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The infection hazards of human cadavers

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Summary

Cadavers may pose infection hazards to people who handle them. None of the organisms that caused mass death in the past – for example, plague, cholera, typhoid, tuberculosis, anthrax, smallpox – is likely to survive long in buried human remains. Items such as mould spores or lead dust are much greater risks to those involved in exhumations. Infectious conditions and pathogens in the recently deceased that present particular risks include tuberculosis, group A streptococcal infection, gastrointestinal organisms, the agents that cause transmissible spongiform encephalopathies (such as Creutzfeldt-Jakob disease), hepatitis B and C viruses, HIV, and possibly meningitis and septicaemia (especially meningococcal). The use of appropriate protective clothing and the observance of *Control of Substances Hazardous to Health* regulations, will protect all who handle cadavers against infectious hazards.

Introduction

Most people rarely, if ever, encounter a dead body and, for the majority, living people with diseases are a far greater hazard to health than the dead. There are a few whose occupational contact with cadavers exposes them to the hazard of infection. Archaeologists or construction workers may be exposed to the remains of people who died long ago. Others are exposed to the recently deceased, either in a controlled setting, such as a mortuary, or where bodies may be damaged and tissues scattered, such as at the scene of an accident. Medical practitioners (in particular, pathologists), nurses, mortuary attendants, forensic scientists, embalmers, funeral directors, and members of the emergency services handle whole corpses. Others, such as technicians in morbid anatomy, may only handle parts of cadavers. All of these are potentially at risk of exposure to pathogenic microorganisms carried by the cadavers with which they come in contact. This paper describes and assesses the infection hazards associated with cadavers (both in old interments and the recently deceased), indicates how they may be minimised, and aims to inform those with statutory responsibilities for the disposal of the dead. Some of the topics (body bags, universal precautions, viewing, hygienic preparation, embalming, and international transport of cadavers) are discussed in greater detail in an accompanying article[1].

Notifiable and other diseases

In the United Kingdom, five diseases (cholera, plague, relapsing fever, smallpox, and typhus) and food poisoning are statutorily notifiable under the *Public Health (Control of Diseases) Act, 1984*[2] and a further 24 are required to be notified under the 1988 regulations[3]. Most of these diseases do not cause serious or life threatening illness in healthy people; their notification is to enable action to be taken to control outbreaks, monitor the effectiveness of immunisation programmes, or facilitate epidemiological investigations. The diseases required to be notified are listed in table 1, with an indication of the risk that these diseases pose to healthy people, and the precautions to be taken when dealing with cadavers known to be infected with these diseases. Table 2 provides similar information about a number of diseases that are not notifiable.

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Table 1 Guidelines for handling cadavers with infections notifiable in England and Wales

Degree of risk	Infection	Bagging	Viewing	Embalming	Hygienic preparation
Low	Acute encephalitis	No	Yes	Yes	Yes
	Leprosy	No	Yes	Yes	Yes
	Measles	No	Yes	Yes	Yes
	Meningitis (except meningococcal)	No	Yes	Yes	Yes
	Mumps	No	Yes	Yes	Yes
	Ophthalmia neonatorum	No	Yes	Yes	Yes
	Rubella	No	Yes	Yes	Yes
	Tetanus	No	Yes	Yes	Yes
	Whooping cough	No	Yes	Yes	Yes
Medium	Relapsing fever	Adv	Yes	Yes	Yes
	Food poisoning	No/Adv	Yes	Yes	Yes
	Hepatitis A	No	Yes	Yes	Yes
	Acute poliomyelitis	No	Yes	Yes *	Yes
	Diphtheria	Adv	Yes	Yes	Yes
	Dysentery	Adv	Yes	Yes	Yes
	Leptospirosis (Weil's disease)	No	Yes	Yes	Yes
	Malaria	No	Yes	Yes *	Yes
	Meningococcal septicaemia (with or without meningitis)	Adv	Yes	Yes	Yes
	Paratyphoid fever	Adv	Yes	Yes	Yes
	Cholera	No	Yes	Yes *	Yes
	Scarlet fever	Adv	Yes	Yes	Yes
	Tuberculosis	Adv	Yes	Yes	Yes
	Typhoid fever	Adv	Yes	Yes	Yes
	Typhus	Adv	No	No	No
High	Hepatitis B,C, and non-A non-B	Yes	Yes	No	No
High (rare)	Anthrax	Adv	No	No	No
	Plague	Yes	No	No	No
	Rabies	Yes	No	No	No
	Smallpox	Yes	No	No	No
	Viral haemorrhagic fever	Yes	No	No	No
	Yellow fever	Yes	No	No	No

Adv = Advisable and may be required by local health regulations. *Requires particular care during embalming.

Definitions:

Bagging: placing the body in a plastic body bag.

Viewing: allowing the bereaved to see, touch, and spend time with the body before disposal.

Embalming: injecting chemical preservatives into the body to slow the process of decay. Cosmetic work may be included.

Hygienic preparation: cleaning and tidying the body so it presents a suitable appearance for viewing (an alternative to embalming).

Old interments

The disposal of relatively small numbers of bodies in rural settings posed little problem in the past. As urban populations grew in the eighteenth and nineteenth centuries, increasing numbers of burials presented health hazards. A movement dedicated to ensuring that burial should only take place outside cities arose in Europe during the eighteenth century[4], but had little impact in Britain. By the 1840s over 50 000 corpses were interred in London each year in only 218 acres of burial grounds. Coffins were often stacked several deep, with little earth cover, and a foul stench frequently emanated from churchyards. The problem was similar in other towns and cities. Crypts and burial grounds had to be cleared out frequently and remains reinterred in charnel pits (see below). Archaeological excavations or building work in the older parts of towns in Britain are quite likely to uncover human remains. As the nineteenth century progressed burial grounds were moved increasingly to the borders of urban areas. Crematoriums have been built in the British Isles since the end of the nineteenth century. Cremation has become increasingly popular and about 70% of cadavers in the United Kingdom are now cremated.

Occasionally, large collections of human bones are discovered, which may be the remains of an overcrowded churchyard, plague pit, or charnel pit. When epidemics occurred, whether in town or country, it was often impossible to bury all the dead in individual graves and the authorities tended to resort to mass burials (plague pits). The locations of larger pits are often indicated in parish records but small unrecorded pits are sometimes found. In plague pits the remains tend to be found in the

form of the human skeleton unless they have been disturbed by previous building activities or land movements. Bones found in charnel pits are either in a random array or may be arranged as – for example – collections of skulls or long bones. Plague pits present no hazards, because bodies were usually interred without coffins. The organisms that caused mass deaths in the past do not survive well outside living hosts and are unlikely to withstand the intense microbial competition that occurs in decay. Charnel pits too are not hazardous because the disarticulated bones they contain have already been exposed to decay.

In many instances when old interments are disturbed, the dead are found in coffins. Old coffins in good condition should be removed intact and reburied, but they are often fragile and should be sleeved in very heavy duty sealed plastic before being moved. Wooden coffins have been used for many centuries, but lead coffins with or without wooden covers or linings and with varying amounts of furnishing and upholstery became popular during the eighteenth and nineteenth centuries.

Rarely it may be necessary to open coffins, or they may have been broken open by building works, soil pressure due to subsidence, or vandals. The degree of preservation of a cadaver cannot be predicted by the type of coffin used or the location of the interment. Completely preserved bodies have been found in wooden coffins buried in the ground and completely decayed bodies in apparently intact lead coffins in crypts. Most lead coffins contain dry bones but some are found to be about one third full of a viscous black liquid (coffin liquor), which contains bones and (sometimes) soft tissues. Well preserved, partially mummified bodies are sometimes found and, very rarely, intact and totally preserved bodies are found that are not even discoloured. Regardless of the age of a burial residual soft tissue is a potential hazard and, if present, expert medical advice should be obtained from the local consultant in communicable disease control (CCDC). This is particularly important with well preserved or mummified bodies and even more so if skin lesions are seen.

Detailed regulations cover the exhumation of human remains[5]. A Home Office licence is required for the disturbance of human remains and, if they are accidentally disturbed, work should be stopped and the Home Office informed. If remains are to be disturbed in a consecrated burial ground or a church crypt, a faculty must be obtained from the local bishop before exhumation can proceed. The local environmental health department (EHD) must always be informed as it has statutory responsibility for the decent and safe disposal of the dead. The EHD will supervise the exhumation on behalf of the Home Office and the church (if involved), should inspect the exhumation site at intervals to ensure that the work is being performed in a decent and decorous manner, and should alert their medical authorities if necessary. Exhumed remains, timbers, and other burial materials should be reburied. Cremation is unsuitable because old remains have a low fat content and require higher temperatures for longer periods than recently deceased bodies, which can damage or destroy the cremator.

Chloride of lime should not be used as a disinfectant during exhumations. It is not particularly effective and is hazardous to the workforce.

Pathogens that may be associated with old burials

Most deaths in the United Kingdom are now due to non-infectious causes – for example, cancer and cardiovascular disease – but many of those interred in graves in previous centuries may have died from infectious diseases such as plague, cholera, typhoid, tuberculosis, anthrax, and smallpox. The organisms that cause the first four of these diseases are unlikely to survive long in a buried cadaver, even in mass burials such as plague pits, and do not

Table 2 Guidelines for handling cadavers with some infections that are not notifiable in England and Wales

Degree of risk	Infection	Bagging	Viewing	Embalming	Hygienic preparation
Low	Chickenpox/shingles	No	Yes	Yes	Yes
	Cryptosporidiosis	No	Yes	Yes	Yes
	Dermatophytosis	No	Yes	Yes	Yes
	Legionellosis	No	Yes	Yes	Yes
	Lyme disease	No	Yes	Yes	Yes
	Orf	No	Yes	Yes	Yes
	Psittacosis	No	Yes	Yes	Yes
	Methicillin resistant *Staphylococcus aureus*	No	Yes	Yes	Yes
	Tetanus	No	Yes	Yes	Yes
Medium	HIV/AIDS	Adv	Yes	No	No
	Haemorrhagic fever with renal syndrome	No	Yes	Yes	Yes
	Q fever	No	Yes	Yes	Yes
High	Transmissible spongiform encephalopathies (for example, Creutzfeldt-Jakob disease)	Yes	No *	No	No
	Invasive group A streptococcal infection	Yes	No	No	No

Adv = Advisable and may be required by local health regulations. * If necropsy has been carried out. Definitions: see table 1.

present a hazard. The risks posed by anthrax and smallpox are less clear.

Anthrax is a potential risk because it can form highly resistant spores. These are affected by moisture, temperature, and pH[6] but can last for long periods in dry conditions. Spore formation occurs only under aerobic conditions and extensive spores could only be formed in association with a human cadaver if blood containing the organism had been spilt at the time of death. Large numbers of spores are therefore unlikely to be found in bodies in old burial sites. In addition, anthrax has been an uncommon cause of death in Britain for 200 years (although there may be foci of anthrax spores where animal products were handled commercially) and infected corpses are unlikely to be found. Humans are moderately resistant to anthrax[6] and unlikely to be infected even if in contact with an infected cadaver.

Britain has been largely free of smallpox since 1935[7] (a few sporadic cases occurred after this date). Relatively recent graves may therefore contain the remains of people who died of this disease. The risk that smallpox might re-emerge if the remains of smallpox victims are disturbed appears to be remote. The virus is thought unlikely to survive in scabs in interments for more than a year[8], although it may persist for longer under certain conditions[8,9] and smallpox virus in scabs has been shown to survive for at least 13 years in envelopes in a laboratory cupboard[10]. Morphologically intact orthopox virus was seen by electron microscopy of tissue from bodies more than 100 years old found in a crypt in Spitalfields, East London in 1985, but the virus could not be grown and was not thought to be infective[11]. It has been suggested that people who excavate crypts should be vaccinated as a precaution[12], but vaccination has its own risks[13]. The initial assessment of risk, and subsequent exhumation of bodies buried in crypts, should, if possible, be performed by people who have been vaccinated in the past and have a resultant scar.

Any inhalation hazards associated with disturbing old interments are likely to be greater in crypts and other enclosed spaces than in the open air[14]. Pathogens associated with cadavers are likely to pose less risk than lead dust, and coffin wood, which may be contaminated with mould or parasite eggs, or powdered by wood boring insects. Protection against these hazards will also protect against any risk of infection with smallpox. Protective equipment should include overalls, head coverings, safety helmets, gloves, face shields, and high quality dust masks or respirators.

The recently deceased

Doctors (especially pathologists), technical staff in pathology, morticians, funeral directors, embalmers, and members of the emergency services are all exposed to risks from the recently deceased. The type of exposure and the risks involved vary with profession but staff of necropsy rooms, funeral directors, and embalmers are exposed most frequently. The conditions and pathogens that present particular risks include tuberculosis, group A streptococcal infection, gastrointestinal organisms, Creutzfeldt-Jakob disease, hepatitis B and C virus, HIV, and possibly meningitis and septicaemia (especially meningococcal). In general, following *Control Of Substances Hazardous to Health* (COSHH) precautions[14a] – especially the use of appropriate protective clothing – will greatly reduce the risk of acquiring infection, but some additional precautions may be advisable for particular infections.

Tuberculosis

Tuberculosis was probably the greatest killer amongst the infectious diseases in Victorian times[15] and the number of notifications remained high until after the second world war[16]. The incidence of tuberculous infection in Britain declined steadily from 1850 until the late 1980s but, since 1987, notifications have risen[17], possibly associated with an increase in the number of recent immigrants who are infected. It may also be due in part to an increase in cases of tuberculosis associated with HIV infection as has been seen in the United States[18].

Opening cadavers infected with tuberculosis is dangerous. Several studies during the 1940s showed a high rate of tuberculin conversion among medical students and pathologists[19-21]. More recent surveys[22-27] have all shown that, although the numbers of cases have fallen, workers in morbid anatomy, pathologists, and mortuary technicians remain particularly at risk[22-27]. This may be because aerosols, particles, and splashes containing tuberculous material can be generated during necropsies[23,28], particularly when power saws are used. This problem has apparently been reduced since the application of the recommendations advanced in the Howie report[29,30] and increased safety precautions adopted because of concerns about bloodborne viruses. The embalming of people who have died of tuberculosis is unlikely to be hazardous because there is little aerosol formation but, because air may be expelled from the lungs of a body when it is lifted, it is recommended that the face of the corpse is covered temporarily with a disposable cloth. The incidence of undiagnosed tuberculosis in cadavers in developed countries is low[31] but presents a hazard to mortuary staff, although probably not to embalmers. BCG vaccination is advised for mortuary attendants, pathologists, and embalmers.

Tuberculous infections of the skin of doctors who conduct necropsies, known as prosecutor's wart or verruca necrogenica (first described in 1826[32]), were sufficiently common earlier this century to be mentioned in medical textbooks as a particular hazard[33] and are still reported occasionally[34]. In the United States recently, a tuberculous skin lesion arose following a needlestick injury received during necropsy of a patient with HIV infection who had died of a strain of *Mycobacterium tuberculosis* resistant to seven antibiotics. Isolates from the lesion showed the same resistance pattern (Dale Morse, personal communication).

Meningitis and septicaemia

Meningitis can be caused by many organisms but the only ones that might present a hazard to those handling the dead are *M. tuberculosis* (see above) and *Neisseria meningitidis*. Septicaemia is commonly a terminal condition and can be caused by many different organisms (often the patient's own flora) most of which present no hazard to those who open the body or prepare it for burial or cremation. Only cases of meningococcal septicaemia or infection with group A streptococci pose a risk. The development of antibiotics has reduced the incidence of

fatal infections with haemolytic streptococci in the general population[35] but cases still occur in patients and mortuary staff[36] and may result from apparently trivial injuries.

Gastrointestinal organisms

Leakage of faeces from bodies is common. All who handle cadavers should wear gloves and impervious disposable aprons, take care not to contaminate instruments or their working environment, and wash their hands carefully after procedures and before eating.

Transmissible spongiform encephalopathies (TSE)

Two of these rare and fatal degenerative diseases are found in humans in the United Kingdom, Creutzfeldt-Jakob disease (CJD) and Gerstmann-Straussler-Scheinker syndrome. The causative agents of these diseases are poorly characterised but are highly resistant to most disinfectants and to heat. A related agent from domestic animals (scrapie) has been shown to survive interment for three years with a hundredfold fall in infectivity[37]. The agent that causes CJD has been shown to survive well in formalinised tissue and the infection has been transmitted experimentally to mice by intracerebral inoculation of formalinised brain tissue from a human who died of the disease[38]. It has been suggested that the use of phenolised formalin may reduce the risk[39] but recent guidance from the Advisory Committee on Dangerous Pathogens did not support this[40]. The agent, once formalinised, has been shown to survive when a specimen is reduced to ash at a temperature of 360°C[41]. Exposure to sodium hypochlorite containing 20 000 ppm available chlorine (for at least one hour) to 1-2M sodium hydroxide, or steam autoclaving at 134°C for at least 18 minutes are needed for decontamination[40]. CJD takes so long to develop that the evidence of risk to those who handle infected tissue is circumstantial, but reports have linked cases of this disease in morbid anatomy technicians to exposure at work[42,43]. The Health and Safety Commission suggested recently that skulls of people who have died of CJD or other high risk infections should only be opened inside a large plastic bag fitted over the head and neck of the cadaver[44]. As the prevalence of undiagnosed CJD in the population is unknown perhaps all skull opening should be performed in this way.

Hepatitis

Hepatitis A is transmitted by the faecal oral route and the same precautions should be taken as for other gastrointestinal pathogens. Vaccination is not essential, but maybe desirable for people who handle cadavers.

Hepatitis B is extremely infectious and transmission continues in many western countries. As little as 0.00001 ml pooled serum containing indicators of intact virus particles has been shown to transmit infection[45]. Workers in clinical laboratories in the United Kingdom have had a higher incidence of hepatitis than the general population for 20 years, although the number of cases has been small[23-26] and has fallen steadily in the past decade[46]. One survey showed that technicians in morbid anatomy were particularly at risk[22]. In the United States in 1978 the rate of infection with hepatitis B in health care workers was four times higher than in the general population, and was particularly high in pathologists, surgeons, and others exposed to blood or blood products[47]. Skin penetration in the necropsy room occurs through contact with instruments, damaged bones, and bone spicules. A survey of embalmers in the United States showed that needlestick injuries were commonly reported and that 13% of embalmers were positive for anti-HBV (about twice the rate in a blood donor comparison group)[48]. Workers in hospital mortuaries and embalmers should be vaccinated routinely against hepatitis B. The bodies of those who died of or were known to be infected with this virus should be handled only by workers wearing full protective clothing.

Hepatitis C is transmitted by the same routes as hepatitis B, but probably less infectious. Its incidence is unknown and no vaccine is available. Similar precautions to those for hepatitis B (full protective clothing) should be taken.

HIV

Hepatitis B and HIV are transmitted by similar routes and the precautions required to prevent the transmission of hepatitis B (full protective clothing) should be adequate to prevent transmission of HIV. HIV is probably about 100 times less infectious than hepatitis B and the risk to those handling infected cadavers is therefore proportionately less. A recent survey in the United States of health care workers with AIDS and HIV infections that may have been acquired occupationally showed that most documented exposures were to blood (91%) and that clinical laboratory technicians and nurses were most at risk[49]. No embalmers or mortuary technicians had developed infection following documented exposure but three developed infections that may have been acquired occupationally. A serological study was carried out on embalmers who worked in an urban area of the United States where HIV infections were prevalent. Four out of 133 were HIV antibody positive,but these four individuals had other risk behaviours. Cadavers examined for medicolegal purposes may present a particular risk because many come from populations at high risk of HIV infection. Not all who die positive for HIV antibody are known to be infected at the time of death[50]. The virus survives for many days after death in tissues preserved under laboratory conditions[51,52]. Care should therefore be taken when handling unfixed material from HIV-infected cadavers, or when undertaking necropsies on cadavers infected with HIV. Embalming bodies of people known or suspected to have been infected is not recommended, and the effectiveness of embalming fluids against HIV in cadavers is unknown[53]. The Advisory Committee on Dangerous Pathogens has published guidance on the risks associated with HIV[54].

Cadavers infected with HIV are often infected with other organisms, such as mycobacteria, which may be more infectious (albeit less dangerous) than the HIV infection itself.

Stillbirths

To what risks are fathers exposed when they handle stillborn babies as part of their grieving? The infectious diseases and organisms most likely to cause stillbirths, and possibly to contaminate stillborn babies, are rubella, syphilis, toxoplasma, cytomegalovirus, parvovirus B19, and *Listeria monocytogenes.* The father is likely to have

Table 3 Use of protective clothing

Hands	
Examination gloves (latex)	For handling hazardous material. Wear whenever handling bodies. Should be worn once only and then discarded. Always wash hands after use. Provide short term (10 minute) protection against formaldehyde.
Chemically protective gloves (nitrile)	Worn over examination gloves to protect from longer term exposure to chemical hazards, such as formaldehyde.
Respiratory protection	
Filter masks	Filter mask to EN 149 for specific hazards, such as lead dust, fungal spores, and aerosols.
Splash protection	
Face: visor	Protects against hazardous splashes to eyes, nose, and mouth.
Body: apron	If splashing to body may occur (hygienic preparation, embalming, collection of traumatised bodies, necropsies).
Feet: rubber boots	In wet situations (mortuaries, embalming rooms, collection of severe multiple trauma cases).
Whole body protection	
Gowns/coats	To protect clothing against splashing. Coverall with hood – to protect clothes and hair from impregnation with dusts, spores, etc.

Other protective clothing (safety helmets, boots, safety glasses, work gloves) should be worn as required to protect against mechanical injury.

been either the source of infection or exposed to it during the pregnancy as a result of living with the mother, and is therefore at little additional risk when handling the child. Basic cleaning of the cadaver, and possibly wrapping in a cloth, should reduce any small residual risk.

Reduction of risk

In the necropsy room

Obvious disease in a cadaver, or knowledge of an antemortem diagnosis of infectious disease, allows the pathologist to take suitable precautions, but covert disease remains a hazard.

The Howie report presented a detailed code of practice for the prevention of infection in laboratories and necropsy rooms[29]. This report, and a subsequent report from the Health Services Advisory Committee (HSAC)[14] and building notes from the Department of Health[55] together gave detailed protocols for the layout, construction, ventilation, and operation of necropsy rooms. In essence, hands should be washed routinely after each procedure and before eating (or smoking), the environment should be cleaned with a phenolic disinfectant daily, and instruments washed in a washer-disinfector, autoclaved, or immersed in a phenolic disinfectant for 20 minutes. A phenolic disinfectant is preferred to hypochlorite because hypochlorite is corrosive and may damage surfaces or instruments; cleaning large areas with hypochlorite may liberate unacceptable amounts of chlorine; and formaldehyde (likely to be found in necropsy rooms and on embalmers' premises) reacts with hypochlorite to produce a potent carcinogen, bis-chloromethyl ether[56].

In funeral directors' premises

Funeral directors are not currently given access to the certificate of the cause of death of bodies they prepare for burial or cremation. They need to know if an infection hazard exists so that their staff may take precautions and they can decide whether embalming or hygienic preparation of the deceased and viewing by the bereaved are appropriate. A change of policy is needed.

Recommendations in the Howie report[29] and in the more recent HSAC report[44] did not fully address the hazards that face the funeral trade. They were concerned with necropsies, in which internal organs are exposed with inevitable spillage of blood and body fluids, sharp and power-driven instruments are used, and tissues and contaminated surfaces are flushed with running water. The hazards that face funeral directors and embalmers are similar but of a lesser order. The handling time for an individual cadaver is about one hour and embalming as practised in Britain is largely a closed procedure. Embalming reduces microbial activity and slows decomposition and is undertaken as a means of temporary preservation. A single abdominal wall incision is made in order to cannulate a major artery for introduction of a solution containing formaldehyde, and insert a drainage trochar into the heart and major body cavities. Drainage effluent is collected in a large closed vessel. The embalming of cadavers that have been in accidents or undergone postmortem examination (especially coroner's necropsies), is more difficult because they may be badly damaged and present particular hazards of damaged bones, bone splinters, and (occasionally) sharp items, such as needles, left in the body. Cosmetic work on cadavers, more common in the United States than in Britain, may also present hazards if the body has been damaged.

In this country up to 70% of cadavers are embalmed (more in urban than rural areas) but it is not always appropriate. For some notifiable diseases (table 1) and if the next of kin so wish, the cadaver simply undergoes "hygienic preparation." This involves washing the face and hands, dressing the cadaver, tidying the hair, and

possibly trimming the nails and shaving. Some ethnic groups require that relatives and religious leaders carry out their own hygienic preparation and rituals, and this may have to be done on the funeral director's premises. It seems unreasonable to restrict such activities unless an obvious hazard exists. The use of gloves and simple protective clothing by the funeral director's staff and anyone else who handles the bodies should be an acceptable and effective safety measure.

The funeral trade would be helped by simple guidelines appropriate to their activities and risks, which acknowledge the need to allow the bereaved friends and relations opportunities to pay their last respects in a safe and aesthetically acceptable environment. Universal precautions, a policy based on the assumption that any cadaver may be an infection hazard, has led to widespread use of body bags. Body bags slow the rate of cooling of cadavers, which allows decay to proceed more rapidly, and means that funeral directors often receive bodies in very poor condition. It is obviously desirable to place cadavers that pose a high risk of transmitting infection in bags. Universal bagging, however, prevents hygienic preparation of bodies and is undesirable, even when bags that permit the upper part of the body to be displayed are used. It renders final viewing impossible, unpleasant, or at least causes an offensive intrusion into a family's grief. Very few conditions make viewing by the bereaved an unacceptable hazard (tables 1 and 2).

All instruments used for embalming or preparing bodies for the funeral should be cleaned in warm water and detergent (if the water temperature is higher than "hand hot" it may fix protein onto instruments) and disinfected by boiling for five minutes or soaking in a phenolic disinfectant for 20 minutes. An autoclave, if available, provides excellent decontamination, but is not justified by existing levels of risk. Phenolic disinfectants should be used to clean up any spills of blood or body fluids, and disposable gloves should be used to protect the hands from contact with the spill. Hands should always be washed after finishing a session.

Environmental health departments are required to inspect the premises of funeral directors and are responsible for the observance of COSHH regulations. Embalmers' premises generally come under the Health and Safety Executive, but responsibility is delegated to environmental health departments in some instances.

Emergency service personnel

Spilt blood is the major hazard that emergency service personnel face from the deceased. The prevention of contact with blood with gloves, face and eye protection, and protective clothing as necessary should greatly reduce risks to personnel (including those from the funeral trade) who attend fatal accidents. Bodies that have been decaying for some time, particularly those which have been in water for some time, present little risk. The organisms likely to be present are their own body flora (particularly anaerobic bacteria) and organisms from water or the environment. Proper protective clothing will protect personnel who handle such material. Bodies should always be transported to mortuary facilities in waterproof body bags or fibreglass temporary coffins.

Summary of risk reduction

Whether dealing with old interments or with the recently deceased – and, in the case of the latter, regardless of which infectious agents may be present – observance of COSHH procedures[14a], the covering of cuts or lesions with waterproof dressings, careful cleansing of any injuries sustained during procedures, and particularly the use of appropriate protective clothing for the procedure (table 3), will greatly reduce the risk of acquiring infection.

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Infection in the deceased: a survey of management

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Summary

Funeral directors, control of infection officers, chief environmental health officers, and consultants in communicable disease control were surveyed to identify the sources and nature of advice about infectious hazards from the deceased available to undertakers. They were asked about management responsibilities, policies, particular activities (viewing, hygienic preparation, bagging, embalming, and final disposal by burial or cremation), specific diseases (hepatitis B, HIV infection, tuberculosis, meningitis, septicaemia, and salmonellosis), and repatriation. A wide range of opinions and advice was received on each topic. Medical personnel need a greater understanding of the work of funeral directors. Policies based on a realistic assessment of risk should be agreed.

Introduction

The main job of a funeral director is to arrange for the disposal of the body of the deceased person, allowing the next of kin to take leave of the deceased as they wish, within the constraints of statutory regulations. The opportunity to spend time with the deceased assists the grieving process. To reduce the distress of 'viewing', the body is usually washed and dressed before being placed in a coffin. The process aims to reduce offensive odours and give the body an acceptable appearance up to the time of final disposal, which is usually seven to ten days after death in the United Kingdom (UK). The best temporary preservation is achieved by embalming[1]. Preparation of the body for viewing after necropsy or severe trauma may require special skills. Some religious groups have their own rituals in relation to funerals, and cultural practices may be very important to the next of kin. Repatriation of the deceased is sometimes requested.

About 600000 deaths occur each year in the UK. Fewer than 1% are associated with known or suspected infectious disease, but such conditions cause considerable concern to funeral directors who are obliged to protect the health and safety of their staff, the next of kin, and the public. Funeral directors commonly say that they are not always informed of the cause of death or the presence of infection, the advice they receive on handling varies, and the application of policies designed for control of infection in hospitals to their business may distress the bereaved. In recent years the emergence of HIV infection has caused great anxiety in the funeral business, not only because of perceived risk but also because the level of confidentiality with which the diagnosis is treated means that funeral directors may not be informed about the infection. The purpose of the regulations about notification of infectious diseases is sometimes misunderstood by members of the funeral trade, who often assume that notifiable diseases are always dangerous.

Small independent funeral directors carry out more than half of the funerals in the UK[2]. Few large companies exist, and policies about handling bodies that may be infected vary widely. It is difficult for associations and training schools for funeral directors and embalmers to apply advice written in microbiological jargon to their situation.

About two thirds of deaths occur in hospitals. Advice based on policies for the control of infection in hospitals may affect the instructions given to funeral directors. The *Health and Safety at Work Act 1974* and the *Control of Substances Hazardous to Health* regulations require appropriate assessments of the risks of infection and other hazards to be made, and action taken to minimise hazards[1]. Environmental health departments have statutory duties in relation to cemeteries and crematoriums and are often responsible for health and safety on funeral premises. None of the agencies concerned with control of infection has wide technical knowledge or experience of the funeral business. They rely on safety guidelines for laboratories and postmortem rooms (neither of which is wholly applicable to the funeral trade), and on theoretical considerations, when asked to advise.

Most of what has been written about occupational risks of exposure to infection from the deceased refers to pathologists and mortuary staff[1], whose degree of exposure at necropsies greatly exceeds that of the staff of funeral premises even where embalming is carried out. Few papers deal with the risks to funeral staff and embalmers[3,4] and prospective studies are needed to assess whether occupationally acquired infections occur. Embalmers are thought unlikely to become infected because they wear protective gloves and aprons, use embalming fluids containing formaldehyde, and the cadavers are usually refrigerated. Nevertheless, anxiety exists about bloodborne viruses, 'notifiable diseases', septicaemia, and 'killer germs.' Purging of stomach contents and faeces (common after death), blood staining of the skin and leaking wounds, and clothing recently stained with faeces or body fluids are at least unpleasant when handling the deceased. Funeral workers other than embalmers do not always wear gloves when handling the deceased, especially when collecting them from the home of the deceased. It is likely that most pathogenic organisms die off soon after death (when commensals, especially anaerobes, take over the decomposition process), but there is evidence that HIV – for example – can be retrieved from tissues many days after death[5-7].

This paper reports on a survey of professional groups with responsibilities for the safe and appropriate disposal of the deceased. The survey was undertaken in order to identify the sources and nature of advice available to people who work in the funeral business about infectious hazards from the deceased.

Methods

A postal questionnaire was sent to samples of 50 of the following four professions concerned with disposal of the deceased: funeral directors in the UK, infection control officers (ICO) in hospitals in England and Wales, consultants in communicable disease control (CCDC) in England and Wales, and chief environmental health officers (CEHO) in England. Recipients who had not responded after two months received a reminder.

Forty of the funeral directors belonged to or were associated with one company, which has branches throughout the UK. One of the authors ((SEJY) acts as the company's microbiological advisor, and the company had indicated its willingness to participate in the survey. The remaining 10 funeral directors worked independently throughout the UK. At least three hospitals from each NHS region were picked at random from the *Health Services Year Book*[8] and their ICOs were sent questionnaires. CEHOs were selected randomly from the Department of Health's directory of environmental health departments in England. CCDCs were selected at random from an unpublished directory.

Questions were asked about management responsibilities, written policies, particular activities (viewing, hygienic preparation, bagging, embalming, and final disposal by burial or cremation), particular diseases (hepatitis B, HIV infection, tuberculosis, meningitis, septicaemia, and salmonellosis), and administrative matters about repatriation from the UK. We chose diseases that often cause anxiety in funeral directors and their staff. Most questions could be answered 'yes' or 'no', but some respondents added comments throughout. Questions that were unanswered or stated to be inapplicable to the respondent were not scored. Space was provided for respondents to comment on problems they encountered.

Results

One hundred and fifty-five of the 200 questionnaires were returned. The overall response was 77.5%, but this varied with profession: 92% for funeral directors, 82% for CCDCs, and 68% for both ICOs and CEHOs. The functions of some respondents overlapped, particularly those mailed as ICOs and CCDCs; some individuals performed both functions but were treated as respondents of the category originally assigned. Some respondents enclosed copies of their policies. ICOs included microbiologists, nurse specialists, and infection control managers. A few questionnaires were completed by people who may have been in an unexpected category, especially among the CEHOs (these included local authority mortuary and crematorium managers, and mortuary technicians). Some respondents in all categories said that they had not been asked for advice and had based their answers on what they might do. Twenty-four of the 34 CEHOs who responded said that their role was confined to National Assistance disposals and suicides for whom no next of kin were traced, or to implementation of the *Health and Safety at Work Act* on undertakers' premises; their medical advice came from CCDCs.

Replies to questions about responsibility for particular aspects of the management of the deceased are summarised in table 1. As might be expected, the funeral directors knew the extent of their responsibilities, namely, the entire business, apart from disposal, which clients determine. The other groups were much more varied in their responses. Most funeral directors (67% to 87%) and ICOs (88% to 94%), but only about half of the CCDCs (36% to 64%), had access to written guidelines for the management of cases of hepatitis B, AIDS / HIV infection, and tuberculosis. Many funeral directors (51% to 67%) had guidelines for dealing with cases of meningitis, septicaemia, and salmonellosis but fewer ICOs did so (28% to 61%), and most CCDCs did not (18% to 24% did). Fewer than a quarter of the CEHOs answered questions about specific diseases. One ICO reported having 'a single composite policy' but did not relate this to the infections listed. A number of ICOs noted that their policy in relation to salmonella cases and carriers applied only to *Salmonella typhi* and possibly *S.paratyphi* infections. Five CCDCs simply said that their 'hospitals or acute units had policies which would be appropriate.'

In relation to the selected infections most respondents said that they would permit viewing in almost all cases. Between 12% and 24% of funeral directors did not allow viewing: the highest proportion of refusals was for salmonellosis. A number of respondents in all categories specified that if a risk of infection was known 'no touch viewing' could be acceptable, or that they might consider a flexible approach, after discussion, if the bereaved were unduly distressed. Some respondents said that they would permit viewing through glass only; a few only agreed to viewing of a sealed coffin in 'cases of infection.'

Over three quarters of funeral directors would not permit hygienic preparation of cases or carriers of hepatitis B or cases of AIDS / HIV infection, compared with fewer than a quarter of ICOs and CCDCs. Conversely, few in any group of respondents (particularly funeral directors) would permit such cases to be embalmed and nearly all required them to be bagged. Responses to questions about the handling of cases of tuberculosis, meningitis, septicaemia, and salmonella infection by all categories of respondent were much more varied. The executors or the local authority have the right to decide on burial or cremation, unless the deceased is known to have expressed a wish not to be cremated. If haste is needed, or the next of kin have not been traced, burial is usually chosen. Opinions were evenly divided in the funeral trade as to whether they would recommend cremation rather than burial for infectious cases. ICOs and CCDCs generally did not.

The responses to questions about 'free from infection' certificates for the repatriation of the deceased indicate considerable uncertainty in this area (table 2). Although most funeral directors would monitor the sealing of coffins before repatriation, few respondents in the other categories said that they would do so.

Discussion

The results of this survey show substantial variation in the advice available to funeral directors as to how they should handle bodies that pose a risk of infection. Comments from many of the respondents illustrated this point: 'no problems', 'there are no policies in this area', 'hospitals often fail to inform us of septicaemia', and 'not always informed by the general practitioner / coroner / hospital of risk of infection.' Funeral directors were frequently made aware of an infection hazard after embalming, when they received the documents required for cremation.

Viewing

Viewing the body of the deceased at the funeral directors' premises is often requested by the bereaved. Most funeral directors have a chapel of rest where the bereaved can

Table 1 Taking responsibility for aspects of management of the deceased

Decisions	Funeral directors		Infection control officers		Consultants in communicable disease control		Chief environmental health officers	
	Yes	No	Yes	No	Yes	No	Yes	No
Permission to view at funeral directors' premises	45	1	3	28	14	16	4	5
Permission for hygienic preparation of the deceased (includes laying out, and customary rites or rituals normally undertaken by next of kin or religious leaders)	44	2	16	17	10	19	4	4
Bagging	41	5	28	6	18	14	6	2
Permission to embalm	4	42	4	27	11	19	2	6
Method of disposal (burial or cremation)	4	40	2	29	13	18	1	–

spend time in private with the encoffined body. This type of 'viewing' is very different from a brief look in a hospital or mortuary, and more closely resembles the access encouraged by hospices. The demand for this type of viewing is increasing. Many bereaved people find it hard to accept that there is a risk of infection, particularly if the deceased was nursed on an open ward or at home. It can seem unduly restrictive to deny the opportunity for viewing, especially if the body has been embalmed. Although a recommendation to forego viewing may be made if temporary preservation has not been carried out, or when a definite risk of transmitting infection is thought to exist, or the appearance of the dead person is unpleasant because of decay or autopsy, the next of kin may insist and on very few occasions can the request be denied. In some communities large groups of friends and relations wish to pay their respects at the unsealed coffin. It is especially difficult for funeral directors to restrict viewing to immediate relatives and deny it to friends, as some respondents suggested – for example, in cases of meningitis and HIV infection.

Body bags and universal precautions

Zipped or sealed plastic body bags may be used for cases thought to be infective to handlers, as a 'universal precaution' against infection, or to transport leaking or otherwise offensive bodies. The bags may be transparent or opaque and some are biodegradable. The survey revealed that the increasing use of body bags was widely misunderstood. In the past, only 'infectious' bodies were bagged, and funeral directors took the body bag as an indication that it would be dangerous to unseal the bag for any reason. Recently, however, many more bodies are received in body bags and the hospital inspired policy of universal precautions is having serious repercussions in the funeral business. Only a very small proportion of deaths are attributable to transmissible infections. A clear indication of hazard is needed to enable funeral directors to do their job, and facilitate viewing by the bereaved. 'Biohazard' stickers defeat the object of universal precautions, and diagnostic information often fails to reach funeral directors. Some ICOs and CCDCs commented that overzealous nurses and mortuary technicians might bag uninfectious bodies despite local policies.

Funeral directors who (reluctantly) open body bags increasingly find that cases from hospitals arrive in a soiled and offensive condition because 'last offices' have not been carried out, and because bodies cool more slowly when enclosed in a plastic bag, facilitating decomposition. Although limited hygienic preparation may be carried out, display of the head for viewing in a plastic bag that has been folded back is not a comforting experience for the bereaved. Bags made of polyvinyl chloride cannot be cremated because dioxins are thereby emitted from the crematorium. Respondents commented about the cost of body bags 'which are not always necessary', referred to 'protests from histopathologists that tissues were rendered unsatisfactory for examination after a body has been stored in a bag', and some said that bags should be reserved for cases that posed a real risk of infection to handlers.

Hygienic preparation and the 'offices'

The 'last offices' performed on the deceased by nursing staff (also known as 'laying out'), washing by relations or religious leaders in some ethnic minority groups, and 'first offices' performed by the funeral staff may be described as hygienic preparation. It includes washing the face and hands, closing the eyes and mouth, tidying the hair, and possibly shaving the face. It may or may not be followed by dressing in special garments. Some hospitals have recently cut hygienic last offices, and funeral directors are receiving increasing numbers of bodies that have not been prepared. One CCDC deplored the fact that last offices no longer included packing of orifices.

Fear of acquiring hepatitis, HIV infection, or other infections through handling the deceased makes workers in the funeral business reluctant even to wash and tidy bagged bodies. Members of ethnic minorities in the UK, especially first generation immigrants, often wish to perform ritual preparation before burial. The suggestion that a loved one has suddenly become an infectious risk to be handled wearing protective clothing, including gloves, is incomprehensible and distressing. Several funeral directors and CCDCs said that they were prepared to be flexible to avoid excessive distress.

Table 2 Freedom from infection certificates

Questions*		Percentage of respondents who answered 'yes'		
		Funeral director	Infection control officer	Consultant in communicable disease control
a)	Do you expect 'Free from infection' certificates to state that:			
–	the deceased did not die from an infectious disease?	96	83	82
–	the deceased was not a carrier of any infectious agent?	78	44	55
–	no infectious disease was currently circulating in the community?	64	0	77
b)	Which diseases do you understand to be included in a 'Free from infection' certificate?			
–	any infectious disease	81	75	48
–	any notifiable disease	91	92	44
–	only diseases subject to International Health Regulations	37	69	64

* Few chief environmental health officers replied to these questions

Embalming

Embalming reduces postmortem staining, restores a more natural colour to the skin, reduces odours, and by retarding decomposition preserves the body until the final rites have been completed. It is carried out in 30% to 70% of cases in the UK – with a higher proportion in urban areas – because of the relatively long time between death and disposal in this country. Modern embalming involves the intra-arterial injection of solutions containing formaldehyde followed by drainage of blood from the heart and instillation of a stronger formaldehyde solution into the abdominal and pleural cavities. Cosmetic treatment is rare in the UK but reconstructive work may be carried out after severe trauma.

Although embalming is thought to reduce the risks of infection to the bereaved, embalmers feel very exposed to infectious risks in their work, particularly from bloodborne viruses and if septicaemia was the cause of death. Funeral directors said that they were often not informed of these conditions and might find out only after embalming had been carried out. Funeral staff want the right to know if and what infection risks exist. Immunising all embalmers with hepatitis B vaccine only partly answers this concern. Three respondents stated that they use an embalmer 'trained in the United States' to embalm bodies of those known to have been infected with hepatitis B virus and HIV. Legal cases in the United States have been brought by relations who claim that failure to embalm an HIV positive body constitutes discrimination. Such cases are now embalmed in many states.

Specific infectious agents

Many respondents commented on the infections mentioned in the questionnaires and some suggested other conditions that caused concern. In 1988 the chief medical officer 'reminded doctors to inform funeral personnel when a body poses a risk of infection which requires it to be handled with safeguards' and drew attention particularly to hepatitis B, tuberculosis, salmonella infection, and HIV infection[9]. Although vaccination of embalmers and mortuary staff against hepatitis B is recommended, fear remains, and the British Institute of Embalmers recommends that its members should avoid working on cases known to be infectious with this virus; and that they should treat HIV with similar caution. Recent work has shown that hepatitis C needs to be treated similarly[10].

The risks of respiratory tract pathogens from the deceased to funeral personnel is probably remote, even from the single exhalation of air that occurs when the body is first moved . Covering the face with a cloth would be a simple precaution. Some respondents expressed reservations about meningitis, but others clearly stated that their recommendations would depend on the causative organism.

Septicaemia causes anxiety to funeral directors, and embalmers avoid handling such cases. Funeral directors commented that they received conflicting advice and that positive guidance on individual cases would be useful. Most ICOs commented that advice on cases that had died of septicaemia would depend on the organism; one said that the funeral director would be notified of the serious risk from group A streptococcal septicaemias but not others.

Postmortem leak from the gastrointestinal tract often occurs after death, and faecal staining of skin and clothing is common, but most answers to questions about salmonella infections mainly related to cases of enteric fever. Salmonellas that cause food poisoning were seldom mentioned.

Cremation or burial

Many respondents wished to recommend cremation for infectious cases. Unless the deceased is known to have expressed a wish not to be cremated, relations or executors have the right to decide about disposal and their wishes and customs take priority over opinions of professionals about the disposal of infective clinical material. In circumstances when there is a need for hurried action or the next of kin have not been traced the local authority has the responsibility to decide, and burial is usually carried out.

International transport of cadavers

Families sometimes wish to repatriate the body of a relation to another country or into the UK. Regulations that cover international transport of cadavers vary from one country to another, and advice can be obtained from appropriate embassies. Most airlines require that the body be embalmed and 'hermetically' sealed in a casket or a zinc lined coffin before they will carry it. Sealing of coffins to avoid leakage of body fluids during transit is normally carried out by the funeral director, who may be supervised by an environmental health officer and/or a consular representative. Export of cremated remains poses few problems. Before bodies can be transferred from one country for final disposal in another, or for burial at sea, a number of requirements have to be met, including certification of freedom from infection.

The 'free from infection' certificate (also known as the non-contagious declaration) is signed by the medical practitioner who attended the deceased. Some countries also require a declaration that no infection is circulating in the community in the area where the death occurred. There are currently no standard formats for such certificates and the statement requested varies from one country to another. The certificates may refer to death due to an infectious disease, death due to a notifiable disease, the presence of infection or carrier state in a person who died from other causes, or the known occurrence of a notifiable / infectious disease in the community where the individual died.

Free from infection certificates are only a small part of the documentation legally required for international transport of the deceased, even after embalming. Respondents to our survey exposed uncertainty about the meaning of 'infectious disease' in this context. Whether such certificates should refer only to those diseases covered by international health regulations (cholera, typhus, yellow fever, and plague) or should include the much commoner bloodborne agents (such as hepatitis B and C viruses, and HIV) needs to be clarified and agreed. Confusion would be reduced by a clear standardised format that indicated which diseases were covered by the certificate and whether it referred only to the cause of death or also to carrier states. Infections may also be incidental or contributory, rather than the cause of death. People with HIV infection and carriers of hepatitis B e antigen continue to cause concern.

Conclusion

Better communication between concerned professional groups would assist funeral directors when dealing with their clients. Funeral directors must be informed which cases present real risks of infection to their staff and which can be embalmed and prepared for presentation to relations, so that they can provide clients with the funeral they request without compromising safe working practices. Education, appropriate protective clothing, and hygienic measures provide safe working conditions for handling most cadavers. It is unrealistic to classify all notifiable diseases or all pathogenic microorganisms as equally dangerous to the funeral director, or to place all bodies in body bags, with the implication that a serious infection risk exists. If the practice of universal bagging is widely adopted some additional indication of real risk is essential. Bagging leads to denial or modification of viewing access or to the reluctant opening of bags that contain a soiled and malodorous body. Religious rites are important to many bereaved people. There seems little justification for preventing customary cleansings before final disposal, except in rare and obviously dangerous conditions.

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Cytomegalovirus infection in England and Wales: 1992 and 1993

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Summary

Cytomegalovirus causes illness through primary infection but also remains latent within the host and may be reactivated, especially if immunity is impaired. We have examined reports of cytomegalovirus infection from laboratories in England and Wales received by the PHLS Communicable Disease Surveillance Centre in 1992 and 1993. A total of 2938 reports were received, and 103 people had recurrent infections within the study period. The age distribution had peaks in infants (< 1 year of age) and in people aged 25 to 34 years. In almost a half of the patients (1371; 49%) factors were reported that indicated impaired immunity. Eighty-three of the 103 with recurrent infection (81%) were also reported to have impaired immunity. Children under 5 years accounted for 18% (543 / 2938) of reports. There were 930 reports of infections in people over 5 years of age who were not reported as immunocompromised. The data presented confirm that cytomegalovirus causes substantial morbidity in young children and people with impaired immunity. Cytomegalovirus infection causes considerable morbidity, especially hepatic, in patients whose immunity is thought to be normal.

Introduction

Cytomegalovirus (CMV) is a member of the herpesvirus family. Like other herpesviruses, it remains latent within the host after primary infection and may reactivate, especially if immunity is impaired[1]. Reinfection can also occur, probably because of CMV's antigenic diversity[1].

Primary infection in people who are immunocompetent is usually subclinical or causes mild symptoms similar to infectious mononucleosis[1]. In neonates[2], people with impaired immunity[3], and a small proportion of immunocompetent patients[1], however, primary infection may be severe and cause hepatitis, pneumonia, retinitis, encephalitis, and Guillain-Barré syndrome. Recurrent infection tends to be less severe in all groups but in people with impaired immunity it is common and may be severe[1,3-5].

This review was carried out in order to update the knowledge of the epidemiology of and morbidity attributable to CMV infection in the light of renewed efforts to find an effective vaccine.

Methods

All laboratory reports of CMV infection in England and Wales received by the PHLS Communicable Disease Surveillance Centre (CDSC) from 1 January 1992 to 31 December 1993 were downloaded from LabBase in ASCII format and imported to Epi Info 5.01b. We examined data on age, sex, date of specimen, method of confirmation, and underlying factors such as impaired immunity. These reports rely on the reporting microbiologist's interpretation of the microbiological and clinical data.

Recurrent infection was defined as two laboratory confirmations in the same patient at least 90 days apart within the study period. Reports separated by less than 90 days were considered to represent the same episode of infection.

A patient was considered to have impaired immunity if reported to be 'immunocompromised', a transplant recipient, or to have HIV infection, AIDS, or cancer.

Results

A total of 2938 reports of CMV infection in 2819 patients were received between 1 January 1992 and 31 December 1993 (1411 in 1992 and 1527 in 1993). One hundred and three patients had recurrent infections: 90 had one recurrence, 10 had two, and three had three.

Infections were confirmed by microscopy and / or isolation in 55% (1615 / 2938) of reports, serology in 43% (1260 / 2938), both in 2% (53 / 2938), and the method of diagnosis was not reported in 10 cases. A total of 3297 specimens were positive for CMV: 249 reports were based on two specimens and 55 on three. The commonest sources were blood / serum (1761), urine (851), throat (377), and sputum / bronchoalveolar lavage / lung tissue (189). Other sources, such as cerebrospinal fluid, liver, and saliva accounted for 4% of specimens (119).

Age distribution was bimodal, with peaks in infancy (< 1 year of age) and in people aged 25 to 34 years (figure 1). Reports in males (1702) exceeded reports in females (1146), but females outnumbered males from 10 to 24 years of age (figure 1).

Immunocompromised patients

One thousand three hundred and seventy-one patients (49%) were reported to have factors indicating impaired immunity and accounted for 1469 reports of CMV infection. Eighty per cent (83 / 103) of patients with recurrent infection were also reported to have impaired immunity. Infections were confirmed by isolation / microscopy in 69% (1008 / 1469) of reports, serology in 29% (425 / 1469), and by both methods in 2% (31 / 1469).

There were 967 reports of infection in 893 males and 448 reports in 426 females. The excess of males occurred mainly in the transplant and AIDS categories (table 1). Reports of impaired immunity peaked at 45 to 49 years compared with 25 to 34 years for reports of patients not

Figure 1 Reports of CMV infection by age group and sex: 1992 and 1993

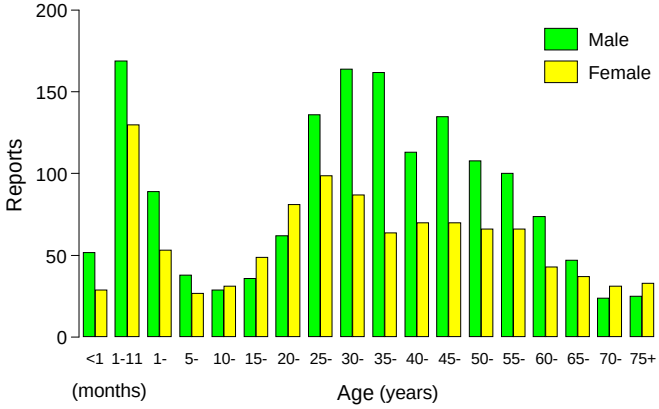


Figure 2 Reports of CMV infection by age and immune status: 1992 and 1993

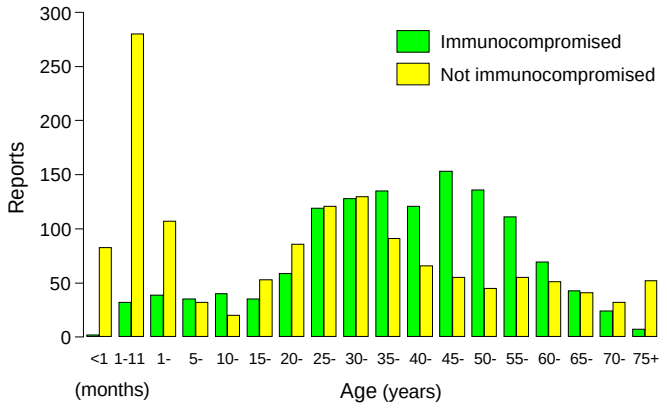
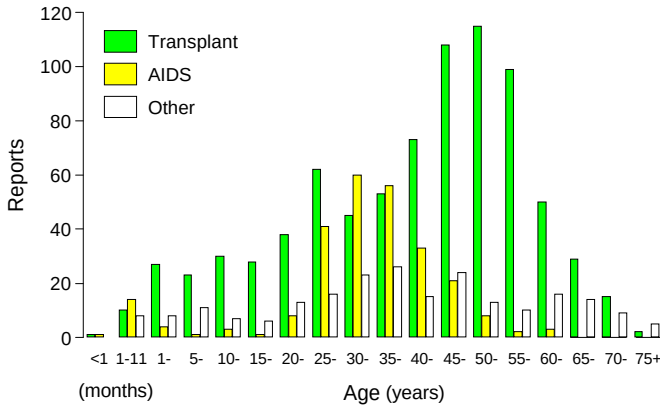


Figure 3 Reports of CMV infection in immunocompromised patients by age: 1992 and 1993



known to be immunocompromised (figure 2). The difference in age distribution was due mainly to reports of transplant patients (figure 3).

Organ transplantation was the commonest reason for impaired immunity, and accounted for 62% (853 / 1371) of patients. Underlying factors in other patients reported to have impaired immunity were AIDS, leukaemia, 'T cell disorders', connective tissue disease, lymphoma, cytotoxic chemotherapy, or treatment with corticosteroids (table 1). Infections were confirmed by isolation / microscopy in 62% of reports about transplant recipients and 91% of reports about patients with HIV infection or AIDS.

Clinical details about immunocompromised patients were recorded in only 12% (180 / 1469) of reports. Pneumonia was reported in 55 (29%), hepatitis in 43 (23%), fever in 27 (20%), and retinitis in 16 (9%).

Infection in pregnancy and young children

Forty-seven reports of CMV infection in pregnancy were made in 1992 and 1993. Intrauterine death or stillbirth was reported in 22 cases. Reports in pregnancy could not be linked to outcomes in live born children as the surveillance system has no formal mechanism for this.

There were 543 reports of infection in 526 children under 5 years (15 had two episodes of infection and one had three), 310 in males and 212 in females (sex was not stated in 21 reports). Thirteen per cent (69 / 526) had impaired immunity and in a further 13% (69 / 526) congenital infection was reported. Infections were confirmed by isolation / microscopy in 80% (436 / 543) of reports, serology in 16% (87 / 543), and by both methods in 3% (18 / 543).

Clinical details accompanied 66 reports. There were 26 reports of pneumonia / lower respiratory tract infection, 13 of hepatitis, six of developmental delay, five of fever, four of sudden infant death, two of hearing loss, and one of encephalitis.

Infection in older children and adults not known to be immunocompromised

There were 930 reports of infections in 922 patients over 5 years of age whose immunity was not reported to be impaired. Eight patients had two episodes of infection. The age distributions for both sexes were similar in this group. Reports in females exceeded reports in males (487; 431; sex not stated in two reports). Reports in females peaked at 25 to 29 years compared with 30 to 34 years in males (figure 4). In contrast to the under 5s, infections were confirmed by isolation / microscopy in 20% (182 / 930) of reports, serology in 80% (740 / 930), and by both methods in less than 1% (6 / 930) of reports.

Clinical details were supplied in 44% of reports (406 / 930). Liver disease was reported in 189 reports (47%), glandular fever in 62 (15%), fever in 39 (9%), pneumonia / lower respiratory tract infection in 35 (9%), and Guillain-Barré syndrome in 12 (3%). Other features reported included five cases of retinitis, four of arthritis, two of pericarditis, two of neuropathy, and one case each of encephalitis, meningitis, and vasculitis.

Mortality

Twenty-eight deaths were reported over the two years. This figure is likely to be an underestimate, as the outcome of 1954 infections (66%) was unknown. Nine of these deaths occurred in infants and 17 other deaths occurred in immunocompromised patients, 13 of whom were transplant recipients.

Discussion

Infection with CMV can produce a spectrum of illnesses, both acutely (whether congenital or acquired) or as reactivated disease[6]. Our data are likely to underrepresent mild or asymptomatic infections, as laboratory requests for CMV testing are more likely to be made for clinically

Figure 4 Reports of CMV infection not associated with impaired immunity, by age and sex: 1992 and 1993

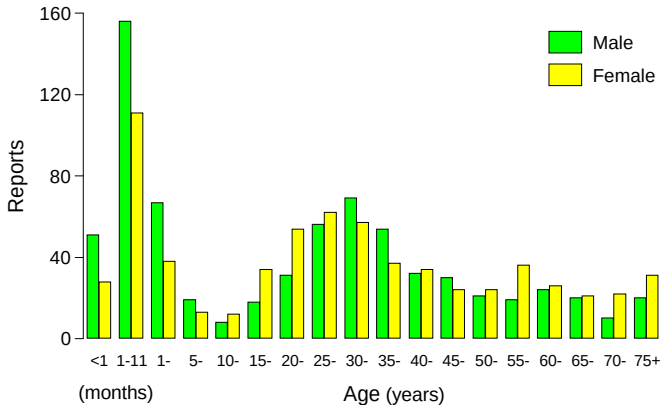


Table Underlying clinical factors in immunocompromised patients in with CMV infection: 1992 and 1993

Underlying factor	Male	Female	Not stated	Subtotal	Total (%)
Transplant					853 (62.3)
renal	206	151	6	363	
bone marrow	89	49	25	163	
heart	127	29	6	162	
liver	30	44	4	78	
heart/lung	9	8	3	20	
lung	5	10	–	15	
not specified	26	24	2	52	
AIDS	247	27	4		278 (20.3)
Malignancy					74 (5.4)
leukaemia	29	18	–	47	
lymphoma	10	7	–	17	
other	4	6	–	10	
'T cell disorder'	31	4	–		35 (2.6)
Connective tissue disorder	4	15	2		21 (1.5)
Cytotoxic chemotherapy/ corticosteroids	6	8	–		14 (1.0)
Renal disease	6	2	–		8 (0.6)
Other specified	11	10	–		21 (1.5)
Other not specified	53	14	–		67 (4.8)
Total	893	426	52		1371 (100)

apparent disease. It is clear, however, that there is a high incidence of infection (both congenital and acquired) in early childhood[2,6]. The male predominance in the under 5s has also been observed with toxoplasmosis[7].

Infections in people with impaired immunity are likely to increase as the prevalence of HIV infection increases. Reports in transplant patients probably reflect a mixture of primary and recurrent infections. The success of serological matching for CMV between organ donor and recipient may be incomplete. This technique does not solve the problem of recurrent disease in previously infected recipients, and organs from CMV positive donors may reinfect CMV positive recipients with antigenically distinct strains.

The predominance of males in the immunocompromised group reflects the fact that most transplant patients and AIDS patients in England and Wales are male. The peak in reports in immunocompromised compared with immunocompetent patients reflects the age distribution of recipients[8].

Morbidity in patients with confirmed CMV infection who are not known to be immunocompromised is considerable. Liver disease was reported in 47% of immunocompetent patients for whom clinical details were available, in contrast to 23% in immunocompromised patients. CMV hepatitis may be a bigger problem in immunocompetent patients than previously suspected. It is important to maintain surveillance of CMV infection, particularly in young children and people with impaired immunity. Further studies are needed to quantify the problem in immunocompromised adults.

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