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Expanding ICU facilities in an epidemic: recommendations based on experience from the SARS epidemic in Hong Kong and Singapore

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Abstract Epidemics have the potential to severely strain intensive care resources and may require an increase in intensive care capability. Few intensivists have direct experience of rapidly expanding intensive care services in response to an epidemic. This contribution presents the recommendations of an expert group from Hong Kong and Singapore who had direct experience of expanding intensive care services in response to the epidemic of severe acute respiratory syndrome. These recommendations cover training, infection control, staffing, communication and ethical issues. The issue of what equipment to purchase is not addressed. Early preparations should include fit testing of negative pressure respirators, training of reserve staff, sourcing of material for physical modifications to the ICU, development of infection control policies and training programmes, and discussion of triage and quarantine issues.

Keywords Critical care · Infection control · Personnel staffing and scheduling · Ethics · Communication · Education

Introduction

The severe acute respiratory syndrome (SARS) epidemic highlighted the need for contingency planning for the rapid expansion of intensive care to treat patients with the epidemic disease whilst maintaining capacity for other emergency admissions. As few intensivists have experience of rapidly expanding services, and there are no published guidelines, a panel of experts with direct practical experience of expanding intensive care services during SARS were assembled to make recommendations.

Methods

Two intensivists, one in Hong Kong and one in Singapore, identified appropriate experts with direct practical experience of expanding intensive care services during the SARS epidemic, ensuring representation by at least one expert in: intensive care medicine, intensive care nursing, engineering, counselling and personal protective equipment. Each expert, singly or in pairs, was invited to draft recommendations on a particular aspect of intensive care expansion based, where possible, on published data. These were then circulated to all panelists and discussed at a meeting on 17–18 January 2005. Further changes were made after a further Medline search in July 2005 using the terms: epidemic or disease outbreaks or severe acute respiratory disease, and critical care or intensive care. All changes were discussed via e-mail and agreed to by all panelists. Throughout the process disputes were resolved by discussion until consensus was reached.

Results

This section is confined to the major principles and recommendations. For further recommendations, discussion and practical details see the electronic supplementary material (ESM). No relevant randomized clinical trials or meta-analyses were identified, and the evidence is limited to case series, laboratory studies and expert opinion. Unreferenced recommendations are based on the authors' experience and opinion. Although the recommendations are limited to the ICU, it is vital to recognize that preparations need to be coordinated with other hospital departments and with ICUs in other hospitals.

Estimating bed requirements

Estimates of ICU bed requirements in an epidemic produce a range that is too wide to be useful. For example, the number of patients predicted to require mechanical ventilation as a result of an influenza pandemic in Australia and New Zealand ranges from 106 to 28,142 [1]. In many countries the number of ICU beds is determined more by resources than by demand, resulting in the need to triage patients [2, 3, 4, 5]. This is even more likely to be true in a pandemic. Therefore it may be more appropriate to base expansion plans on estimates of feasibility rather than estimates of requirements. Depending on local factors the maximum number of intensive care beds may be limited by equipment, physical environment or staffing. It is important to guard against over-ambitious expansion. This may lead to an increased risk of iatrogenic injury and staff infection due to unfamiliarity of staff with the environment, equipment and each other. It may also result in a standard of care too poor to be of value due to over-dilution of resources. Once the epidemic starts, it is important that data are systematically collected to allow more precise prediction of bed requirements (disease attack rate, ICU admission rate, mechanical ventilation rate, latency between presentation and ICU admission and length of stay). In relatively small epidemics it may be appropriate to admit all patients with the disease to a few designated hospitals (see ESM).

Infection control

In addition to causing personal suffering, staff infection may exacerbate manpower and morale problems [6, 7, 8]. Effective infection control is absolutely crucial, and a rapid response system must be in place and practised before an outbreak occurs. Some of the safety measures may be unnecessary, but it is preferable to err on the side of caution. A step-down approach in which precautions shown to be unnecessary are abandoned is preferable to a step-up approach, which in the SARS epidemic was associated with staff infections [9]. In the absence of knowledge of the mode of transmission one should assume that the disease is spread by contact and airborne transmission. This recommendation is based on the overriding importance of preventing staff infection, not on the probability of a new disease being transmitted by the airborne route.

Certain preparations require more time (e.g. mask fit-testing for all staff), and these should take priority. Periodic rehearsals and checks on staff readiness and proficiency in managing these systems are recommended. Stock personal protective equipment (PPE) and equipment for source isolation (e.g. high efficiency bacterial/viral filters) in the ICU. The size of the stock will depend on the projected time for delivery from suppliers, but should be at least 3–7 days' requirements. An automated re-stocking mechanism should be in place so that stocks do not need to be continually checked by clinical staff during the epidemic. Confirm that central supplies departments have contingency plans should their usual supplier fail.

Important elements of infection control include the physical environment of the ICU, ICU equipment, PPE, protocols, training and enforcement. Details of infection control procedures are given in the ESM.

Physical environment

Expanded, temporary or modified ICUs should ideally meet published minimum standards including recommendations on location within the hospital [10, 11]. In practice, hospital infrastructure (e.g. availability of piped gas) is a major determinant of the location of a temporary ICU.

Isolation or cohorting of patients is important to prevent nosocomial disease transmission. If possible, patients who clearly have an unrelated disease should be cared for in a physically separate ICU. Separating patients with the disease from those with a similar disease is difficult and can only be achieved with certainty by using individual rooms. If this is not possible, patients should be cohorted according to the probability that they have the index disease. Cohorting can be facilitated by creating segregated areas within the ICU. These can be constructed in a few hours by using pre-fabricated walls. These should be positioned so that the resulting cubicles can be easily modified to meet the standard of isolation wards [12], particularly requirements for hand hygiene and ventilation, while optimizing observation and monitoring of patients from outside the cubicle.

Negative pressure ventilation can be created by mounting industrial exhaust fans in an external window of each cubicle (Fig. 1), ideally at floor level, if this does not create a hazard. To provide the recommended 12 air changes per hour [13] the stated flow capacity of the fan should be 50% greater than the calculated flow requirement (12 times room volume per hour) to allow for sub-optimal performance. The actual flow can be measured using a hood barometer. The Centers for Disease Control and Prevention (CDC) recommend that the air changes achieved and the negative pressure inside rooms be monitored regularly [13], but this may not be feasible when resources are stretched. The effectiveness of the fan may be crudely monitored by adjusting the spring of the relevant door so that the door remains ajar when the fan is operating properly (Fig. 1). If exhaust of unfiltered gas into the environment is a concern, systems that integrate a high efficiency particulate air (HEPA) filter can be purchased but these systems are less readily available and may need to be purchased in advance. Current CDC recommendations for air that is not known to be contaminated is that exhaust and air intake ducts should be separated by at least 8 m [13]. Separation should probably be greater for contaminated exhaust. Ideally, exhaust gas should be vented at above roof level [13].

Fig. 1 An industrial fan mounted in a window can be used to create negative pressure. Mounting at floor level is preferable if this does not create a hazard. Door springs can be adjusted so that the door remains ajar when the exhaust fan within the room is operating normally. This provides a crude method for monitoring air changes

Modify air-conditioning systems to introduce more fresh air, eliminating re-circulation of gas if possible. Any recirculated gas should pass through a HEPA filter. These filter 99.97% of 0.3-μm particles. "HEPA-like" filters may be less efficient. Additional outdoor air may be introduced via windows in selected locations. Air should flow from "clean areas" (e.g. staff and common areas) to "contaminated areas" (i.e. the patients' rooms) and out to the external environment. Carry out airflow studies using smoke tests to ensure stagnation of air does not occur [12]. If such modifications are not possible, portable HEPA filters may be useful, but care should be taken to avoid creating turbulent air flow.

Hand hygiene facilities (alcohol-based hand-rub and hand-washing basins) should be easily accessible in the patient area and at each of the gowning-up and gowning-down areas.

Use a separate entrance and exit to "contaminated" areas, with separate areas to don and remove PPE, in order to minimize the risk of contamination of staff prior to donning PPE. Install additional hand hygiene facilities at the entrance and exit and create space at the entrance in which to store PPE. Site an emergency decontamination area, including a shower, close to the exit. In addition, provide facilities to allow staff to shower at the end of each shift. Staff rest areas, bedrooms for resident medical staff and offices should be sited in low-risk areas with no re-circulation of air from patient areas. Site additional offices away from the ICU. This allows staff to carry out administrative and teaching duties with minimal risk of infection and, with appropriate rostering, may allow those who are quarantined to return home for short periods.

Standard recommendations for piped gas and electrical outlets [10, 11] are sufficient but an additional suction port per bedspace may be required to facilitate scavenging of expired gas from mechanical ventilators.

It is important to realize that the physical modifications to the ICU may reduce the bed capacity.

ICU equipment

Modifications should be made to maximize source isolation. If airborne spread is a possibility, these should include use of high efficiency, preferably pleated hydrophobic [14], bacterial/viral filters in ventilator circuits and bag mask ventilation systems, closed suction systems and scavenging of expired gases. Non-invasive ventilation is not recommended because of the risk of increasing airborne transmission [15, 16, 17]. When purchasing equipment consider staff familiarity with the equipment and that the proportion of patients who require advanced organ support is likely to be higher than usual as a result of stricter triage. Equipment purchases should be proportionate to the availability of reserve staff.

Personal protective equipment

In general, ensuring a greater degree of protection must be balanced against greater cost, discomfort and difficulty in carrying out tasks. Standard PPE which should be stocked in preparation for an epidemic are disposable negative pressure respirators, waterproof gloves, protective long sleeve gown, cap, full face shield and eye protection (e.g. goggles).

Currently available devices for respiratory protection include surgical and surgical-like masks, negative pressure respirators and powered air-purifying respirators (PAPR). Surgical masks have limited ability to protect the respiratory tract [18, 19, 20, 21, 22, 23] and masks of a similar design, but with improved filtration efficiency (e.g. laser masks) also appear to perform poorly [24]. Although one study suggests that surgical and N95 masks offer similar protection against SARS in vivo, methodological flaws in the study mean that these data should be interpreted with caution [25].

Negative pressure respirators are recommended for protection against airborne pathogens [12]. In general respirators meeting the United States N95, P95 or R95 standard or above or the European Union FFP2 or FFP3 standard are suitable. However, for these masks to work effectively they must have a tight seal around the face. To ensure that the seal is adequate CDC recommend that each member of staff be fit-tested to find a model that provides an adequate seal. This is important as the average penetration by ambient aerosol was found to be 33% for unfitted disposable N95 respirators, compared with 4% for fitted respirators. Importantly, for a given model of respirator the proportion of volunteers in which an adequate seal was obtained varied from 0% to 88% [26]. It is therefore vital to carry out formal fit testing for all staff likely to be exposed to infected patients. We recommend quantitative testing using an ambient aerosol particle counter, such as the Portacount (TSI, St. Paul, Minn., USA). The manufacturer states that there is no possibility of cross-infection from the device. As not all staff will successfully fit the initial mask, testing each member of staff takes an average of around 30 min. There are no effective alternatives to formal fit-testing. A user seal check was found to be incorrect 25–29% of the time [27]. No form of tight fitting negative pressure respirator is effective in bearded subjects [28]. We recommend disposable filtering facepiece respirators rather than the less comfortable reusable elastomeric masks which require decontamination after use.

While PAPRs provide a high level of protection, they have a number of disadvantages which make them less suitable for routine use:

- Advantages:
  - Do not require fit-testing.
  - Can be used in subjects with facial hair.
  - Expected to reduce the risk of transmission of air borne pathogens by about 240 times.
  - Comfortable to wear.
  - Provide some splash protection.
  - Models are available which integrate into a full body protective Tyvek suit.
- Disadvantages:
  - Require decontamination after use.
  - Not all models are easy to remove without becoming contaminated. They may be best used in conjunction with a decontamination shower. This may result in significant logistic problems as PPE should be removed when staff use the toilet or go for meal breaks.
  - Battery life of around 8 h may not be adequate.
  - Not all models have a low flow alarm when the battery starts to run flat.
  - Not all models can have the battery changed without changing the entire unit.
  - Not all models can be charged without removing the battery.
  - Some models are so noisy that it is impossible to work without using radio communications or perform auscultation with a conventional stethoscope.
  - Smaller staff may complain of back pain from wearing the belt mounted filter pack.

However, the major improvement in safety warrants their use when performing high-risk procedures such as intubation, bag-mask ventilation and bronchoscopy or for staff who cannot be adequately fitted with a negative pressure respirator. If such devices are used, the issues of how and where they can be charged, how they can be decontaminated after use, and how the filters will be changed and disposed of need to be considered. In addition, a policy decision should be made regarding emergency re-intubation following accidental extubation. Donning PAPR takes 3–5 min, during which time the patient is not ventilated.

Although surgical helmets appear similar to PAPR and were used during the SARS epidemic [29], their efficacy in reducing the ambient particle count is similar to that of surgical masks [23, 29, 30] and they are not recommended.

Protocols

Protocols should be developed for donning and removing PPE, safe handling of contaminated PPE, managing the unprotected staff areas (e.g. toilets, showers and rest areas), monitoring staff health, quarantine of staff, transport of patients, high-risk (e.g. aerosol generating) procedures, use of respiratory equipment, visiting, and cleaning and disinfecting equipment and the environment. In formulating policies on visiting, consider the risk of spread of the disease in the community, the difficulty of ensuring adequate PPE for visitors (e.g. fit-testing negative pressure respirators) and the need to supervise visitors to prevent lapses of infection control. For a disease of moderate or high infectivity a ban on visiting may be reasonable. The benefit from aerosol-generating procedures should be carefully balanced against the potential for increased disease transmission. Details of protocols used at our hospitals are given in the ESM.

Training

Infection control training is vital. Despite an infection control policy that stressed use of negative pressure respirators a substantial proportion of ICU staff believed that a paper and/or surgical mask was adequate protection against SARS [31]. Training should include the principles of how PPE function and an assessment of competence in their use (see Table 3). The risk of staff infection with SARS, despite the use of PPE, was associated with having less than 2 h of infection control training and a lack of understanding of infection control procedures [32]. Although the emphasis of training should be on personal protection it is important to stress that improper use of PPE increases patient nosocomial infection [33].

Enforcement

Allocate a member of staff (who need not be trained in intensive care) to ensure compliance with infection control procedures, particularly in the early stages of the epidemic when compliance may be poor [34, 35].

Staffing

When planning for an epidemic take staff illness into account. An estimated 40–70% of staff may not be able to work during an influenza pandemic [1]. Vaccination may help to reduce staff sickness and should be actively encouraged if an effective vaccine is available. Similarly, consider prophylactic treatment for staff, if available. Plan staffing and rostering to avoid overstressing staff. In particular, consider the problems of assimilation of less well trained additional staff into the team.

Nurses

Important issues include the time spent donning and removing PPE, need for additional rest days to counter the effect of increased work stress, changes in skill mix of staff (increase in the proportion of nurses with little ICU experience), increased administrative burden on senior nurses and need to allocate nurses to enforce infection control procedures. As a result nursing manpower should be increased by 20–25%, even without an increase in bed numbers. Should it be necessary to increase bed numbers, increase nursing manpower beyond the number predicated by an increase proportional to bed numbers. Appropriate nurse-patient ratios depend on the roles carried out by nurses, the usual nurse-patient ratio, the lay-out of the

Table 1 Recommended nurse staffing during an epidemic in units which normally operate with nurse-patient ratios of 1:1–1:1.5. The appropriate level of staffing depends on the roles carried out by nurses, the usual nurse-patient ratio, the lay-out of the ICU and the skill mix of the staff. “Resident” nurses refers to nurses working in the ICU prior to the epidemic

Category	Recommended minimum	Notes
Clinical bedside nurses	One nurse per ICU patient on every shift One additional nurse for each 4–10 patients One or two resident nurses to each newcomer	Clinical bedside nurses are defined as nurses whose primary responsibility is direct patient care.
Team leaders	One or two per shift depending on the size of the ICU	In very small units (< 6 beds) it may be possible for the team leader to take on more than one role.
Infection control nurse	One per shift	Role is to ensure compliance with infection control procedures including proper use of PPE and environmental cleaning procedures. This nurse need not have had specific ICU training.
Nurse specialist	One per ICU	To provide training and support for new staff.
Nurse administrators	One or two per ICU depending on size	The administrative workload is markedly increased during an epidemic with the need to increase communication, coordinate deployment and training of new staff and need to ensure an adequate supply of PPE, equipment and consumables and to implement expansion plans.

ICU and the skill mix of the staff. The figures given in Table 1 are recommended for units which normally operate with nurse-patient ratios of 1:1–1:1.5. Units that have developed working practices which allow for a lower number of staff will need proportionately fewer staff. Nevertheless the net effect of these recommendations is that intensive care bed capacity cannot be increased by more than 50–100%.

Ancillary staff

Daily practices should be examined to determine which duties could be carried out by non-clinical staff and appropriate measures taken to identify and train staff that can be drafted into the ICU to carry out these duties. Pay particular attention to ensure that there are sufficient cleaners to ensure compliance with environmental infection control measures. Ancillary staff had a higher rate of infection in the SARS epidemic [36]. They must receive infection control training.

Medical staff

The appropriate number and skill mix of medical staff is highly dependent on local factors and on the epidemic disease. In well staffed units with very experienced staff it may be unnecessary to increase medical staffing unless there is an increase in bed numbers. This is because the time taken to don and remove PPE is counterbalanced by the fact that care is simplified by the uniformity of disease. However, in many units staffing will need to be increased. In large ICUs one senior physician should be allocated solely to coordinate with other departments. The following are recommendations for minimum staffing in an ICU where a large proportion of the medical staff are relatively inexperienced:

– Daytime: either (a) one ICU specialist and one junior ICU trainee/non-ICU physician for every 8 patients or (b) one ICU specialist, one senior ICU trainee and one junior ICU trainee/non-ICU physician for every 10–12 patients
– Nightime: one resident ICU specialist, one senior ICU trainee and one junior ICU trainee/non-ICU physician for 18–20 patients

Rostering

Take into account the need to maintain staff well-being and morale and reduce the magnitude of potential staff–staff transmission. During the SARS epidemic a significant proportion of Toronto's ICU capacity was lost because a large number of ICU staff were quarantined [6]. Consider dividing nurses into teams, giving nursing staff an additional day off per week and avoid nurses working for more than 4 or 5 consecutive days.

Medical rosters should avoid very prolonged shifts (in excess of 24 h) as these are associated with attention failures and increased errors in patient management [37, 38]. It is highly likely that they are also associated with errors in infection control.

Consider giving all staff rest periods which exceed the duration of the incubation period. This may provide intermittent reassurance that they are not infected and allow quarantined staff to return home intermittently.

Identifying additional reserve staff

Maintain a register of staff with previous ICU experience, with their consent. When identifying other potential reserve staff, bear in mind that departments of internal medicine and emergency medicine are likely to be overstretched and unable to contribute staff. In contrast, it is likely that elective surgery will be postponed, freeing staff from departments of anaesthesia and surgery.

Training

The aims are to train additional reserve staff so that they can be rapidly assimilated into the ICU team during an epidemic and to train both current and reserve staff in infection control measures. Inadequately trained staff should not work in the ICU. The risk to patients and themselves cannot be justified.

Conduct training in advance as training during an epidemic is difficult. Pre-epidemic training for reserve staff should cover two main areas: intensive care medicine or nursing (Table 2) and infection control (Table 3) [17]. During the epidemic give reserve staff a refresher programme on both intensive care medicine or nursing and infection control, with emphasis placed on knowledge and infection control measures relevant to the epidemic disease. Much of the recommended material for physicians is covered in two readily available teaching packages: Fundamental Critical Care Support (http://www.sccm.org/education/fccs_courses/index.asp) and Basic Assessment and Support in Intensive Care (www.aic.cuhk.edu.hk/web8/BASIC.htm).

Ethical issues

Drafting staff to work in ICUs may be necessary if there are insufficient volunteers. This process should be fair, transparent, participatory, understood and publicized before the epidemic. It is intrinsically difficult to set the

Table 2 Recommended syllabus for pre-epidemic training for reserve physicians and nurses

Topic	Specific areas of importance
Physicians	
Infection control	Prevention of nosocomial infection, prevention of patient-staff transmission
Assessment of the critically ill patient	Recognition of critically ill patient, importance of estimating time available for assessment prior to resuscitation, need for simultaneous resuscitation and further or repeated assessment
Airway management	Bag mask ventilation, use of artificial airways, insertion of laryngeal mask, preparation for tracheal intubation; the panel specifically do *not* recommend teaching tracheal intubation itself
Haemodynamic monitoring	Assessment of tissue perfusion, non-invasive blood pressure monitoring, invasive blood pressure and central venous pressure monitoring; practical instruction on insertion of central venous and arterial cannulae
Cardiovascular support	Rapid assessment of the type of shock, fluid resuscitation, inotropes and vasopressors, recognition and management of arrhythmias
Acute respiratory failure	Pathophysiology, respiratory monitoring, oxygen therapy, indications for intubation and mechanical ventilation
Mechanical ventilation	Basic principles, common modes of ventilation, troubleshooting, ventilation of patients with obstructive airways disease and acute respiratory distress syndrome, sedation
Oliguria and acute renal failure	Management of oliguria, indications for renal replacement therapy, treatment of hyperkalaemia
Other organ failures	Recognition and supportive management of neurological, haematological and hepatic failure
Metabolic and electrolyte abnormalities	Management of severe sodium or potassium disturbances, management of diabetic ketoacidosis and hypoglycaemia
Investigations	Interpretation of supine chest radiography, interpretation of arterial blood gases
Miscellaneous	Nutrition, stress ulcer prophylaxis, deep vein thrombosis prophylaxis
Nurses	
Infection control measures	Need for infection control and infection control policy in the ICU
Basic nursing assessment of the critically ill patient	–
Basic bedside equipment	Basic principles, operation and trouble-shooting of bedside equipment. Interpretation of parameters in relation to patient's clinical state
Respiratory nursing care	Practical instruction on arterial blood sampling, basic artificial airways; types of oxygen devices in ICU
Mechanical ventilation care	Basic principles, common modes and trouble-shooting; practical instruction on care of patients with endotracheal tubes; basic principles and operation of the scavenging system for expired gas
Cardiovascular care	Recognition of life-threatening cardiac arrhythmias; practical instruction on setting up, interpretation and trouble-shooting of arterial line monitoring; basic interpretation of 12-lead ECG
Pharmacology	Recognition of the preparation, effect and side effect of common drugs used in critically ill patients
Nutrition	Basic principles and safe adminstration of artificial feeding in critically ill patients
Psychological support to patient and family	Recognition of the psychological needs of a critically ill patient and his family

limits of professional duty of care in terms of acceptable risk [39]. Individuals, professional bodies and society need to weigh the risks and consequences of infection against the duty of healthcare workers to care for the sick. It is important to be aware that the "duty of care" is not unilateral. The principle of reciprocity dictates that healthcare institutions provide reasonable workplace protection for staff [39]. This duty includes providing environmental safety, provision of protective equipment and general measures such as psychological support and guaranteed insurance for illness or death.

Quarantine of health workers also has ethical implications [40]. Loss of individual liberty must be balanced by the demonstrable need for restrictive measures to protect society. Measures must be the minimum that are necessary [41]. Note that staff who are not quarantined are more likely to fulfil their professional duties [42]. The principle of reciprocity requires that proper preparation be made to minimize suffering resulting from quarantine [39, 43]. Adequate food, living environment and communication facilities should be available [41]. This is logistically difficult and requires substantial forward planning.

Table 3 List of recommended topics for infection control training

Topic	Specific areas of importance
Modes of disease transmission and prevention	–
Environmental control	Setting up areas for donning and removing PPE; cleaning and disinfection of environment
Patient care practice	Appropriate modification in the delivery of respiratory therapy. Proper management of secretions and excrement
Personal protective equipment (PPE)	Basic principles and practical instruction in proper mask fit-checking, donning, wearing, removal and disposal of PPE; when to change PPE (note that training on how to remove PPE is at least as important as how to don PPE); types of high-risk procedures and the additional precautions required. Compulsory fit testing of negative pressure respirators
Hand-hygiene	–
Equipment	Cleaning and disinfection of equipment; modifications to respiratory therapy equipment
Handling of specimens and medical records, management of linen and waste	–
Infection control measures outside the clinical area	Infection control measures in non-clinical areas (e.g. rest areas, toilets) and at home

The principles of triage [2] are largely unchanged by an epidemic although thresholds will require adjustment. If priority is to be given to persons thought essential to maintain health services or stable societal function (e.g. healthcare professionals, political leaders, police), justification for such decisions should be drawn up in advance and publicized [44].

The moral principles of justice and transparency also require that equity be maintained between victims of the epidemic and those who still require treatment for other diseases. Diversion of resources from essential services should be carefully considered on the basis of the principles of justice and utility. Well considered procedures to deal with the setting of these priorities should be developed in preparation for the next epidemic.

Counselling and stress reduction

During an epidemic risk of infection is a constant concern for healthcare staff [7]. High stress during the SARS epidemic was common, particularly amongst younger staff, nurses and those who perceived their health to be poor. Correctable factors associated with psychiatric morbidity were perceived inadequacy of: counselling and psychological support, insurance and compensation, feedback from frontline staff to administrators, clarity of infection control procedures and protective facilities, and temporary residential arrangements [45]. Prior liaison with counselling services may facilitate patient, family and staff counselling during the epidemic. Peer support groups for staff should be considered.

Communication

Develop a crisis communication plan and nominate a senior member of staff to be the ICU spokesperson [46]. This person should have the ability and authority to make decisions on behalf of the ICU and will usually be the ICU director or his deputy. The communication plan should include channels of communication with hospital administration, other hospital units and ICUs in other hospitals, as well as with staff and relatives. Daily briefing and debriefing sessions with staff are vital to inform them of the status of the epidemic and changes in policies and protocols and to facilitate feedback, but it is equally important to communicate with staff not rostered to work.

Develop modes of communication that minimize the need for face to face communication. Telephone, videophone, videoconferencing, email, intranets and the Internet were used successfully during the SARS epidemic.

Changes in methods of communication between staff and patients' relatives may be necessary, particularly if visiting is prohibited. Daily phone calls by medical staff to a telephone number specified by the family may be the best compromise between minimizing risk for families and maintaining confidentiality.

Discussion

It is important to note that there is no direct evidence to support (or refute) many of these recommendations, which are based on achieving what we consider a reasonable standard of intensive care. We have tested the feasibility of most recommendations in our units, but ease of implementation and standards may vary between healthcare systems and this should be taken into account at the planning stage. If the recommendations are not achievable, a choice will need to be made between providing fewer beds or a lower standard of care (see ESM: anticipating bed requirements).

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