


A 2009 cross-sectional survey of procedures for post-mortem management of highly infectious disease patients in 48 isolation facilities in 16 countries: data from EuroNHID

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Abstract

Purpose The handling of human remains may pose a risk for transmission of highly infectious agents. The use of appropriate biosafety measures is very important in case of management of patients deceased from highly infectious diseases (HIDs), such as Ebola virus disease. This paper presents the capabilities and resources in this field in 16 European countries, and suggests indications for the safe post-mortem management of HID patients.

Methods The European Network for Highly Infectious Diseases conducted in 2009 a survey in 48 isolation facilities in 16 European countries. 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 performance of autopsies in HID patients. A Biosafety Level 3 autopsy room was available in eight (16.6 %) facilities, other technical devices for safe autopsies were available in nine (18.7 %). Overall, four facilities (8.3 %) reported to have all features explored for the safe management of human remains. Conversely, in five (10.4 %) 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 was not satisfactory, and improvements are needed.

Keywords Autopsy · Infection control · Highly infectious diseases · Isolation facilities · Biosafety · Hygiene

Other members of EuroNHID Working Group are listed in “Acknowledgments.”

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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), such as Ebola virus disease (EVD) [1, 2]. In particular a large outbreak of EVD is currently ongoing in West Africa, some cases have been imported and few local transmission events occurred among healthcare workers in western countries.

Since the handling of people who have died as a result of an HID may represent a source of nosocomial transmission, and since 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 autopsy 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 viral hemorrhagic fevers including Ebola, smallpox, and *Mycobacterium tuberculosis* [3, 10, 11], and additional concerns have been posed by several diseases, including plague, SARS, and influenza virus strains [8, 9, 12, 13].

Before, during, and after post-mortem handling, 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, 14]. Most 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 the intensity of potential exposures, such as during autopsies, thus requiring specific considerations. Recently, a brief guidance for safe handling of human remains of Ebola patients in hospitals and mortuaries has been disseminated by the Royal College of Pathologists for the United Kingdom, and by CDC for USA [11, 15].

The EuroNHID project

The European Network for Highly Infectious Diseases (EuroNHID) is a European Union-funded project (July 2007–December 2010), whose aim is to support isolation facilities and provide appropriate infection control advice for isolation centers responsible for managing cases of emerging, re-emerging, or deliberately released HID agents. EuroNHID is coordinated by the National Institute for Infectious Diseases ‘Lazzaro Spallanzani’ (Rome, Italy) [1, 2, 16].

In 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. This survey assessed many infection control issues, including the availability of procedures and capabilities for the safe management of deceased 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.

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, Marburg virus, Ebola virus, Crimean Congo hemorrhagic fever virus, Lassa virus, the recently recognized Lujo virus, and South American hemorrhagic fever viruses: Junin, Machupo, Sabia, and Guanarito)
- Severe acute respiratory syndrome (SARS) and middle-east respiratory syndrome (MERS) coronavirus
- Multi-drug-resistant and extensively drug-resistant *Mycobacterium tuberculosis* (MDR- and XDR-TBC)
- Newly emerging highly pathogenic strains of influenza virus
- Smallpox and other orthopox infections (e.g., monkeypox, but excluding vaccinia virus)
- Other emerging highly pathogenic agents with the same characteristics (i.e., Nipah and Hendra virus), including agents of deliberate release (e.g., pneumonic plague), some of which could also be extensively antibiotic-resistant

Materials and methods

In order to assess the preparedness to HID among isolation facilities in Europe, a cross-sectional study was performed to investigate resources and capabilities on many infection control issues, including 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 UK).

This paper is written in accordance with the recommendations developed by the strengthening the reporting of observational studies in epidemiology initiative [17].

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 two institutions involved).

In order to survey only isolation facilities identified by National Health Authorities for the referral and management of HIDs, we asked 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 (Fig. 1).

Data collection

Data were collected during on-site visits, using a set of checklists specifically developed (complete checklists are available on the website <http://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: (1) the availability of written procedures for management of human remains (e.g., where to keep and how to transport the corpses); (2) the availability of safety procedures for the performance of autopsies; (3) availability and location of a Biosafety Level 3 (BSL3) autopsy room; and (4) availability of specific devices for safe postmortem examination [e.g., high-level personal protective equipments (PPE)—such as powered air-purifying respirators equipped with N-95 respirator or high-efficiency particulate air (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.

All on-site visits were performed by the project coordinator together with a representative of the surveyed

Fig. 1 Participating countries into EuroNHID project (in gray) and location of surveyed isolation facilities (dark gray dots). Numbers indicate the number of facilities in the same city



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

<p>1. Existence of specific procedures for the management of remains in HID patients</p> <p>(a) Do you have specific procedures/written protocols for the management of corpse? Yes/no</p> <p>(b) Do you have specific procedures/written protocols for the safe performance of autopsy? Yes/no</p> <p>If yes, please specify:</p> <p>(1) Autopsy is done by a pathologist with specific experience or specifically trained in Highly Infectious Diseases (able to work with full PPE);</p> <p>(2) Autopsy is done by a not-specifically experienced/trained pathologist under the supervision of an infection control expert;</p> <p>(3) Only needle necroscopies are performed;</p> <p>(4) Autopsies are not performed in these patients for safety reasons;</p> <p>(5) Other, describe: _____</p> <p>2. Existence of adequate technical facilities for the safe performance of autopsy in HID patients</p> <p>(a) Do you have a specially equipped (BSL3) autopsy room? Yes/no</p> <p>If yes, please specify:</p> <p>(1) it is within the facility</p> <p>(2) it is close to the facility (within 100 m)</p> <p>(3) it is not close to the facility. Please specify the distance: _____</p> <p>(b) Do you have specific medical device for the safe performance of autopsy (such as high-level PPE, devices for reducing aerosolization)? Yes/no</p>

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 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 post-mortem management explored by the questionnaire. Conversely, in five 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 was a dedicated specifically trained pathologist in charge to perform autopsies equipped with full PPE and trained in infection control, in 2 the autopsies were performed under the supervision of an

infection control expert, in one post-mortem needle biopsies only were allowed, in the last one the procedure details were not available.

A BSL-3 autopsy room (e.g., a room including 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 has been adapted from international guidelines and from consensus documents for isolation facilities [1, 11, 13, 15, 18–21]) was available in eight facilities (16.6 %). In six of these, the BSL-3 autopsy room was located within the facility, and in the close proximity in two. Specific devices for safe autopsy (e.g., high-level PPE, and devices for the reduction of aerosol production during the use of oscillating saw) were available in nine facilities (18.7 %), six facilities were equipped both with BSL-3 and specific devices, while four facilities have specific devices but no BSL-3 room, and three facilities have infrastructure BSL-3 design only, with no specific devices.

Discussion

To minimize the transmission risk of infectious agents, 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 BSL3 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, 13, 15, 18–21].

Our study has been performed in 48 facilities identified by National Health Authorities to care patients with HIDs in 16 European countries. Consequently, these facilities should have detailed procedures and adequate logistics for dealing with HIDs, given their recognized role at National level. Despite that, an optimal level of preparedness for the post-mortem management was present in four centers only, where all explored features were 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 did not assess their application in the real life, and the compliance of staff to them. Moreover, another limit is represented by the fact that surveys were performed early in 2009, and this means that we collected most of the data before the influenza A(H1N1) pandemic experience, and before the recent EVD outbreak in West Africa, that is requiring an additional effort for preparedness in many European countries. The knowledge gained during the pandemic, as well as the current EVD outbreak, may have lead to modifications and improvements of procedures and capabilities, not registered in our data. Indeed, brief guidance for safe handling of people deceased from confirmed/suspected EVDs in hospitals and mortuaries has been disseminated in UK and USA [11, 15].

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. Moreover, it is possible that some other BSL-3 autopsy rooms were available in the country included in the study, but not connected with the clinical facilities surveyed, despite it is not probable since these facilities are those identified by National Health Authorities for the management of HIDs, and because we considered in our questionnaire that the BSL-3 autopsy room may be located even far away from the clinical facility [see Table 2, question 2(a)].

The indications for adequate management have some limits, also, but not linked to the study itself. Given the infrequency of suspected and confirmed HIDs, no high-quality studies exist, or no studies at all. Consequently, neither evidence-based recommendations nor 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.

First of all, these data represent the only available about this issue in European countries. Also in the light of the recent, and still ongoing EVD outbreak in West Africa, these data, even if collected in 2009, may represent a relevant source of information about the general level of preparedness of European facilities in dealing with corpses of patients deceased because of an HID.

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 was given to safe autopsy procedures, since about half of facilities lack written procedures. This may represent a limit, given the fact that autopsies may be often necessary in these patients (especially if a clear diagnosis has not been established), and represent a 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 [22]. Similarly, a better attention should be given to select a small number of selected pathologists, those in charge for performing autopsies in these patients, in order to train them to work with full PPE and to safely remove them, as suggested for other HCWs [23]. Moreover, despite the fact that special autopsy suites and equipments are advocated by existing guidelines to increase the safety of autopsies [3, 18–21], the BSL-3 autopsy rooms were few, and the use of special devices, such as those for the reduction of aerosol production during the use of oscillating saw, was rarely reported. In some cases, as in the three facilities that reported to have a BSL-3 design for autopsy room but no specific devices and procedures, results seem inconsistent, since the availability of an equipped BSL-3 autopsy room is not enough if specific procedures are lacking. These data are more alarming in the specific setting of isolation facilities managing HIDs, where the use of special autopsy rooms and equipment is essential and may be more frequent.

Table 3 EuroNHID indications for the safe management of human remains in case of HIDs [1, 3, 4, 7, 8, 11, 13, 15, 18–21]

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 National Institute for Occupational Safety and Health (NIOSH) 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
 - Bodies of patients known or suspected to have died because of an HIDs should not be repatriated or expatriated. However, following body cremation, ashes may be safely transported following general regulations for their transport
- 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, 7, 8, 11, 13, 15, 18–21]

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 supports 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 pathologist with previous specific experience and/or training in Highly Infectious Diseases (able to work with full PPE) management
 - Procedures for the safe transport, handling and keeping of tissues and other specimens

Moreover, the panel recommends 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; however, this safety measure does 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, two 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

Generalisability of results and conclusions

Our survey included 15 among the 27 European Member States in 2009 plus Norway. Despite the fact that geographic coverage was not complete, our results may be considered a suitable 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. Of note, most of high-income European countries, which could invest more economic resources in the preparedness for HIDs, 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 HIDs was 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 and 4 [1, 3, 4, 7, 8, 11, 13, 15, 18–21]. EuroNHID panel proposes minimal and optimal standards procedures, with the aim of improving healthcare workers 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.

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Compliance with ethical standards

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

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

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