Title: A cross-sectional survey of procedures for post-mortem management of Highly Infectious Disease patients in 48 Isolation Facilities in 16 countries: data from EuroNHID

Authors:

1. Francesco M. Fusco, National Institute for Infectious Diseases (INMI) “L. Spallanzani”, Rome, Italy; francescomaria.fusco@inmi.it;

2. Lucia Scappaticci, National Institute for Infectious Diseases (INMI) “L. Spallanzani”, Rome, Italy; lucia.scappaticci@inmi.it;

3. Stefan Schilling, Department for Infectious Diseases, Goethe University, Frankfurt, Germany; Stefan.Schilling@kgu.de;

4. Giuseppina De Iaco, National Institute for Infectious Diseases (INMI) “L. Spallanzani”, Rome, Italy; giuseppina.deiaco@inmi.it;

5. Philippe Brouqui, Research Unit on Emerging Infectious and Tropical Diseases, Marseilles, France; philippe.brouqui@univ-amu.fr;

6. Helena C. Maltezou, Hellenic Center for Disease Control and Prevention, Athens, Greece; helen-maltezou@ath.forthnet.gr;

7. Hans-Reinhard Brodt, Department for Infectious Diseases, Goethe University, Frankfurt, Germany; reinhard@brodt.net;

8. Barbara Bannister, Royal Free Hospital, London, United Kingdom; b.bannister@nhs.net;

9. Giuseppe Ippolito, National Institute for Infectious Diseases (INMI) “L. Spallanzani”, Rome, Italy; giuseppe.ippolito@inmi.it;

10. Vincenzo Puro, National Institute for Infectious Diseases (INMI) “L. Spallanzani”, Rome, Italy; vincenzo.puro@inmi.it;

11. EuroNHID Working Group (Other members of EuroNHID Working Group are listed in Acknowledgment section)
Corresponding author:

Name: Francesco M. Fusco, MD.

Address: National Institute for Infectious Diseases (INMI) “L. Spallanzani”, Via Portuense 292, 00149 Rome, Italy.

E-mail: francescomaria.fusco@inmi.it; Fax number: 0039-065582825;

Word count: 1996
Abstract

**Background:** The handling of human remains, and in particular the performance of autopsy, may pose a risk for disease transmission. The use of appropriate biosafety measures is very important in case of management of human remains of patients deceased for an Highly Infectious Diseases (HIDs), such as viral hemorrhagic fevers. The aim of this paper is to present data about capabilities and resources in 16 European countries, and to suggest optimal and minimal indications, for the safe post-mortem management of HID patients.

**Methods:** The European Network for Highly Infectious Diseases (EuroNHID) project conducted in 2009 a survey in 48 isolation facilities, identified by National Health Authorities of 16 European countries for the management of HID patients. A set of standardized checklists, filled during on-site visits, have been used for data collection.

**Results:** Thirty-nine facilities (81,2%) reported to have written procedures for the management of human remains, and 27 (56,2%) for the safe performance of autopsies in HID patients. A Bio-Safety Level 3 autopsy room is available in 8 (16,6%) facilities, while other specific technical devices for safe autopsies are available in 9 (18,7%). Overall, 4 facilities (8,3%) reported to have all features explored for the safe management of human remains. Conversely, in 5 (10,4%) facilities none of these features were available.

**Conclusions:** The level of preparedness of surveyed isolation facilities in the field of post-mortem management in case of HIDs is not satisfactory, and targeted interventions in this area are needed.

**Keywords:** autopsy; pathology; infection control; highly infectious diseases; biosafety.
**Background**

In the last years, ongoing global events are modifying the Infectious Diseases epidemiology, causing more frequently the appearance and rapid spreading of emerging and re-emerging diseases. Among these, a special threat is posed by Highly Infectious Diseases (HIDs, see table 1).[1,2] Since the handling of people who have died as a result of an HID may represent a source of nosocomial transmission, and that these diseases are frequently fatal, attention should be given to safe post-mortem management. **HID have often a rapid and dramatic clinical course, consequently in the real life autopsies are frequently used as an essential tool to establish/confirm the diagnosis.**[3,4] Moreover, post-mortem examination has been recently advocated as surveillance tool for emerging diseases and bioterrorism event,[4,5] but it is well known that may represent a high-risk procedure for transmission.[4,6-9] Among HIDs, transmission during management of human remains and autopsies have been reported for VHF, smallpox and M. tuberculosis,[3,10] and additional concerns have been posed by several diseases, including plague, SARS, and highly pathogenic Influenza strains.[8,9,11,12]

During the post-mortem, transmission may happen by contact with body fluids, and during autopsies by percutaneous inoculation (e.g., injury), splashes to unprotected mucosa, and inhalation of infectious aerosols.[4,13] Currently existing guidelines for biosafety are pointed to infection control among living persons, or to laboratory specimens. Although certain of these infection-control measures are applicable to the handling of human remains too, some differences exist in transmission mechanisms and intensity of potential exposures, such as during autopsies, thus requiring specific considerations.

**The EuroNHID project**

The European Network for Highly Infectious Diseases (EuroNHID) is a European Union-funded project (July 2007 to December 2010), whose aim is to support isolation facilities and provide
appropriate infection control advice for isolation centers responsible for managing cases of emerging, reemerging or deliberately released HID agents. EuroNHID is coordinated by the National Institute for Infectious Diseases ‘Lazzaro Spallanzani’ (Rome, Italy).[1,2,14]

During 2009 field surveys were conducted in 48 isolation facilities in 16 European countries to assess resources and capabilities for the safe and effective management of HID patients. The objective of this study is to describe the data collected on the management of human remains and autopsies, and to present the indications of the EuroNHID panel for the safe post-mortem management of HID patients.

Material and methods

A cross-sectional study was performed to investigate resources and capabilities on management of human remains in 48 isolation facilities in 16 countries (Austria, Bulgaria, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, Norway, Poland, Slovenia, Spain and United Kingdom).

This paper is written in accordance with the recommendations developed by the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Initiative.[15]

Setting and participants

National Health Authorities in all European countries were contacted by the EuroNHID Coordination Team and by the European Commission; each was asked to suggest as a project partner a physician with expertise in the management of HIDs. This process resulted in the inclusion of 16 countries, and for each country one institution has been involved (except France, with 2 institutions involved).
In order to survey only isolation facilities identified by National Health Authorities for the referral and management of HIDs, we asked to the partners to provide official documents in which these hospitals are clearly indicated. This process led to the identification of 48 isolation facilities, representing all centers officially endorsed by National Authorities to care for HID patients, for all participating countries except Spain, from which only centers from Catalonia were identified (Figure 1).

**Data collection**

Data were collected during on-site visits, using a set of checklists specifically developed (complete checklists are available on the website www.eunid.eu, after registration, under ‘‘Documents’’). Three checklists were designed, including 16 main items, 44 topics, and 148 specific questions. “Postmortem procedures” was one of the main item, and the following features were evaluated in the 48 surveyed facilities: (i) the availability of written procedures for management of human remains (e.g. where to keep and how to transport the corpses); (ii) the availability of safety procedures for the performance of autopsies; (iii) availability and location of a Bio-Safety Level 3 (BSL3) autopsy room and (iv) availability of specific devices for safe post mortem examination (e.g. high-level PPE - powered air-purifying respirators equipped with N-95 respirator or HEPA filters, impermeable protective clothing, surgical and cut-proof gloves; and devices for the reduction of aerosol production during the use of oscillating saw – plastic cover or vacuum bone dust collector to be attached to the saw). The specific topic/questions are reported in the table 2, in some cases additional details have been collected during the on-site visits.

All on-site visits were performed by the project coordinator together with a representative of the surveyed facility (usually the head of Isolation facility, and/or persons responsible for Infection Control) from February to November 2009.

**Panel indications**
On the basis of the literature and partners’ expert opinions, EuroNHID developed optimal and minimal indications for the management of human remains and for the safe performance of autopsies in HID suspected/confirmed deceased patients. These indications were discussed with all partners, and a consensus agreement was reached during the Project final meeting, held in Rome in May 2010.

Results

Among the 48 surveyed facilities, 4 (8.3%) reported the availability of all features for the safe postmortem management explored by the questionnaire. Conversely, in 5 facilities (10.4%) none of these features were available.

In particular, 39 (81.2%) reported to have written procedures for the management of human remains, and 27 (56.2%) for the safe performance of autopsies in HID patients. Of these 27 facilities, we collected details about these procedures: in 7 the procedures stated that no autopsies should be performed on HID patients; among the remaining, in 16 facilities there is a specifically trained pathologist in charge to perform autopsies, in 2 the autopsies are performed under the supervision of an infection control expert, in one post-mortem needle biopsies only are allowed, in the last one the procedure details are not available.

A BSL-3 autopsy room (a room separated by other areas, with wall, floor and ceiling material suitable for easy cleaning and decontamination, sealed doors and windows, access to shower for staff, an air-handling system with a minimum of six air changes per hour, negative pressure relative to adjacent areas and direct exhaust of air to the outside or passed through HEPA filters, this definition, limited to infrastructure issues, has been adapted from international guidelines and from consensus documents for isolation facilities [1, 6, 12,16-18]) is available in 8 facilities (16.6%). In 6 of these, the BSL-3 autopsy room is located within the facility, and in the close proximity in 2.
Specific devices for safe autopsy (e.g. high-level PPE, and devices for the reduction of aerosol production during the use of oscillating saw) are available in 9 facilities (18.7%), 6 facilities are equipped both with BSL-3 and specific devices, while 4 facilities have specific devices but no BSL-3 room, and 3 facilities have **infrastructure BSL-3 design only, with no specific devices**.

**Discussion**

To minimize the risk of infections, some clinical isolation facilities managing HIDs developed specific resources and capabilities for the appropriate post-mortem handling. A web-base survey conducted in United States in 2009 by the National Association of Medical Examiners explored capabilities to conduct infectious disease surveillance by autopsies among 68 Medical Examiners and Coroners. This survey included biosafety resources, and half of the respondents reported some Biosafety Level 3 features in their facilities, including negative pressure ventilation, double-door entry into autopsy suites, or appropriate air exchange and ventilation systems [5]. A similar survey exploring resources and capabilities in Europe have never been conducted. Moreover, international legal mandatory standards for management of human remains in HIDs do not exist, despite the fact that special attention and specific measures are currently advocated in existing guidelines and consensus.[1,3,4,7,8,12,16-18]

Our study has been performed in 48 facilities identified by National Health Authorities to care patients with HIDs in 16 European countries. Despite that, an optimal level of preparedness for the post-mortem management is present in 4 centres only, where all explored features are available, while one or more inadequacies were present in the remaining facilities.

**Limits of the study**

A limit of our study is represented by the fact that surveys were mainly performed about the availability of procedures, but we didn’t assess their appropriateness, their application in the real
life, and the compliance of staff to them. Similarly, we didn’t collect data about the contents and the completeness of staff training. Moreover, another limit is represented by the fact that surveys were performed early in 2009, and this means that we collected most of data before the Influenza A(H1N1) pandemic experience. The knowledge gained during the pandemic may have lead to modifications and improvements of procedures and capabilities, not registered in our data.

Another limit is that the representatives of the facility usually involved during the on-site surveys have been the Infectious Diseases and/or the Infection Control specialists, and not directly the pathologists, except few cases. This may have limited the level of details of data collected about this particular item.

The indications for adequate management have some limits, also. Given the infrequency of suspected and confirmed HIDs, no high-quality studies exist, or no studies at all. Consequently, no evidence-based recommendations, neither any system of ranking of recommendations, is possible. Therefore our indications are based on experiences reported in the literature and on the partners’ expert opinion.

Interpretation of results

Despite these limits, our data suggest some interesting remarks.

Our study shows that the special concerns posed by the post-mortem management in case of HIDs have been considered by the most part of surveyed facilities. Indeed, the majority of them report to have written procedures for the safe management of human remains.

Conversely, poor attention is given to safe autopsy procedures, since about half of facilities lack of written procedures about it. This may represent a limit, given the fact that autopsies may be often necessary in these patients, and represent an high-risk procedure. The lack of written, well-known and exercised safety procedures is considered cause of an increased risk of exposures for the workers performing the autopsy.[19] Similarly, despite the fact that special autopsy suites and
equipments are advocated by existing guidelines to increase the safety of autopsies,[3,16-18] the
BSL-3 autopsy rooms are few, and the use of special devices, such as those for the reduction of
aerosol production during the use of oscillating saw, is poorly reported. In some cases, as in the facilities that report to have a BSL-3 design for autopsy room but not specific devices and
procedures, results seem inconsistent. Indeed, the presence of a safe infrastructure design, in
absence of specific devices, personal skills and procedures, is not enough for an effective infection control. These data are more alarming in the specific setting of isolation facilities managing HID, where the use of special autopsy rooms and equipment is essential and may be more frequent.

Generalizability of results and conclusions

Our survey included 15 among the 27 European Member States in 2009 plus Norway. Despite the geographic coverage is not complete, our results may be considered suitably representative of the whole European picture, considering that the survey included the most populated European countries, covering about the 80% of the population of the European Union. Moreover, most of high-income European countries, that could invest more economic resources in the preparedness for HID, were included in the survey.

In conclusion, the level of preparedness of surveyed isolation facilities in the field of post-mortem management in case of HID is not satisfactory, and targeted interventions in this area are needed.

EuroNHID indications

The indications by the EuroNHID panel about the safe management of human remains and autopsies in case of HID are reported in tables 3-4.[1,3,4,6,7,8,12,16-18] EuroNHID panel proposes minimal and optimal standards procedures, with the aim of improving HCWs awareness about the risks they take and to encourage them to be provided with the state-of-art knowledge and technologies to reduce the risk of infection.
Conflict of interest statement

All authors report no conflicts of interest relevant to this article.

Founding

This work was supported by the EC grant EuroNHID (2006205) and by the Ministero della Salute, Italia-Ricerca Corrente, Istituti di Ricovero e Cura a Carattere Scientifico.

Ethics: Since the research do not involve human subjects, human material, or human data, does not require ethical approval.

Authors’ contribution: FMF drafted the manuscript, substantial contributed to design the study, participated in the acquisition and analysis of data, and gave the final approval of the version to be published; LS drafted the manuscript, and gave the final approval of the version to be published; SS, GDI, HRB, PB, HCM, BB, and VP substantial contributed to design the study, participated in the acquisition and interpretation of data, and gave the final approval of the version to be published; GI substantial contributed to design the study, and gave the final approval of the version to be published. All authors read and approved the final manuscript.

Acknowledgments

We acknowledge Ms. Ramona Iacovino for her administrative support during the project. Additional members of EuroNHID Working Group who contributed to data are Norbert Vetter (Austria), Mira Kojouharova (Bulgaria), Kremena Parmakova (Bulgaria), Peter Skinhoej
(Denmark), Heli Siikamaki (Finland), Christian Perronne (France), René Gottschalk (Germany)

Olga Adrami (Greece), John Lambert (Republic of Ireland), Robert Hemmer (Luxembourg),

Michael Borg (Malta), Anne Lise Fjellet (Norway), Arne Broch Brantsæter (Norway), Andrzej

Horban (Poland), Franc Strle (Slovenia), Antoni Trilla (Spain) and Gail Carson (United Kingdom).
References


### Table 1 – Definition and list of Highly Infectious Diseases (HIDs) [1,2]

Highly infectious Diseases (HIDs) are those that:

- are easily transmissible from person-to-person;
- cause life-threatening illness; and
- present a serious hazard in healthcare settings and in the community, requiring specific control measures.

The following agents/diseases are included among HIDs:

- Viral hemorrhagic fevers (VHFs, Marburgvirus, Ebolavirus, Crimean Congo hemorrhagic fever virus, Lassa virus, the recently recognized Lujo virus, and South American haemorrhagic fever viruses: Junin, Machupo, Sabia, and Guanarito);
- SARS and MERS Co-V;
- Multi-drug-resistant and extensively drug-resistant Tuberculosis (MDR- and XDR-TBC);
- Newly emerging highly pathogenic strains of Influenza virus;
- Smallpox and other orthopox infections (eg, Monkeypox, but excluding vaccinia virus)
- Other emerging highly pathogenic agents, including agents of deliberate release (eg, pneumonic plague), some of which could also be extensively antibiotic-resistant.

### Table 2 – Topic/questions included in the checklist about post-mortem management

1- *Existence of specific procedures for the management of remains in HID patients*

1.a) Do you have specific procedures/written protocols for the management of corpse? YES/NO

1.b) Do you have specific procedures/written protocols for the safe performance of
autopsy? YES/NO

If yes, please specify:

i) Autopsy is done by a specifically trained pathologist;

ii) Autopsy is done by a not-specifically trained pathologist under the supervision of an infection control expert;

iii) Only needle necroscopies are performed;

iv) Autopsies are not performed in these patients for safety reasons;

v) Other, describe:______________________________________

2 - Existence of adequate technical facilities for the safe performance of autopsy in HID patients

2.a) Do you have a specially equipped (BSL3) autopsy room? YES/NO

If yes, please specify:

i) it is within the facility

ii) it is close to the facility (within 100 metres)

iii) it is not close to the facility. Please specify the distance in meters:_____

2.b) Do you have specific medical device for the safe performance of autopsy (such as high-level PPE, devices for reducing aerosolization)? YES/NO

Table 3 – EuroNHID indications for the safe management of human remains in case of HIDs [1,3,4,6, 7,8,12,16-18]

The EuroNHID panel indicates, as optimal standards, that:

• written procedures, well-known by the staff, must be available and accessible;
all handling of the human remains should be performed by personnel wearing appropriate Personal Protective Equipment (PPE), and direct contact with the body must be discouraged;

all isolation facilities should have an area for the temporary safe-keeping of deceased patients, large enough to contain and decontaminate sealable coffins and other mortuary equipment. Alternatively, take the body within the isolation area and move it only when a safe environment/procedure has been defined for the burial/cremation;

if a separate/dedicated pathway is available for the ingress of the patient, it should be used for the transport of the corpse, also;

the body should be fully sealed in an impermeable bag before removal from the isolation room/area, to avoid leakage of body fluid;

if an autopsy is being considered, the body may be held under refrigeration in the mortuary and be moved only when a safe environment can be provided for the autopsy;

during any procedure on the body, the staff should wear waterproof disposable longsleeved, cuffed gown or a waterproof apron in addition to the gown, if not waterproof. Nonsterile, latex gloves should be worn covering cuffs of gown. Use facial protection in any case: face shield (preferably) or goggles and a fitted FFP2, N95 NIOHS equivalent. Remove PPE in an appropriate and safe sequence, and perform hand hygiene after removal of PPE;

in any case, the body cremation is recommended at the end of procedures. If cremation is not compatible with local culture, a closed casket burial should be recommended in any case.

EuroNHID also proposes minimal requirements:

a general procedure (how to handle and where to keep the body) must be available;
• all handling of the human remains must be performed wearing appropriate PPE;
• move the human remains only in a secured transport bag;
• suggest cremation as preferred burial procedure.

Table 4 – EuroNHID indications for the safety autopsy procedures in case of HIDs

[1,3,4,6, 7,8,12,16-18]

The EuroNHID panel indicates, as optimal standards, that:

• a “risk assessment” approach, taking into account the likelihood of diagnosis, the severity of the HID suspected, the level of necessity of the autopsy, and the availability of infection control procedures and resources, should be applied before to decide to proceed or not to autopsy;
• despite the fact that autopsies are often necessary in order to establish/confirm diagnosis in patients deceased for a suspected HID, in general the performance of autopsy in these patients should be avoided if not strictly necessary;
• if the risk assessment support the need to perform the autopsies, it is suggested to prefer procedures not producing aerosols (minimal invasive autopsies, e.g. exploration of abdomen only, or needle biopsies only, or endoscopic autopsies imaging);
• if there is a need to perform a complete autopsy, written procedures, in line with national/local policies, must be available including:
  • the risk assessment, also including consideration of alternatives such as use of pre-mortem specimens or needle biopsies,
  • the presence of a specifically trained pathologist,
  • procedures for the safe transport, handling and keeping of tissues and other specimens.
Moreover, the panel recommend that:

- post-mortem examination on a subject died from an HID should be done in a BSL-3 autopsy room, with special engineering controls. A BSL-3 autopsy room includes a minimum of six (old construction) to twelve (new construction) air changes per hour, negative pressure relative to adjacent areas and direct exhaust of air to the outside or passed through a HEPA filter if air is re-circulated. Exhaust systems around the autopsy table should direct air (and aerosols) away from personnel performing the procedure (e.g., exhaust downward). For autopsies, local airflow control (e.g., laminar flow systems) can be used to direct aerosols away from personnel.

Moreover, the autopsy room should be separated by other areas, with wall, floor and ceiling material suitable for easy cleaning and decontamination, sealed doors and windows, and have access to shower for staff. However, these safety measures do not eliminate the need for appropriate PPE. Ideally, these rooms could have a separate way-in and way-out, and a dedicated area for the removal of PPE;

- all personnel performing an autopsy must wear high-level PPE (powered air-purifying respirators equipped with N-95 respirator or HEPA filters, impermeable protective clothing, 2 layers of surgical gloves plus an additional middle pair of cut-proof gloves);

- in order to reduce aerosolization, bone surfaces could be moistened before sawing to cut down the dispersal of bone dust, plastic cover or a vacuum bone dust collector should be attached to the vibrating saw. High pressure water sprays should not be used.
Figure 1 – Participating countries into EuroNHID project (in grey) and location of surveyed isolation facilities (white dots)*

*Numbers indicate the number of facilities in the same city
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