal Medicine, Lausanne University Hospital, for his expertise in the investigation of the medical records of Mr Arafat. All authors wrote the report.

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See Online for appendix