

Impact case study (REF3b)

<p>Institution: University of Leicester (UoL)</p>
<p>Unit of Assessment: UoA1 Clinical Medicine</p>
<p>Title of case study: Post-mortem computer tomography (PMCT) as an alternative, or adjunct, to invasive autopsy</p>
<p>1.Summary of the impact</p> <p>The East Midlands Forensic Pathology Unit (EMFPU) and Academic Imaging, both based at the University of Leicester, have led the development of post-mortem computed tomography (PMCT) – CT scanning – as an alternative or adjunct to conventional autopsy since 2002. The team has the largest experience in the UK in terms of number of cases investigated and publications, covering natural, traumatic, mass fatality and homicide deaths. It has also contributed directly to national and international guidelines, recommendations, protocols and operational systems. Since 2008, this research has had an impact on public authorities, (contributing to guidelines ranging from natural death to national disaster planning), and on the community.</p>
<p>2. Underpinning research</p> <p><u>Background</u> Professor Guy Ruty (Chief Forensic Pathologist) and Professor Bruno Morgan (Radiologist) lead this project with a multidisciplinary team including forensic pathologists, an academic cardiologist (Dr David Adlam), cardiac radiologists, the UK’s first specific NHS forensic radiographer, and outside collaboration with a forensic anthropologist and odontologist (Professor Black, Dundee and Dr Adams, Wales).</p> <p>In 2002 the team was the first to apply PMCT to UK adult <i>forensic</i> practice (proposing the term ‘necroradiology’ to indicate a new subspecialty; 1). The team has developed, tested and validated PMCT systems to enable them to work in the dead and improve diagnostic accuracy. Their work is recognised internationally for both natural and unnatural deaths -- including trauma, mass fatality and homicide investigations – in relation to disaster planning, victim identification and anthropology.</p> <p><u>Research into use of PMCT in mass fatalities</u> The group was commissioned by the Home Office (see grants 2006) to develop investigation of mass fatalities. They were the first to report the use of mobile CT scanners in a temporary mortuary, showing this could provide more, and faster, information than the multiple radiological sources normally used (2). The team was instrumental in subsequent national guidance documents.</p> <p>With EC funding (see grants 2007), Ruty led the UK’s largest multi-agency, international supported contaminated mass fatality exercise (Operation Torch), which was a simulation exercise involving cooperation from ALL emergency services and a mobile CT radiology provider (3).</p> <p>In 2009 the group proposed a system to the DOH to deal with scan data in the event of a mass fatality - the forensic identification imaging system, ‘FiMag’. This system ensures appropriate image reporting and secure data transfer from scene to mortuary to ID completion, meeting the stringent requirements of the criminal justice system (4).</p> <p>The work on FiMag encouraged the Department of Health to form a new advisory body for post-mortem imaging with Professors Ruty and Morgan amongst the founding members. Subsequently, the advisory body has produced a ‘Ministerial requested’ national strategy and related guidance documents.</p> <p><u>Research into techniques to advance use of virtual imaging</u> Morgan and Ruty have developed a novel form of PMCT angiography (targeted PMCTA) to</p>

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assess the coronary arteries after death, a major obstacle to replacing invasive autopsy with PMCT in natural sudden death (5,6). Since 2008 the group has scanned over 500 corpses referred from HM Coroner with autopsy control and consent from the next-of-kin, specifically studying road traffic deaths and sudden death due to cardiac causes. Their research suggests that PMCT angiography could reduce the number of HM coroner requested autopsies in the UK by thousands per year (7).

The researchers introduced the concept of using PMCT for remote anthropological assessment of bones. This avoids defleshing the bones, essential for standard assessment (8). Developing from this, further research has additionally shown high resolution 'virtual histology' imaging of the coronary arteries using optical coherence tomography for the first time in a cadaver (9), and has also developed ventilation during PMCT to examine the lungs.

3. References to the research

- 1 Rutty G.N, Swift B. Accuracy of magnetic resonance imaging in determining cause of sudden death in adults: comparison with conventional autopsy. *Histopathology*. 2004 Feb;44(2):187-9.
- 2 Rutty G.N, Robinson C.E, BouHaidar R, Jeffery A.J, Morgan B. The Role of Mobile Computed Tomography in Mass Fatality Incidents. *J Forensic Sci*. 2007; 52: 1343-1349
- 3 Rutty GN, Rutty JE. Did the participants of the mass fatality exercise Operation Torch learn anything? *Forensic Sci, Med Pathol*. 2012; 8: 88-93
- 4 Rutty G.N, Robinson C, Morgan B, Black S, Adams C, Webster P. Fimag: the United Kingdom Disaster Victim/Forensic Identification Imaging System. *J Forensic Sci*. 2009; 54(6): 1438-1442.
- 5 Saunders SL, Morgan B, Raj V, Robinson C, Rutty GN. Targeted Post-mortem Computed Tomography Cardiac Angiography; Proof of concept. *Int J Legal Med* 2011; 125:609-16
- 6 Morgan B, Biggs MJ, Barber J, Raj V, Amoroso J, Hollingbury FE, Robinson C, Rutty GN. Accuracy of targeted post-mortem computed tomography coronary angiography compared to assessment of serial histological sections. *Int J Legal Med*. 2012 Nov 10. [Epub ahead of print]
- 7 Saunders S, Amorosa J, Morgan B, Rutty G. Consent of the recently bereaved to post-mortem targeted angiography research: 207 adult cases. *J Clin Path* 2013 Apr;66(4):326-9 and Rutty GN, Rutty JE Perceptions of near virtual autopsies. *J Forensic Leg Med*. 2011;18:306-9
- 8 Robinson C, Eisma R, Morgan B, Jeffery A, Graham EA, Black S, Rutty GN. Anthropological measurement of lower limb and foot bones using multi-detector computed tomography. *J Forensic Sci*. 2008;53(6):1289-95.
- 9 Adlam D, Joseph S, Robinson C, Rousseau C, Barber J, Biggs M, Morgan B, Rutty G. Coronary optical coherence tomography: minimally invasive virtual histology as part of targeted post-mortem computed tomography angiography. *Int J Leg Med* 2013 [Epub].

Funding:

Mass Fatality: Home Office £150,000 (2006) and European Commission CBRN exercise grant €498,902 (2007).

Anthropology: Home Office £17,850 (2007). Awarded to investigate the role of remote anthropology reporting of PMCT imaging for mass fatality investigations.

Cardiac PMCTA: National Institute for Health Research £196,742 (2010). Awarded to investigate a novel system of targeted PMCTA.

Medico-legal PMCT: Home Office: £50,000 (2012). Awarded to investigate role of PMCT in road traffic collisions, suspicious and homicide deaths, and role of ventilated PMCT in criminal courts.

4. Details of the impact

Background

Postmortem imaging is now a rapidly growing field. Rutty and Morgan, together with their collaborators, have helped advance postmortem imaging to the stage where it has become 'routine consideration to confirm cause of death' (A) and 'standard procedure in the forensic examination of

human remains both after a disaster and in individual cases' (B).

Impact on policymakers

Rutty and Morgan as founding members of a Department of Health National Imaging Board helped produce national guidance documents with the Ministry of Justice and Royal Colleges of Pathology and Radiology. Rutty was lead author of a 'vision' document for the introduction of a national PMCT service (C). The team's sharing of their research has been the 'driving force' (D) behind the new recommendations.

Rutty and Morgan's research has had a particularly significant influence in the area of disaster victim identification (DVI). Lessons learnt from 'Operation Torch' have been published in an official report (E) which will assist member states of the EC in planning for and responding to similar incidents. As a consequence of Torch, Professor Rutty was awarded a Metropolitan Police Service Assistant Commissioner Commendation (2009). In 2010 he was awarded an MBE.

The FiMag system has been presented to the International Red Cross and Interpol, and similar systems are now being planned in the Netherlands and Australia. PMCT is part of the latest working version of Interpol's general guidance for mass fatality incidents, and the International Society of Forensic Radiology and Imaging (ISFRI) Disaster Victim Identification group's positional statement (F). Rutty represents the UK at the Interpol Standing Committee on Disaster Victim Identification and is Vice-Chair (Chair in 2013-4) of ISFRI. A representative of Queensland Health Forensic and Scientific Services said: "One of the many positive aspects of the technology is that it lends itself to multicentre utilisation and interdepartmental communication." (B)

Impact on practitioners

Following successful use of PMCT in the 2009 Black Saturday bushfires, the Australasian Disaster Victim Identification Committee prepared a business case for service implementation. They asked for the help of Professor Rutty for background information, a description of FiMag, and costing for the purchase of a 'BodyTom' mobile scanner, which appears to 'do everything ADVIC would want' (G).

Within the field of DVI, PMCT has a major impact on investigation, such as identifying component parts of an improvised explosive device or identification of the dead using odontology or old injuries. It allows efficient management of personnel and limited resources. Offsite specialists can be involved in disaster response, which has 'enormous cost-benefit yet to be recognised.' (B). The Chief Constable, National Pathology and Disaster Victim Identification Lead says: "Due to the work at Leicester, contingency plans for mass fatality incidents now include an option to source mobile CT scanners to enhance operations at designated mortuaries." (H)

The research is impacting on police investigations in the UK, and PMCT in 'single death' postmortems is being 'monitored with interest' by senior officers and forensic specialists' (H). The technology can be a strong investigative tool in trauma and can also be useful for re-examination if suspicions arise after a body has been cremated (a 'virtual exhumation').

In September 2012 the group launched the UK's first training course in PMCT and from 2014, PMCT based teaching will be offered to all medical students attending the University, the first such initiative in the country.

Impact on the public

Increasing media profile has disseminated this research to a wider audience (I). Demand for a less invasive post-mortem procedure is expected to grow, particularly in Muslim and Jewish communities, whose religious and cultural principles oppose invasive autopsies. The Saad Foundation was set up by a former police superintendent to provide support and assistance to the Muslim community in dealing with sudden death procedures (J). He used the Leicester team's research on imaging to help persuade the Charity Commission to grant 'registered status'. The Coroners' Society, thanks to lobbying from Rutty and other academics, professionals, and politicians such as Baroness Warsi, is now allowing imaging as an alternative to intrusive

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autopsies. Rutty has been involved in the training of all Coroners' Officers in West Yorkshire, resulting in a 'change in mindset' among previously resistant practitioners (Saad Foundation).

Other impact

The group has collaborated with other international groups such as the Technical Working Group Postmortem Angiography Methods (TWGPAM), an international cooperation establishing a database for post-mortem angiography. Rutty and Morgan united other researchers across the world in 2012 with the first publication outlining a common nomenclature in this field.

5. Sources to corroborate the impact

- A. National Clinical Director for Diagnostics, NHS England. 26 June 2013
- B. Regional Senior Forensic Pathologist, Queensland Health Forensic and Scientific Services, Australia. 5 July 2013
- C. Report from the NHS Implementation Sub-Group of the Department of Health Post Mortem, Forensic and Disaster Imaging Group (PMFDI). Can Cross-Sectional Imaging as an Adjunct and/or Alternative to the Invasive Autopsy be implemented within the NHS? October 2012.
- D. Associate Director- Molecular Imaging, Alliance Medical Group.
- E. Home Office Guidelines 'The safe handling of contaminated fatalities', 2009 (Restricted).
- F. Article in Journal of Forensic Radiology and Imaging. [Use of Radiology in Disaster Victim Identification: Positional statement of the members of the Disaster Victim Identification working group of the International Society of Forensic Radiology and Imaging. May 2013](#)
- G. Detective Superintendent, Forensic Services Department, Victoria Police
- H. Chief Constable, National Pathology and Disaster Victim, Identification Lead, National Police Business Areas, England, Wales and N Ireland. 20 June 2013
- I. The Guardian: Virtual autopsy: does it spell the end of the scalpel? 23 Feb 2013
<http://www.theguardian.com/science/2013/feb/23/virtual-autopsy-virtopsy-forensic-science>
- J. Saad Foundation. 28 July 2013