



# The conventional autopsy in modern medicine

Tariq Ayoub<sup>1</sup> • Jade Chow<sup>2</sup>

<sup>1</sup> Foundation Year 1 (F1), Conquest Hospital, Hastings, UK

E-mail: ms015628@sgul.ac.uk

<sup>2</sup> Consultant Histopathologist, St. George's, University of London, Cranmer Terrace, London SW17 0RE, UK

E-mail: jchow@sgul.ac.uk

Correspondence to: Dr Tariq Ayoub

## DECLARATIONS

### Competing interests

None declared

### Funding

None

### Ethical approval

Not applicable

### Guarantor

TA

### Contributorship

Both authors  
contributed equally

### Acknowledgements

Thanks to Dr Ian  
Hawley, Consultant  
Histopathologist at  
Conquest Hospital,  
Hastings for his help  
in reviewing the  
article

## Summary

In many countries, including the UK, where relatives' consent is required, clinical autopsy rates (i.e. autopsies other than those required by law) have been declining since the 1950s. In the UK, even in teaching hospitals, the clinical autopsy rate has fallen to only 10% of deaths or less. At this rate of decline, clinical autopsies – and the pathologists who perform them – face extinction. The future practice of medicine will be blind to the many adverse consequences of clinical actions or omissions. The reasons for this decline are manifold and these have to be addressed if autopsy is to stand a chance of survival. The future of autopsy lies in promoting public support for autopsies, in some cases adapting the autopsy to address specific questions, thus making more effective use of information from autopsies. Only by ensuring that the next generation of doctors have experienced the powerful educational benefit of examining the body after death will the importance of autopsy to modern medicine be understood.

## Introduction

Twenty percent of all deaths are subjected to medico-legal autopsies. In many countries where relatives' consent is required, however, including the UK, clinical (i.e. non-medico-legal) autopsy rates have been declining since the 1950s. In the UK, even in teaching hospitals, the clinical autopsy rate has fallen to only 10% of deaths or less.<sup>1</sup> Everyone has heard of the infamous Alder Hey scandal that broke out at the end of the last century, when it was discovered that several hospitals across the UK had been retaining body organs of deceased infants for the purposes of research without prior consent from the parents. Such incidents only serve to reduce autopsy rates.

If clinical autopsy rates continue to decline, such autopsies and the pathologists who perform them will become extinct, leaving the future practice of medicine blind to the many adverse consequences of clinical actions or omissions. Public health measures to reduce mortality from common

fatal conditions by scientific validation will be hindered. However, by recognition of the likely negative impact on medicine and by proactive measures to stop or reverse the decline, it may be possible to avert the extinction of hospital autopsy and ensure that the information derived from it continues to sustain a high medical standard.

This article discusses the importance of conventional autopsy, alternatives available to the conventional autopsy and the reasons for its decline.

## What is autopsy?

The term 'autopsy' literally means to 'see for oneself', and is synonymous with the terms 'post-mortem', 'post-mortem examination' and 'necropsy'. An autopsy includes a detailed external examination as well as dissection of organs from the different body cavities – cranial, thoracic, abdominal and pelvic. Examinations restricted to a particular body cavity or to sampling of the organs in the opened body with a

biopsy needle are also regarded as autopsy examinations.

In a full conventional, non-coronial hospital autopsy, every body cavity is examined in great detail in a systematic way to ensure that nothing is missed. This form of autopsy ensures that incidental findings are uncovered which may or may not be related to the death.

### **Importance of conventional non-coronial hospital autopsy**

The information obtained from autopsies not only instructs and confirms but also serves as a pathway of study and source of investigation. It remains a necessary tool in elucidating the changing spectrum of diseases. The goal of autopsy is not to point out to clinicians their mistakes or judge them but rather to inform clinicians so they learn from their own mistakes. Despite improvements in diagnostic technology, the frequency of misdiagnosis has not decreased significantly.<sup>2</sup>

Autopsies have in the past shed light on the mechanisms of diseases that cannot be elicited in the living being, and they continue to do so to this day. Knowledge of diseases of the brain and the heart relies greatly on autopsies. Three factors bear upon this: first, diseases of the brain and heart account for the majority of deaths in 'developed' countries; second, these organs are the least amenable to investigation (by biopsy) during life; and third, these organs – more than any other – have the greatest symbolic significance, and their emotive associations underlie the reluctance of many relatives to agree to their retention at autopsy.<sup>3</sup> Autopsies are still essential for the detailed characterization of the central nervous system and of the heart. Knowledge of variant Creutzfeldt-Jakob disease (vCJD) relies heavily on the study of post-mortem brain tissue.<sup>4</sup> Autopsies contribute to a clearer understanding of the changes that occur in people who have had organ transplantations and help to explain diseases related to chronic dialysis, such as aluminium encephalopathy.<sup>5</sup>

The autopsy is an integral part of protocols for the verification of cause of death in clinical trials in which death, or its avoidance, is an outcome measure; deaths in clinical trials may be due to the intervention (e.g. unexpected fatal side effect of the treatment), to unrelated disease or to the condition which is the trial's focus of attention. However, even though autopsy has been chosen as the gold standard for the correctness of clinical diagnoses, it is not infallible. Some diseases may be difficult to

detect by pathological examinations (e.g. cardiac arrhythmias) and pathologists may make mistakes in their assumptions.

Autopsies as an educational tool for teaching, by correlating pathology with clinical context, remain unrivalled: no equivalent alternative exists. The impact of seeing the morbid anatomical features of disease is potent and long-lasting. The discovery of clinico-pathological discrepancies in the post-mortem room is also a powerful tool for identifying faults in medical practice and the need for clinical audit utilizing autopsy data. However, many pathologists do not appreciate students' psychological reactions to seeing dissected cadavers; this emotional experience may detract from the potential educational benefit. It is therefore the pathologists' duty to ensure that appropriate steps are taken to minimize these reactions so that the autopsy is an educational experience for the students.<sup>6</sup>

DNA is robust enough to retain sufficient integrity to enable genetic analysis of post-mortem tissue. In cases in which the fatal lesion may have had an inherited genetic cause, it may be worthwhile to use post-mortem tissues for molecular DNA analyses where no ante-mortem samples are available. The findings could be used to counsel the family of the deceased about the risks of inherited disease and about the possible prophylactic measures available.<sup>7</sup>

Autopsy has an important potential role in assessing the effectiveness and side-effects of gene therapy. It not only provides an opportunity to assess the effectiveness of gene therapy in helping improve the disease for which it is given, but also enables access to a wide range of tissue and cell types in order to investigate the specificity of the localization of retroviral vectors. This method was employed in a study of 32 autopsy cases where the site of the retroviral vector was found to be as expected, thus providing reassurance of the effectiveness of the gene therapy.<sup>8</sup>

Surveys of hospital and community doctors generally show that they appreciate receiving autopsy reports and that in a high proportion of cases the findings are unexpected and could influence their future clinical practice.<sup>9</sup> Information from autopsies also has important benefits for bereaved relatives; many bereaved parents find it helpful to have a sensitive and reasonably full explanation for the death of their child in order to help them come to terms with their loss. In a survey of family members of 102 patients who died in a teaching hospital in the USA, 88% responded that they considered autopsy beneficial, citing as

reasons the comfort from knowing the actual cause of death, reassurance that the clinical care was appropriate and advancement of medical knowledge.<sup>3,10</sup> However, many family members complained about the long delay in receiving information about the autopsy findings.

## Alternatives to a full autopsy

### Limited autopsies

The full autopsy is unrivalled as a method of auditing the reliability of clinical diagnosis, because complete dissection of the body ensures that significant unexpected morphological findings are detected. In some cases, however, performing a full autopsy may not be feasible – for example, in cases in which there is an infectious hazard or in cases in which the relatives cannot tolerate the prospect of agreeing to a full autopsy, but would be prepared to allow a less extensive examination. Thus a limited autopsy may be problem-oriented, focusing on an organ or body cavity in which there is the greatest clinical curiosity.

An alternative form of limited autopsy is the use of endoscopic techniques that do not require the large incisions or removal of organs for which some relatives may withhold their agreement. This form of autopsy can only be performed by a person skilled in the operation of such a device, and can only be used in areas of the body that will allow passage of an endoscopic device. A recent study on the efficacy of laparoscopic autopsy concluded that it is more acceptable to the families of patients than the conventional form, resulting in a higher consent rate. Additionally, performing these autopsies gave surgical residents invaluable training in laparoscopic skills.<sup>11</sup> The sensitivity of this technique is found to be very high for fatal traumatic lesions<sup>12</sup> but unacceptably low for fatal non-traumatic lesions,<sup>13</sup> rendering it useful only for a very limited group of post-mortem examinations.

With needle autopsies, no gross information is obtained other than from external examination of the body. However, the technique may enable relatives to agree to a less disfiguring way of autopsy investigation, providing they are aware of the limitations. Needle autopsy, performed under lawful circumstances, also enables very fresh tissue (e.g. for microbiology, genetic studies or autolysis-free histology) to be obtained very soon after death irrespective of whether there is subsequently to be a full autopsy. However, a study comparing the needle biopsy post-mortem with the conventional

autopsy concluded that needle biopsy is inferior to the conventional biopsy.<sup>14</sup>

Both the above forms of autopsy are not an alternative to a conventional full autopsy, but rather different forms of limited autopsy.

### Non-invasive autopsies

Many institutions across the world are evaluating imaging as a non-invasive means of performing an autopsy. This is due to the personal, religious or cultural objections to the autopsy by dissection and the stressful nature of seeking consent at a time of bereavement. Amongst the imaging techniques, magnetic resonance imaging (MRI) has thus far proven to be the most promising in the various studies being conducted.

In one such study, 20 stillborn, miscarried or aborted fetuses were examined by MRI and subsequent autopsy dissection. Only eight cases showed complete agreement with the two examinations, but MRI examination revealed information in four cases that was not evident by autopsy dissection.<sup>15</sup> Another study looked at the accuracy of post-mortem MRI in determining the cause of sudden death in adults. Sudden unexpected adult deaths in the community, reported to the coroner but excluding suspicious, violent or potentially drug-related deaths, were submitted to whole-body MRI followed by full invasive autopsy. The study suggests that post-mortem MRI can identify some abnormalities relating to the common causes of sudden death in adults but could also have application in the context of a non-coronial hospital post-mortem. There is a need, however, for greater experience in correlating MRI with autopsy findings before a reliable cause of death can be ascertained by MRI alone.<sup>16</sup> Similar studies are in progress examining the reliability and effectiveness of MRI in investigating deaths in adults. However, it is doubtful if MRI autopsy will become the gold standard autopsy for the following reasons:

- MRI cannot sample the body for toxins or micro-organisms
- MRI does not have the spatial resolution to identify very small but significant lesions
- MRI cannot provide histological conformation of findings
- Most MRI machines are fully used for the investigation of living patients, often after a prolonged waiting period.

Nevertheless, there may be some circumstances in which a very specific problem needs

investigating and for which MRI would be useful, after proof of its sensitivity and specificity have been confirmed.

### Reasons for decline in autopsy

The nineteenth century saw the heyday of the autopsy and the twentieth century has seen its subsequent decline. Several factors have been implicated in the decline in autopsy.

A primary factor in the decline in hospital autopsy rates is because clinicians do not want them. The reasons offered by clinicians for not requesting autopsies are varied and range from a distaste for the procedure<sup>3</sup> to a belief that the modern investigative techniques are so accurate that the autopsy can add nothing extra to the clinical picture.<sup>17</sup> Clinicians' diminishing clinical interest and their increasing clinical confidence in their ante-mortem diagnosis has resulted in fewer autopsies being requested.<sup>18</sup> Pathologists have countered this with numerous studies which show that the discrepancy rate between the cause of death offered by clinicians before autopsy and that revealed by the autopsy is 10–30%.<sup>19–24</sup> With the current trend towards increasing amounts of litigation,<sup>25</sup> however, it is unlikely that individual clinicians will reverse the trend in demand for autopsies.

This has been compounded by the public resistance to autopsies due to the considerable adverse media attention to the retention of organs, particularly hearts and brains. This attitude has been further fuelled by the sordid portrayal of autopsies in film and drama. In many instances, insufficient priority has been given to autopsies by pathologists. This is due to a multitude of factors, including the increasing workloads from surgical resections, biopsies and cytology, and the lack of respect for autopsy-based research.

The recent changes in medical undergraduate curricula are resulting in many medical students graduating from some medical schools without ever having seen an autopsy. This means that in many cases, future doctors will have even less knowledge of the role of autopsy in verifying cause of death. Neither will these new doctors have had any personal experience of autopsies to enable them to give informed answers to the concerns of relatives whose agreement is being requested.

Despite the overall fall in autopsy rates, some institutions have succeeded in maintaining a high clinical autopsy rate or reversing a declining rate.

Factors contributing to this sustained high autopsy rate were:

- Timely communication of autopsy findings to clinicians
- Use of autopsy data in institutional risk management
- Emphasizing to family members the quality-control benefits of unexpected findings
- Training in the seeking of consent for autopsy
- Effective organization, management and integration of all aspects of the autopsy service.<sup>26</sup>

In a study done by Lugli *et al.*,<sup>27</sup> these strategies helped increase autopsy rate from 16 to 30% within six months and up to 36% in one year. However, when these interventions were discontinued, the autopsy rate fell to 6%.

### Conclusion

Conventional non-coronial autopsy plays a very important role in modern medicine. Its benefits over other forms of post-mortem examination have been outlined above. Medicine today, however, cannot reap the full benefits of this diagnostic tool due to the decline in autopsy rates. So what can be done to revive the autopsy? Simultaneous attention needs to be given to a number of factors:

- Better and greater exposure of medical students to autopsies
- Better training of pathology trainees and a greater commitment from senior staff
- Improved mortuary design to create a more attractive environment
- Use of modern imaging recording and archiving to enable clinician to see, discuss and refer to, at any time, the gross findings of the autopsy with the pathologist
- Improved public education about autopsies and their benefits for the health of future patients and of the nation
- Application of modern laboratory methods in the post-mortem detection of genetic and biochemical abnormalities.

It is not only the number of autopsies performed that is important but the also standard and quality of the autopsy. If fewer autopsies are performed to a higher standard then this will increase the confidence of the public towards autopsies and will help impress on clinicians the importance of autopsy in advancing medical knowledge. This in turn will help improve the autopsy uptake rate.

The future of autopsy lies in promoting public support for autopsies, in some cases adapting the autopsy to address specific questions, thus making more effective use of information from autopsies. Only by ensuring that the next generation of doctors have experienced the powerful educational benefit of examining a body after death will the importance of autopsy to modern medicine be understood.

## References

- 1 Start RD, McCulloch TA, Benbow EW, Lauder I, Underwood JCE. Clinical autopsy rates during the 1980s: the continuing decline. *J Pathol* 1993;**171**:63–6
- 2 Shojania KG, Burton EC, McDonald KM, Goldman L. Changes in rates of autopsy-detected diagnostic errors over time: a systematic review. *JAMA* 2003;**289**:2849–56
- 3 Hull MJ, Nazarian RM, Wheeler AE, Black-Schaffer WS, Mark EJ. Resident physician opinions on autopsy importance and procurement. *Hum Pathol* 2007;**38**:342–50
- 4 Lillquist PP, Thomas N, Belay ED, Schonberger LB, Morse D. Barriers to autopsy: Creutzfeldt-Jakob disease in New York state. *Neuroepidemiology* 2006;**26**:207–11
- 5 Zatta P, Zambenedetti P, Reusche E, et al. A fatal case of aluminium encephalopathy in a patient with severe chronic renal failure not on dialysis. *Nephrol Dial Transplant* 2004;**19**:2929–31
- 6 Benbow EW. Medical students' views on necropsies. *J Clin Pathol* 1990;**43**:969–76
- 7 Fernando R. Sudden unexpected death due to familial hypertrophic obstructive cardiomyopathy. *Forensic Sci Int* 1990;**46**:285–8
- 8 Long Z, Lu P, Grooms T, et al. Molecular evaluation of biopsy and autopsy specimens from patients receiving in vivo retroviral gene therapy. *Hum Gene Ther* 1999;**10**:733–40
- 9 Karunaratne S, Benbow EW. A survey of general practitioners' views on autopsy reports. *J Clin Pathol* 1997;**50**:548–52
- 10 McPhee SJ, Bottles K, Lo B, Saika G, Crommie D. To redeem them from death: reactions of family members to autopsy. *Am J Med* 1986;**80**:665–71
- 11 Cacchione RN, Sayad P, Pecoraro AM, Ferzli GS. Laparoscopic autopsies. *Surg Endosc* 2001;**15**:619–22
- 12 Avrahami R, Watemberg S, Daniels-Philips E, Kahana T, Hiss J. Endoscopic autopsy. *Am J Forensic Med Pathol* 1995;**16**:147–50
- 13 Avrahami R, Watemberg S, Hiss Y, Deutsch AA. Laparoscopic vs. conventional autopsy: a promising perspective. *Arch Surg* 1995;**130**:407–9
- 14 Foroudi F, Cheung K, Duflo J. A comparison of the needle biopsy post-mortem with the conventional autopsy. *Pathology* 1995;**27**:79–82
- 15 Brookes JA, Hall-Craggs MA, Sams VR, Lees WR. Non-invasive perinatal necropsy by magnetic resonance imaging. *Lancet* 1996;**348**:1139–41
- 16 Roberts ISD, Benbow EW, Bisset R, et al. Accuracy of magnetic resonance imaging in determining cause of sudden death in adults: comparison with conventional autopsy. *Histopathology* 2003;**42**:424–30
- 17 Nemetz PN, Tanglos E, Sands LP, Fisher WP Jr, Newman WP 3rd, Burton EC. Attitudes toward the autopsy – an 8-state survey. *Med Gen Med* 2006;**8**:80
- 18 Sinard JH. Factors affecting autopsy rates, autopsy request rates, and autopsy findings at a large academic medical center. *Exp Mol Pathol* 2001;**70**:333–43
- 19 Cardoso MP, Bourguignon DC, Gomes MM, Saldiva PH, Pereira CR, Troster EJ. Comparison between clinical diagnoses and autopsy findings in a pediatric intensive care unit in Sao Paulo, Brazil. *Pediatr Crit Care Med* 2006;**7**:423–7
- 20 Shojania KG, Burton EC, McDonald KM, et al. Changes in rates of autopsy-detected diagnostic errors over time – A systematic review. *JAMA* 2003;**289**:2849–56
- 21 Goldman L, Sayson R, Robbins S, Cohn LH, Bettmann M, Weisberg M. The value of autopsy in three different eras. *NEJM* 1983;**308**:1000–5
- 22 Sheehan MW. Diagnostic errors in clinical practice. *Tex Med* 1978;**74**:92–8
- 23 Britton M. Clinical diagnostics: experience from 383 autopsied cases. *Acta Med Scand* 1974;**196**:211–9
- 24 Britton M. Diagnostic errors discovered at autopsy. *Acta Med Scand* 1974;**196**:203–10
- 25 Bove KE, Iery C. The role of the autopsy in medical malpractice cases I: a review of 99 appeals court decisions. *Arch Pathol Lab Med* 2002;**126**:1023–31
- 26 Haque BM, Patterson RC, Grafe MR. High autopsy rates at a university medical centre: what has gone right? *Arch Pathol Lab Med* 1996;**120**:727–32
- 27 Lugli A, Anabitarte M, Beer JH. Effect of simple interventions on necropsy when active informed consent is required. *Lancet* 1999;**354**:1391–2