

Institution: University of Leicester		
Unit of Assessment: UOA1		
Title of case study: Victim identification in mass fatality incidents: the creation, international adoption and use of mobile computed tomography		
Period when the underpinning research was undertaken: 2003-2016		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s): (1) Prof Guy Rutty (2) Prof Bruno Morgan (3) Dr Mike Biggs (4) Dr Alison Brough	Role(s) (e.g. job title): (1) Chief Forensic Pathologist (2) Professor of Cancer Imaging & Radiology (3) Clinical Associate Professor in Forensic Pathology (4) Research Associate	Period(s) employed by submitting HEI: (1) 2001 - present (2) 1996 - present (3) 2013 - present (4) 2009 - 2016
Period when the claimed impact occurred: 2013-2020		
Is this case study continued from a case study submitted in 2014? N		
<p>1. Summary of the impact</p> <p>Establishing identity of the deceased is an important component in the reporting of death, whether from natural causes, acts of war, terrorism or disaster. Researchers at University of Leicester, led by Professor Rutty, have been at the forefront of pioneering work which has led to the establishment of both mobile and static computed tomography (CT) as the principal method of radiological investigation used globally in mass fatality investigations. Their ground-breaking research, disseminated in publications, exercises and bespoke training has resulted in national and international implementation. The CT technology is now incorporated into national guidance by the Home Office for disaster victim identification (DVI) processes and has been adopted internationally including Australia, Netherlands, Poland, Denmark, Norway and New Zealand. The use of CT technology for DVI has also been embraced by international NGOs including INTERPOL and the Red Cross.</p>		
<p>2. Underpinning research</p> <p>In 2004, Rutty made the novel proposal that a mobile CT scanner could be used at both mass fatality scenes and mortuaries (permanent and temporary facilities) as a single radiological tool replacing the traditional plan film and fluoroscopic approach, to assist in the disaster victim identification (DVI) process [R1]. Though the proposal was initially rejected by DVI radiology service providers, Rutty continued investigations and promotion of the concept.</p> <p>In the aftermath of the London Bombings, interest in Rutty's proposal increased. In 2006 the Home Office commissioned the University of Leicester to develop the concept as part of a nationwide research programme to consider a pathology response to a contaminated mass fatality incident (CBRN) [G1]. The Leicester Imaging team (LIT) was led by Rutty and comprised</p>		

Professor Morgan, Professor of Cancer Imaging and Radiology, and Claire Robinson of University Hospitals Leicester; the NHS' first full time forensic radiographer.

As part of this programme, LIT completed and published pioneering research into the use of electronic fingerprinting of the dead, a system now widely available as a standard practice option for investigators [R2]. Between 2006 and 2011 LIT were able to demonstrate the efficacy of their concept in a real-world scenario. Following a multiple fatality road traffic incident in Lincolnshire, Rutty's expertise was requested and, for the first time ever, used a mobile CT scanner to investigate the deaths. Based upon this success, the Victoria Institute of Forensic Medicine (Melbourne, Australia) used their mortuary-based CT scanner to assist the investigations of the Victoria Bush Fires [E11]. LIT were approached privately by a representative of the British Army to discuss their forthcoming deployment of CT scanners in Afghanistan during the conflict. Rutty's concept of CT scanning in DVI was becoming generally accepted.

Disasters often involve people from all over the world and therefore may require global reportage. By 2008, LIT had detailed proposals for the use of remote reporting of images for DVI resulting in the creation of the FiMag system which facilitated the remote sharing, reporting and storage of CT acquired images for DVI purposes [R3]. The use of mobile CT was researched, exercised and the results reported to the Home Office resulting in its incorporation into the national protocols for the DVI process following a CBRN incident [E6, E7].

LIT obtained a funded PhD position in 2009 to consider the use of virtual forensic anthropology obtained by Alison Brough. Brough developed a virtual osteological assessment system from CT images to facilitate remote forensic juvenile osteological identification [R6]. She was able to demonstrate how a considerable part of the current INTERPOL DVI Pink form can be populated from CT derived data alone. The research enhanced the application of CT system for subsequent work all over the world.

FiMag was a significant innovative advance recognised by the European Commission who provided further development funding for the concept in the form of Operation Torch in 2009. This operation, managed by LIT, was the largest multi-national, multi-agency mass fatality exercise involving a contaminated and non-contaminated scenario ever conducted in mainland Europe. Operation Torch had mobile CT scanning at its heart. In the UK, LIT research demonstrated the viability of sending mobile CT images across the world during a mass fatality investigation leading to the establishment of reporting teams as far afield as South America, Australia and New Zealand with access to live DVI data [G2].

By 2012, LIT research had established mobile CT as part of the provision for non-contaminated disasters in the UK demonstrated by its inclusion in the disaster investigation protocols for the London Olympics. Use of CT scanners in the manner proposed by LIT was seen subsequently during terrorist incidents, including the Tunisian beach shootings and Manchester Arena bombings, and high-profile disasters including the Grenfell Tower fire [R4].

In 2013 and 2014, Rutty presented the research on the use of CT scanning for DVI and its demonstrable benefits at the annual meeting of the DVI Steering Committee for INTERPOL in Lyon and authored advisory documents for the Canadian, Netherlands and Australian police forces on CT implementation as well as similar guidance for the International Red Cross.

In 2011, Rutty was a founding member (and later, Chair) of the International Society for Forensic Radiology (ISFRI). Within the ISFRI, Rutty created and leads the society's DVI advisory group. Under his leadership, this group has produced 6 internationally adopted positional statements on the use of radiology for mass fatality investigations and the use of CT [R5].

3. References to the research**PUBLICATIONS**

[R1] 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

[R2] Rutty GN, Stringer K, Turk EE. 'Electronic fingerprinting of the dead'. Int J Legal Med. 2007.; 122: 77-80

[R3] 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: 1438-1442.

[R4] Rutty GN, Biggs MJP, Brough A, Morgan B et al. 'Remote post-mortem radiology reporting in disaster victim identification: experience gained in the 2017 Grenfell Tower disaster'. Int J Legal Med 2019. 10.1007/s00414-019-02109-x

[R5] Hofman P, Rutty G, et al. 'Use of Post-mortem Computed Tomography in Disaster Victim Identification. Updated positional statement of the members of the Disaster Victim Identification working group of the *International Society of Forensic Radiology and Imaging*'. J Forensic Radiol Imag 2019. <https://doi.org/10.1016/j.jofri.2019.100346>

[R6] Brough AL, Morgan B, Rutty GN, et al. 'A minimum data set approach to post-mortem computed tomography reporting for anthropological biological profiling' Forensic Sci Med Pathol 2014; 10: 504-12

[R7] Biggs, MJP, Marsden, P., 'Dental identification using 3D printed teeth following a mass fatality incident' Journal of Forensic Radiology and Imaging, 2019
<https://doi.org/10.1016/j.jofri.2019.07.001>

GRANTS

[G1] Rutty (PI) Home Office CBRN grant £150K 2006. 'Development of a pathology response to a chemical, biological, radiological or nuclear mass fatality incident.'

[G2] Rutty (PI) European Commission CBRN exercise grant €498,902. 'Operation Torch'

4. Details of the impact

On 17th July 2014, Malaysia Airlines Flight 17 (MH17) was shot down over Eastern Ukraine killing all 298 people aboard. During the ensuing investigation, LIT research played an important role.

For the first time in a multinational temporary mortuary, mobile CT scanning was utilised for DVI. Rutty provided expert input and guidance throughout the process which enabled the number of invasive autopsies to be limited to an absolute minimum with the majority of victims undergoing no autopsy examination at all **[E5]**. This achievement directly resulted from LIT research and development on the extended use of CT imaging. Non-invasive autopsy techniques have been shown to be superior in identifying trauma and haemorrhage in addition to minimising the need for dissection which can cause significant distress to the loved ones of the deceased **[E9]**. The Dutch Official Secrets Act prevents further disclosure on this incident presently.

Those repatriated to the UK from MH17, in addition to the victims of the Shoreham air disaster, further demonstrated the benefits of mobile CT scanning as a replacement for invasive autopsy. Dr Mike Biggs of the East Midlands Forensic Pathology Unit (EMFPU) utilised a mobile CT scanner to examine the victims of both incidents without invasive autopsy; the first time this had happened in the UK, and to our knowledge, the world both in terms of the criminal charges enabled and technological application in mass fatalities.

In 2017, mobile scanning was used at both the Manchester Area Bombings and the Grenfell Tower disaster **[E3,R5]** the latter case being the first time that remote reporting for mass fatality investigations, conceived by Rutty, had been used globally **[R4]**.

The use of CT scanning was recommended as 'good practice in all relevant cases' by the Pathology Delivery Board of the UK Home Office in 2017, **[E6]** following on from the prior incorporation of mobile CT scanning as a national protocol for DVI following a CBRN by the UK National Crime Agency **[E7]**.

As a result of their successful research implementation at Grenfell, Rutty and LIT led the team that designed the first ever radiology form incorporated in the INTERPOL DVI 'Unidentified Human Remains (pink) form' used for recording the details of each unidentified human remain in any mass fatality incident. The adoption by INTERPOL of this form ensures that each of the 194 national police forces worldwide utilise LIT research methodology during mass fatality investigations **[E1,E4]**. Rutty also authored the guidance document accompanying the form and led the ISFRI group that wrote the positional statement on its use.

PMCT technology was also employed to examine the victims of the Leicester Hinckley Road Explosion and the King Power Stadium helicopter crash. As part of the former investigation, new dental identification processes were utilised by employing a 3D print from the PMCT system **[E10, R7]**.

The 3D printing of teeth by a DVI odontologist was pioneered by LIT at the Hinckley Road Explosion where Biggs successfully produced a 3D print of one of the victims' teeth and was therefore able to confirm their identity. This approach was essential in identifying the deceased as the normal dental structure for identification purposes had been damaged by the fire. As far as we are able to tell, this was the first time that this had ever been accomplished globally **[E10]**.

In 2019, the use of the non-invasive post-mortem imaging techniques pioneered by Rutty and LIT were recommended by the UK Chief Coroner who stated that 'The Chief Coroner encourages coroners to consider the use of less invasive forms of examination in appropriate cases' **[E8]**.

Since conceiving of the idea in 2003/4, Rutty's LIT have broken new ground and led the world in the field such that today, mobile and mortuary based CT scanning is now internationally established as a radiological investigative tool for mass fatalities and for standard autopsies.

The impact of their work is summarised below:

1. Changing national and international protocol in relation to the examination practice fatality DVI investigations **[E3, E7]**. This has included the introduction of remote DVI reporting, electronic fingerprinting of the dead and virtual anthropology for DVI incidents **[E1]**. Enabling accurate, tailored identification processes to support both law enforcement, policy makers and provide closure to loved ones of the dead.
2. Introducing a new radiology form (paper and electronic format) along with the guidance notes to the INTERPOL system for post-mortem investigations, a form now adopted by every member police force globally **[E1]**.
3. Leading the professional international society for this field in the authoring of six positional statements of best practice for the use of radiology in mass fatality DVI **[E2]**.

Creation, validation and development of entirely new technologies to vastly expand the capability of DVI teams to identify the victims and thus providing closure and peace of mind for the victims' families [E1, E3, E8, E9].

5. Sources to corroborate the impact

- (E1) [INTERPOL Pink Form and Guidance](#).
- (E2) [ISFRI Position Statement](#)
- (E3) [Remote Post-mortem Radiology Reporting in Disaster Victim Identification; Experience Gained in the 2017 Grenfell Tower Disaster – Report](#)
- (E4) International adoption of CT scan technology by [Polish Society of Forensic Medicine and Criminology](#)
- (E5) [The loss of Malaysian Airways flight MH17: a forensic and humanitarian task](#). J Law Med 2015; 22:745-750
- (E6) [Home Office Pathology Delivery Board minutes](#):
- (E7) [National Crime Agency \(NCA\) Identification Process – Good Practice](#)
- (E8) [Chief Coroner Guidance \(2019\)](#)
- (E9) [‘Breakthrough in how autopsy practice is conducted worldwide’ Science Daily 2017](#)
- (E10) Quotations from Leicester Mercury (27/2/18) (7/3/18) (8/3/18) (16/9/18)
- (E11) [‘Contribution of postmortem multidetector CT scanning to identification of the deceased in a mass disaster: Experience gained from the 2009 Victorian bushfires’](#)