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Hospital preparedness to bioterrorism and other infectious disease emergencies

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Abstract. In the last 2 decades, successive outbreaks caused by new, newly recognised and resurgent pathogens, and the risk that high-consequence pathogens might be used as bioterrorism agents amply demonstrated the need to enhance capacity in clinical and public health management of highly infectious diseases. In this article we review these recent and current threats to public health, whether naturally occurring or caused by accidental or intentional release. Moreover, we discuss some components of hospital preparedness for, and response to, infectious disease of the emergencies in developed countries. The issues of clinical awareness and education, initial investigation and management, surge capacity, communication, and caring for staff and others affected by the emergency are discussed. We also emphasise the importance of improving the everyday practice of infection control by healthcare professionals.

Keywords. Hospital preparedness, emerging infectious diseases, bioterrorism, infection control.

Introduction

The global eradication of smallpox, arguably the greatest international public health achievement of the twentieth century, was certified in 1980 at a time of almost untrammelled optimism that the fight against infectious diseases had been won. In the following 2 decades, successive outbreaks of infectious diseases caused by new, newly recognised and resurgent pathogens – which have been described as a series of 'perfect microbial storms' – amply demonstrated that such optimism was misplaced, and that, far from winding down capacity in clinical and public health management of highly infectious diseases, it was necessary to enhance it [1, 2]. The risk that high-consequence pathogens, including smallpox (variola) virus, might be used as biological weapons or bioterrorism agents had been recognised, and policy makers and planners were encouraged to ensure that that health and other services were adequately prepared to deal with the threat, even before the attacks on the World Trade Center and the Pentagon in September 2001 [3, 4]. These attacks, coupled with the deliberate release of letters containing anthrax spores via the US Postal Service a month later [5], showed that the threat was real, and that work to improve preparedness and response was urgently needed at local, national, and international levels.

In this article we review recent and current threats to public health in developed countries from bioterrorism and other highly infectious diseases, and discuss some of the components of hospital preparedness for, and response to, infectious disease emergencies. We also emphasise the importance of improving the every-day practice of infection control by healthcare professionals and of taking a generic, 'all-hazards' approach to hospital preparedness, integrating planning for response to infectious disease emergencies, whether naturally occurring or caused by accidental or intentional release, with planning for major incidents and natural disasters.

Critical agents, high-consequence pathogens and highly infectious diseases

The concepts used in developing laboratory biosafety guidelines forms the basis for categorisation of biological agents by risk group and the designation of appropriate

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biosafety levels. These concepts rely on expert risk assessment of the severity of human infection, the potential for transmission to exposed individuals and to the wider community or environment, and the availability of effective prophylaxis or treatment. Additional assessments include likely ease of dissemination by terrorists and the estimated overall impact of any dissemination to generate lists of 'critical agents' [6, 7]. The lists then rank the biological agents that might be used in deliberate release by priority, and identify measures needed to ensure public health preparedness. Critical agent lists are also being used to set priorities in biodefence research, including basic research on biology and pathogenesis, and development and evaluation of molecular diagnostic assays, vaccines, antivirals, and other preventive or therapeutic interventions [8]. Although critical agent lists generally make provision for inclusion of newly recognised or recently emergent pathogens, they were developed specifically to improve preparedness for bioterror events. So though all categorise smallpox virus as a high-priority, 'category A pathogen', none accords high-priority to highly pathogenic influenza viruses, or severe acute respiratory syndrome (SARS) coronavirus, despite the fact that these viruses are epidemic prone, and capable of rapid global spread and enormous public health impact.

The term 'highly infectious diseases' describes infections caused by pathogens that are transmissible from person to person, cause severe or life-threatening illness; present a serious hazard in healthcare settings and in the community; and require specific control measures, which may include management of cases in a highly secure isolation unit. It thus includes some, but not all, of the infections caused by category A critical agents (including smallpox, Lassa, Marburg, Ebola and Congo Crimean haemorrhagic fevers, and pneumonic plague, but excluding anthrax, bubonic plague, tularaemia and botulism because these are not transmissible from person to person), and also includes SARS, influenza caused by avian influenza virus H5N1 or other highly pathogenic influenza virus, and unusual illness of unknown, but possibly infectious, aetiology.

Deliberate release and bioterrorism

Incidents caused by the intentional release of pathogens are rare: in the last 50 years, five such incidents have been recognised and reported. Three of the first four incidents involved gastrointestinal pathogens (*Salmonella typhi*, *Salmonella enteritidis*, *Shigella dysenteriae*); in the fourth a group of students developed asthma and pulmonary eosinophilia after being fed *Ascaris suum* [9–12]. In the largest of the outbreaks of gastrointestinal infection, over 700 people developed symptoms after eating from salad bars in two restaurants in Dalles, Oregon, in 1984. This was a 'covert' deliberate release: unannounced, without any warning or indication of the organism involved, or of the population affected, and it was not until late in 1985 that it was discovered that followers of Baghwan Shree Rajneesh had deliberately contaminated the salad bars with cultures of *S. enteritidis*, nicely illustrating that intentional and naturally occurring outbreaks may be indistinguishable.

In the United States, the intentional dissemination of anthrax through the postal service in 2001 led to 22 cases of anthrax (11 pulmonary, 11 cutaneous) among residents of seven states along the eastern seaboard. Five of the pulmonary infections were fatal [13–19]. This was an example of an 'overt deliberate release', insofar as explicitly threatening notes were enclosed in the envelopes containing the anthrax spores, although the diagnosis of the first cases preceded recognition of the risk. Most (18) cases occurred in postal service employees or employees of the media companies targeted in the attacks; environmental sampling detected widespread anthrax contamination of the postal system. Anthrax, along with all other infections caused by category A pathogens, is uncommon in developed countries, and lack of familiarity with the disease, coupled with failure to include it in the differential diagnosis of an unusual skin lesion or of sudden onset of serious sepsis and respiratory failure led to delays in diagnosis: the median time from onset to diagnosis of the cases of cutaneous anthrax in the first cluster was 10 days [20]. Many of these had already occurred by the time that the index case of pulmonary anthrax was diagnosed in Florida by an alert clinician who had recently undergone bioterrorism preparedness training. Although the number of cases was small, the overall impact of the incident on an already stretched public health system was considerable. In New York alone, over 700 'suspect' cases, identified as a result of intensive case finding in hospitals and through clinician networks, or by self-referral by calls to telephone hotlines, required clinical assessment. All those who had potentially been exposed to anthrax required assessment for prophylaxis; completion of a 60-day course of post-exposure antibiotics was recommended for over 10,000 persons [21]. Laboratories within the Laboratory Response Network tested over 125,000 clinical specimens. The incident highlighted the need for coordination and clear command structures at local and national levels; for stronger linkages between clinicians, clinical microbiologists, hospitals and public health departments; for information, communications and laboratory systems with inbuilt 'redundancy', readily capable of expansion to meet surges in requirements, and for coordinated and effective communication with clinicians, the media and the public [22].

In the Oregon outbreak, the organism had been obtained from a commercial source; in two of the three other outbreaks caused by gastrointestinal pathogens, the per-

petrators, a bacteriologist and a laboratory worker, had access to organisms from their laboratories. The source of the *B. anthracis* used in the United States in 2001 remains uncertain. Recent changes intended to strengthen containment of critical agents within laboratories include more stringent regulation of work on, and transfer of, high-consequence pathogens, and updated guidance that recommends that all clinical, diagnostic and research laboratories develop threat and risk assessment based site-specific biosecurity plans covering personnel selection, access and inventory control, specimen accountability, reporting of incidents, injuries and breaches, and response to an emergency [23–25].

Other recent and current infectious disease threats

The epidemic of SARS in 2002–2003, with over 8000 cases in 29 countries, illustrated how a new infection can, given the speed and reach of international air travel, spread globally within weeks [26]. Transmission was amplified within hospitals, as early cases were cared for without effective infection control measures; 22% of SARS cases in Hong Kong and nearly half (43%) of SARS cases in Toronto and Singapore (41%) occurred in healthcare workers. Overall, 20% of hospitalised patients required mechanical ventilation, and 15% of hospitalised cases died. SARS coronavirus, although a newly emergent virus, was transmitted in the same way as more common respiratory infections, mainly by respiratory droplet spread, and the SARS epidemic was controlled by the efficient application of long-recognised public health control measures: rapid identification and early isolation of cases, and stringent adherence to infection control precautions. In Canada, where SARS 'paralysed the Greater Toronto Area healthcare system for weeks' [27], and the Toronto public health department investigated 2132 potential cases of SARS, identified over 23,000 contacts as requiring quarantine and logged more than 316,000 calls on its SARS hotline [28], a national review commission identified systemic deficiencies in response capacity, including 'inadequacies in institutional outbreak management protocols, infection control and infectious disease surveillance', and found that these deficiencies resulted at least in part from failure to implement lessons learned from earlier public health emergencies [22].

Global travel and global trade expose industrialised countries to other infectious disease threats.

Human monkeypox is a zoonosis, normally geographically confined to west and central Africa, which is clinically similar to smallpox in that a vesiculopustular rash follows a febrile prodromal illness. The illness tends to be milder than smallpox; in contrast with smallpox, lymphadenopathy is often a prominent feature, and person-to-person transmission is uncommon. In 2003, the first cluster of human cases (37 confirmed, 72 suspected) of community-acquired monkeypox in the Western hemisphere occurred in the United States [29, 30]. Infection followed exposure to infected pet prairie dogs that had been housed or transported with African rodents imported from Ghana. Although pox virions were seen on electron microscopy of clinical samples from the index case, the diagnosis of smallpox was excluded because the development of pocks in the case followed, and was localised to, the site of a bite by a sick pet prairie dog. The diagnosis of monkeypox was made by specialist testing of referred samples in the national laboratory. This incident again highlighted the role of the astute clinician in outbreak recognition; the value of maintaining close working relationships between clinicians working in healthcare facilities and in public health departments, and the need for multi-level, multi-agency cooperation, including collaboration between animal and human health experts, in outbreak management.

In 2005, an outbreak of Marburg haemorrhagic fever in Angola, and the potential for exported cases prompted the rapid development of national guidelines for risk assessment and case management in countries that had not previously published such guidelines [31, 32]. Marburg viral haemorrhagic fever, and Ebola, Congo-Crimean, and Lassa haemorrhagic fevers are of particular concern in healthcare settings because there is a high risk of person-to-person transmission through percutaneous or mucocutaneous exposure to blood. Lassa fever is endemic in West Africa, where estimates suggest that around 300,000 cases occur each year [33]; Congo-Crimean haemorrhagic fever has a wide geographic range that includes Greece, Albania and Pakistan; and outbreaks of the more geographically restricted Ebola and Marburg haemorrhagic fevers have recently occurred with apparently increasing frequency [34, 35]. Despite this, imported cases of viral haemorrhagic fever are uncommon: 5 laboratory confirmed cases of Lassa fever (likely to be the most frequent importation) have been reported from the United States, and fewer than 20 from other industrialised countries since the disease was recognised in 1969 [36–39]. This is perhaps because transmission and outbreaks of haemorrhagic fever viruses occur mostly in rural areas, which thus limits the opportunities of most business travellers or tourists for exposure. Nevertheless, and because there have been reports of weaponisation of Marburg, Ebola and Lassa viruses [40], all of which are category A pathogens, clinicians should remain alert to the possibility of these infections, maintain an awareness of current outbreaks, and should know how to conduct a risk assessment of febrile illness compatible with a diagnosis of viral haemorrhagic fever, how to safely undertake initial management and apply appropriate infection control measures, and, most important, know whom to contact for further advice on diagnosis and further management [33, 41, 42].

One of the consequences of the resurgence in biodefence-related research is that more laboratories, and more laboratory workers, are now working with category A pathogens, which increases the potential for occupational exposure, for occupationally acquired infection and, for some pathogens, for onward transmission to others. Laboratory workers may also be exposed to high-consequence or newly emerging pathogens whilst working on diagnostic or surveillance-related samples. Since 2000, cases of laboratory acquired glanders (1 case, US military research laboratory, the first case reported in the United States since 1945) [43]; the WR strain of vaccinia (1 case, research laboratory, Brazil) [44]; recombinant vaccinia virus (4 cases, research laboratories in Germany, United Kingdom, Canada, and United States) [45–48], tularaemia (3 cases, US research laboratory) [49]; SARS (4 cases, in research laboratories in Taiwan, Singapore, and China; all occurred after the end of the SARS epidemic, infection spread from the 2 laboratory workers in China to a further 7 people, 1 of whom died) [50–52]; Ebola viral haemorrhagic fever (1 fatal case, Russia, research laboratory) [53]; anthrax (1 cutaneous case, US laboratory) [54]; brucellosis (2 linked cases, US clinical microbiology laboratory) [55]; and West Nile virus (2 cases, US laboratories) [56] have been reported. In several of these cases, diagnosis was delayed because the possibility of occupationally acquired infection was not considered, and/or because of difficulties in identifying the organism in the clinical microbiology laboratory. In only 5 of these 19 cases was the exposure that led to infection identifiable. Guidelines on laboratory biosafety advise that laboratory workers should have access to expert occupational health advice, including, where appropriate, pre-exposure prophylaxis, and that those working in BSL3 or BSL4 facilities should carry 'medical contact cards' [23]. Clinicians should take an occupational history as a routine, and, if a laboratory or animal house worker presents with an unexplained febrile illness, a senior clinician should obtain further information from the laboratory director about the agents to which the patient may have been exposed, regardless of whether the worker can recall a specific exposure.

Since 1997, a new, highly pathogenic strain of avian influenza virus, A/H5N1, has emerged, initially in SE Asia, but with more recent spread to countries in Europe, the Middle East, Central Asia, and Africa. The first human cases were reported from Vietnam in 2003; to date (May 2006), 206 laboratory-confirmed cases, including 115 deaths (case fatality rate 56%) have been reported to the World Health Organisation from 10 countries (Azerbaijan, Cambodia, China, Djibouti, Egypt, Indonesia, Iraq, Thailand and Turkey) [57]. There is limited evidence of human-to-human transmission of the virus [58]; most cases have followed close contact with infected birds (often from household or 'backyard' flocks) or their faeces, other body fluids or carcasses.

It is not known whether, and if so, when, how or where, influenza virus A/H5N1 will evolve to become more easily transmissible between humans. Nor is it known whether an increase in transmissibility would be accompanied by a change in lethality. However, the World Health Organisation believes that the threat of pandemic human influenza is now greater than at any time since 1968, when the last influenza pandemic occurred [59].

The World Health Organisation uses a series of six alert levels to inform the world of the seriousness of the threat, and to recommend progressively more intense preparedness activities. At present (pre-pandemic threat level 3) [59], clinicians need to be aware of the potential for infection in travellers returning from affected countries, and in those who may have had occupational (e.g. poultry farmers, veterinarians, animal cullers) or other contact with infected domestic, commercially farmed or wild birds, a human case or virus in the laboratory. Advice, algorithms and response protocols for investigation and management of possible cases or case clusters have been published, and give details of reporting mechanisms, diagnostic specimens, infection control measures and other containment responses [60–62].

Assessments of preparedness plans in Europe and the United States suggest that, at best, most countries remain only moderately prepared for pandemic influenza; furthermore, the degree to which planning at the national level has been translated into increased preparedness at the local level within healthcare facilities remains unknown [63–65]. It would be prudent, however, for planners within hospitals to review existing influenza pandemic contingency plans in conjunction with the relevant national preparedness plan, with the aim of ensuring preparedness to provide supportive medical care for influenza cases, prevent transmission of infection and at the same time continue to provide essential medical services to their community. Where concerns arise about issues (e.g. criteria for hospital admission; prioritisation of antiviral use; prioritisation of admission to intensive care units; responsibility for decisions to defer elective surgical admissions; sourcing of additional supplies e.g. of personal protective equipment; use of volunteer personnel) that are not clearly dealt with within the national plan, urgent clarification should be sought from the relevant national authority.

Hospital preparedness for infectious disease emergencies

The overall aim of hospital preparedness for an infectious disease emergency is to be able to provide adequate medical care to those affected whilst at the same time continuing to provide essential medical services to the community.

The phases of the traditional disaster management cycle (preparation, response, recovery and mitigation) are paralleled in infectious disease emergency management by preparedness (activities undertaken before an event, including planning, training, and undertaking practice drills and exercises to test the plans); surveillance and detection (recognising that an infectious disease emergency is occurring); and response, control and containment (the clinical, public health and other measures that minimise the health, social and economic consequences of the incident).

Effective preparedness planning requires a multidisciplinary approach, involving emergency planners, clinical practitioners, laboratorians, managers and administrators, emergency responders, pharmacists, voluntary agencies, mental health and occupational health services, religious and spiritual advisors, support staff including catering, housekeeping, portering and security, medical records, communications, information technology and transport/courier services; with clear, pre-event designation of roles and responsibilities and clear chains of command, control and communication, and regular testing and evaluation of 'major incident' or emergency operations' plans by drills and exercises.

Hospital preparedness for infectious disease emergencies needs to be sufficiently versatile to encompass response to incidents that range from those of high/moderate probability-low/moderate consequence (e.g. a local, but severe point-source outbreak of norovirus infection), through low probability-moderate consequence (e.g. managing a single imported case of viral haemorrhagic fever or a hospital-associated outbreak of legionellosis), to low probability-high consequence (e.g. pandemic influenza; bioterrorist attack).

Clinical awareness and education

Early diagnosis and prompt institution of effective control measures are critical determinants of the eventual impact of any infectious disease emergency [66]. Nine of the 11 cases of pulmonary anthrax in the US outbreak in 2001 presented direct to hospitals or emergency rooms. These clinicians are also likely to be the first to see cases of newly emergent highly pathogenic influenza, re-emergent SARS or imported viral haemorrhagic fever. Clinicians need, therefore, to maintain their awareness of current infectious disease threats by daily review of national, regional and international Web-based alerting systems, or by ensuring that their department receives national cascade alerts, and to incorporate relevant epidemiological information into their daily practice (e.g. by using knowledge of areas currently affected by avian influenza H5N1 coupled with travel and occupational histories to exclude the diagnosis in patients with febrile respiratory illness). Useful and reliable open-access sources of medical intelligence include the Web sites developed by the Infectious Diseases Society of America (ProMed; http://www.promedmail.org) [67], the World Health Organization (http://www.who.int/csr/don/en/) [68]; further links to additional sources can be found at http://www.ecdc.eu.int/.

All clinicians must remain open to the possibility that they may be the first person to recognise a deliberate release or other infectious disease emergency; must be prepared to consult urgently with their local infectious disease specialist, clinical microbiologist and public health department on suspicion alone, without waiting for a definitive diagnosis, and must remain alert to the unusual, the unexpected and the case that 'just doesn't fit'. Examples of the unusual include unusual illness (e.g. a sudden, unexplained febrile death, critical illness or pneumonia in a previously healthy adult); an unusual number of patients with the same symptoms presenting within a short time frame; illness unusual for the time of year (e.g. 'flu in summer'); an illness unusual for the patient's age group (e.g. chicken pox in a middle-aged adult); illness in an unusual patient (e.g. cutaneous anthrax in a patient with no history of contact with animals, animal hides or products); an illness acquired in an unusual place (e.g. tularaemia acquired in the United Kingdom); unusual clinical signs (e.g. mediastinal widening on chest X-ray; symmetrical flaccid paralysis of sudden onset; 'chickenpox' rash predominantly on the extremities); and unusual progression of illness (e.g. lack of response to usually effective antibiotics) [69].

Most of the illnesses caused by high-consequence pathogens are uncommon in industrialised countries (though some e.g. plague, anthrax remain endemic elsewhere) so few clinicians have direct experience of them; similarly, few of those now practising have ever seen a case of smallpox. Considerable resources have therefore been invested since 2001 in training clinicians and emergency responders to recognise illnesses caused by these pathogens, and in developing Web-based and other training materials, guidelines, fact sheets, and incident response check lists for health care and emergency response professionals. These can be found on, or through, national authorities' Web sites (e.g. http://www.bt.cdc.gov; http://www.hpa.org.uk) and used, where formal face-to-face training programmes are not accessible, as the basis for self-directed learning. Decision-based algorithms for diagnosis and clinical management pathways have also been developed, and can be used to guide initial responses to suspected cases of smallpox, SARS, viral haemorrhagic fever or avian influenza [62, 69–72].

Infection control

Effective infection control saves lives. All healthcare workers have a responsibility to ensure that their clinical

practice prevents transmission of infection, and puts neither their own health, nor that of their patients, coworkers or others at risk. All healthcare workers should be trained in standard and transmission-based infection control precautions at induction [73]. Overall standards might be improved if an annual demonstration of competence was made a requirement for re-accreditation, and if a more stringent approach was taken to any recognised breach of infection control practice.

Infection control guidelines, updated after the SARS epidemic, now stress the importance of incorporating 'respiratory hygiene' or 'cough etiquette' – simple measures designed to prevent transmission of respiratory infections – into standard infection control precautions [74, 75]. This is particularly applicable to emergency departments, outpatient clinics and day-care centres – and includes training staff to identify and segregate or spatially separate patients with signs and symptoms of respiratory tract infection from others; offering a surgical mask to symptomatic patients; instructing all patients to cover their nose and mouth with tissues when coughing or sneezing, to dispose of used tissues safely and to clean their hands frequently, and providing tissues and tissue-disposal and hand-cleaning facilities for patients [74, 75].

Emergency departments should review their existing infection control practices and consider whether these are adequate to prevent intra-hospital transmission of infection, from the moment that a patient with an unrecognised but highly infectious disease arrives in the department, through the initial evaluation and investigation, to the point when the patient is admitted or transferred elsewhere. This should include identifying a space (ideally a negative pressure room) suitable for airborne infection and respiratory isolation and ensuring that staff understand when and how it should be used; review of available personal protective equipment (PPE: gloves, gowns, face and eye protection, surgical masks or other respiratory protection e.g. N95-type respirators), hand-cleaning facilities, and sharps safety and disposal arrangements; assessment of staff competency in choosing, and safely using, removing and disposing of the PPE available, ensuring that, if N95-type respirators are to be used, staff have been fit-tested and know how and when to perform fit checks; reinforcement of the importance of hand hygiene; arrangements for cleaning and ensuring environmental hygiene; and setting triggers for notifying the infection control team and public health department, and for seeking further expert advice. Departmental competency can and should be tested by regular drills and simulation exercises.

Infection control planning for infectious disease emergencies should also consider the number of isolation or single rooms available, and determine when, where and how cases posing a risk of transmission to others could be cohort-nursed once the supply of single rooms is exhausted.

Initial investigation and management

The aim of the initial investigation and management of a patient suspected of having a highly infectious disease, or a patient who presents with an unusual, and possibly highly transmissible, illness is to provide life-sustaining medical care to the patient whilst ensuring staff safety. This implies placing the patient in a side room, limiting the number of staff exposed to the patient to the minimum necessary, evaluation of the patient by a senior clinician, using appropriate personal protective equipment during the evaluation (gloves, gown, face and eye protection, surgical mask or N95-type respirator for staff, surgical mask for patient), and urgently seeking expert advice about management and diagnostic testing before taking diagnostic samples. Expert advice should also be sought on the desirability and mechanism of transfer of the patient to a highly secure infectious disease unit.

Detailed, disease-specific national guidance on the management and investigation of highly infectious diseases has been produced by many countries, and can usually be found on the website of the relevant national authority [32]; planners should download this guidance, incorporate relevant points (e.g. contact details for national or regional laboratories that will undertake specialised laboratory diagnostic testing; smallpox response team) into emergency plans, and designate the task of ensuring that the locally available version is up-to-date to a specific jobholder.

Laboratorians should be involved in planning, and protocols for the safe collection, transport and external referral of clinical specimens should be available, and should comply with international transport regulations and international and national guidance on biosafety and biocontainment. Robust systems for information management and specimen tracking should also be in place pre-event. If the event is linked to deliberate release or criminal action, or there are other forensic considerations, chain of custody (sometimes called 'chain of evidence') documentation of samples, and close liaison with the police or security forces will be required.

Surge capacity

Surge capacity is the ability to expand healthcare provisions to respond to an increased number of patients that exceeds usual capacity, including the provision of specialised or unusual medical care (e.g. paediatric care; intensive care requiring mechanical ventilation; haemodialysis or haemofiltration). This is sometimes split into 'surge' capacity – the expansion of healthcare provision whilst retaining near-normal care standards, and 'super-surge' capacity – further expansion, requiring the use of alternative care facilities (e.g. schools, church halls) and/

or significant changes in standards of care, sometimes referred to as 'planned degradation of care' [65].

Infectious disease emergencies may range from providing care to a single, seriously ill, highly infectious patient, to providing care to a community affected by a bioterror event or pandemic influenza. Surge requirements might include not only the ability to increase bed and personnel capacity to cope with an increased number of acute admissions, but also, for example, the ability to manage an increased number of laboratory samples, increased clinical waste for disposal, increased communication and information technology requirements (e.g. networked computers, cell phones, telephone lines connected to automatic routing systems), and increased requirements for supplies of PPE. Planners need also to consider, and formalise, with nearby healthcare providers, arrangements for collaborative working and mutual aid, and to consider also how essential functions (e.g. providing ventilatory support; communications) might be maintained if utility supplies (e.g. electricity, fuel) were compromised [76, 77].

Modelling estimates for pandemic influenza in the United States suggest that, although many patients could be cared for at home, if the pandemic was severe, and numbers affected paralleled those of the 1918 pandemic, at the peak, hospitals would need 191% of available non-intensive care beds; 461% of available intensive care beds; and 198% of available ventilators for influenza alone [65, 78]. Thus, for influenza, the ability to provide intensive care might well be the rate-limiting step in surge capacity, and criteria for admission to intensive care and for continuation of intensive support might need to be different from those that would normally be used. This raises complex ethical and legal questions, which are best thought through, preferably at the national level, in advance of, rather than during, the event.

Communication

Effective communication is essential to management of infectious disease emergencies, and a communication plan is an integral part of any emergency management plan.

'Communication' is a broad term that encompasses provision of accurate, timely, complete, easily understood information to the community about what the emergency is, what is being done to control it and what people can do to make themselves safer; provision of information to healthcare professionals about diagnosis, investigation, and pre- or post-exposure interventions; communication with families and others close to those affected by the emergency; communication with the media; and communication within and between all levels of all those involved in managing the emergency.

Recent international guidelines on risk communication, and on communicating with the media and the public during an infectious disease emergency provide greater detail, and highlight the importance of communicating in ways that build or maintain trust, of planning and testing outbreak communications strategies, and of providing media communications training for all public officials as part of professional development [79, 80].

Caring for staff and others affected by the emergency

Occupational health services should be involved in hospital preparedness planning. This involvement will help to ensure that staff are as well protected before the event as is possible (e.g. by ensuring uptake of seasonal influenza vaccine, pneumococcal vaccine and hepatitis B vaccine by all those who are eligible under existing national policies, and of vaccines specifically relevant to laboratory staff). Occupational health services should also participate in development of systems for surveillance of infection in health care workers, which are needed both pre-event, as a means of detecting that an infectious disease emergency is occurring [81], and during an event, to monitor the outcome for potentially exposed workers, and of infection specific protocols for post-exposure management [32, 82].

Any traumatic incident, emergency or disaster, whether natural or man-made, has a psychological impact on those involved – survivors, the bereaved, witnesses, rescuers, responders and health professionals, and their families, relatives, friends and workmates. Planning should ensure that, whatever the emergency, staffing levels will be sufficient for time on duty to be limited to no more than 12 h a day, and should make provision for staff rotation from highly taxing to less taxing functions. Staff will need somewhere quiet, safe and private 'off-scene' to eat, drink and rest without interruption, and facilities will also need to be such that staff are able to stay in touch with friends and family. Staff should also be made aware of other sources of support (e.g. their family doctor, hospital chaplain, and other religious and spiritual advisors), and should be provided with details of how to contact confidential listening or counselling services [69, 83].

Conclusions

It is impossible to predict when, where or how another deliberate release of a biological agent will occur, and equally impossible to predict which emergent infection will next threaten global public health, or whether the influenza pandemic will occur this year, next or in some years time. It is, however, possible to predict that infectious disease emergencies will continue to occur

with regularity, and it is possible, with appropriate planning, to be prepared to meet them in a way that ensures that they cause as little social disruption as possible. The greatest danger is complacency – the belief that 'it cannot happen', or that ' it could happen, but it will happen somewhere else'. It is not clear to what extent the efforts made at the international and national level and the long lists of lessons learned have translated into improved and sustainable hospital preparedness at the local level; we hope this article will provoke you to prepare, plan and practice, now.

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