Chemical Biological Radiological Annex

to the Queensland Health Disaster Plan

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Published July 2015

Authorisation

The Queensland Health Chemical Biological Radiological Annex (the annex) is issued under the authority of the Director-General, Queensland Health, in accordance with the Disaster Management Act 2003. It is an annex to the Queensland Health Disaster Plan.

The annex applies to all Queensland Health services, other entities under the control of Queensland Health and those entities listed within, and provides for the effective and timely management of natural, accidental, criminal or terrorist related releases of chemical, biological and radiological agents into the community in Queensland.

The annex is maintained by the Chief Health Officer on behalf of the Director-General, Department of Health.

Tasking Agency Endorsements

This annex has been developed in collaboration with members of the emergency response tasking agencies and has been endorsed for application within those agencies:

_____

Dr Jeannette Young
Chief Health Officer
Department of Health
Date

_____

Ms Katarina Carroll
Commissioner
Queensland Fire & Emergency Services
Date

_____

Mr Russell Bowles ASM
Commissioner, Queensland Ambulance Service
Department of Health
Date

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Part I: Structure and governance

1.1. Purpose and scope

The purpose of this Queensland Health Chemical, Biological and Radiological Annex is to provide a consistent response framework for planning and management of chemical, biological and or radiological incidents to support the Queensland Health Disaster Plan. This annex may be used as a guide by Queensland Health facilities to assist in the development of local plans.

The annex outlines responses specifically applicable to chemical, biological radiological events. These will occur in addition to the generic major incident responses as outline in the Queensland Health Disaster Plan. The annex details the arrangements necessary to undertake disaster management for natural, accidental, criminal or deliberate release of chemical, biological or radiological agents into the community.

Activation of the annex occurs in conjunction with the Queensland Health Disaster Plan. Reporting arrangements in a CBR incident occur as outlined in the QHDP with recognition that certain changes may be necessary to address the unique challenges posed by this type of incident. These are outlined in this annex.

1.2. Governance

Monitoring and review

The annex shall be reviewed at the following times:

- annually
- following the activation of the plan in response to an event
- within one month of any exercise designed to test the effectiveness of the annex and/or on the introduction of any major structural, organisational or legislative changes that affects Queensland Health operations.

1.3. Legislation acts and plans

The *Queensland Disaster Management Act 2003* and the *Disaster Management and Other Legislation Amendment Act 2010* provide the legislative basis for disaster management arrangements in Queensland.

Part II: Prevention and preparedness phase

2.1. Introduction

Chemical, biological and radiological (CBR) agents have the potential to seriously threaten the health of the community, as well as to seriously disrupt normal community function. They also pose a significant risk both to property and the environment. Such agents may also engender significant fear in both healthcare providers and the general population alike, and for this reason, an incident involving CBR agents will require special arrangements from the health system in general, and Queensland Health in particular, in order to mount a successful response.

The release of CBR agents may occur either as a consequence of an accident, a liquid chlorine spill as a consequence of a road traffic crash for example, or a deliberate act, such as the 1995 deliberate release of the nerve agent sarin into the Tokyo subway system by members of the Aum Shinrikyo cult.

	Accidental	Deliberate
Chemical	Accidental methyl isocyanate release, Bhopal, India, 1984. 2500 Deaths	Deliberate release of Sarin nerve agent into subway, Tokyo, Japan, 1995 12 Deaths
Biological	Accidental smallpox infection in hospital worker, East Birmingham Medical School, Birmingham, UK, 1978	Deliberate release of Anthrax into postal system, USA 2001 5 Deaths.
Radiological	Accidental dispersal of Caesium-137 radiotherapy source by scrap metal dealers, Goiânia, Brazil, 1987 4 Deaths	Landmine with attached payload of radioactive material defused by security forces, Argun, Chechnya 1998 No Casualties

Table 1. Examples of previous CBR incidents

Chemical case study: Deliberate release of Sarin in Tokyo subway, March 20th 1995 [1,2]

Until the mid-1990's, emergency response planning in Tokyo had focussed on the traditional threats of earthquakes, floods and tsunamis. Little consideration had been given to the possibility of CBR incidents, and so little capability existed within the healthcare system to identify and address such an incident. There was no CBR plan, and no appropriate stores of personal protective equipment (PPE) existed outside the Japanese military. The hospitals had no contingency plans for decontamination of multiple casualties.

During the morning rush hour on 20 March 1995, members of the Aum Shinrikyo cult, using relatively low purity sarin and an unsophisticated delivery mechanism, staged a deliberate release of nerve agent on five trains in the Tokyo subway. This generated a surge of patients presenting to Emergency Departments (ED) across Tokyo, especially to St Luke's International Hospital, which was the closest. On the day of the attack, the St Luke's ED experienced 640 acute presentations from the incident. Overall in Tokyo, a reported 5,510 casualties sought medical treatment[3]. Of these, 12 died, 17 were critically ill, 37 seriously ill and 984 moderately ill. Six percent of the casualties were emergency services and healthcare personnel. An estimated 4,000 of the attendees had not been exposed to any significant quantity of chemical agent[4].

Fortunately, large scale CBR incidents leading to significant numbers of casualties are relatively rare. Given the extreme difficulty of conducting ethical trials in this area, much of the evidence basis for planning is based on post hoc reports from significant incidents[1–3]. Such studies are vulnerable to significant reporting bias. Further information is available from some large scale exercises, simulations, and some computer based simulations [5–7].

History shows that it is not uncommon in CBR incidents for casualties to bypass the traditional emergency pre-hospital response system, instead, self-presenting to local healthcare facilities and emergency departments[2,8]. Meticulous and careful contingency planning is necessary for such a complex incident to be appropriately managed by all the agencies involved.

Such an incident, therefore, no matter how small, carries a significant risk of having a disproportionate impact on the ability of Queensland Health facilities to effectively conduct their day to day business. Contingency planning is therefore essential, and this planning should be based on an all hazards approach.

In addition, Queensland Health's lead agency status in both biological and radiological incidents means that it may be called upon to offer specialist advice and guidance to other government stakeholders throughout such an incident.

There is a lack of consistency amongst the literature concerning CBR incidents, with some texts utilising the terms HAZMAT (Hazardous Material) incident and CBR incident interchangeably. For the purposes of this document, however, the term HAZMAT should be taken to imply accidental release of an agent and CBR to imply deliberate release.

2.2. Planning

Relevant Queensland Health facilities should have a local CBR plan which is appropriate, scalable and proportionate to their likely risk of being involved in the response to a CBR type incident. Such plans should adopt an all hazards approach, but should also be based on a thorough risk assessment of likely local threats (e.g. organophosphate poisoning in a rural area, hydrofluoric acid near to fuel refineries, radioactive isotopes in ports accepting visits from nuclear powered vessels etc.).

The local CBR plan should be regarded as a whole of hospital responsibility, rather than simply the responsibility of the emergency department (ED), since significant extra human resources may be required to address the needs of a CBR incident, some of which will require training in a new skillset,

rather than specialist emergency knowledge. Such a plan should also be capable of being implemented 24 hours a day, seven days a week if required. Staff who are expected to be involved in such a response must be provided with adequate training in skillsets appropriate to their role. Essential components of any response plan may include:

- notification procedures
- decontamination plan and procedures
- appropriate identification and training of staff
- adequate lockdown procedures
- planning of triage and treatment processes
- facility recovery procedures.

It is essential that the local CBR plan should not only provide procedures which accommodate a range of circumstances ranging from arrival of casualties by the Queensland Ambulance Service (QAS) to the arrival of contaminated patients by personal transport, but should also allow appropriate lock down of areas or an entire facility in order to protect patients, staff and infrastructure from potential cross contamination. Local plans should also include contingency planning for situations where the facility's capability to decontaminate patients becomes overwhelmed, in which further assistance from other Queensland Health facilities or government agencies, such as Queensland Fire and Emergency Services (QFES) may be required. Pre-agreed arrangements with potential partner agencies may also be appropriate.

Relevant communication planning is also of the utmost importance, since such an event is likely to engender significant media interest, as well as obvious concerns amongst the local population.

Effective crisis communication in the context of a CBR incident serves to[9]:

- increase the likelihood of at-risk members of the population taking appropriate protective measures
- reassures members of the population at lower risk.

Crisis communication during an incident should be heavily coordinated at a state level to ensure a consistent message is delivered. The public message should be based on:

- building trust
- announcing information early
- communicating transparently
- listening
- planning.

2.3. Notification

Facilities may become aware of the existence of an incident via either:

- pre-alert from the QAS
- pre-alert from the Queensland Health Retrieval Services and Counter Disaster Unit
- arrival of unannounced casualties at the facility
- identification at a facility of a cohort of patients presenting with similar signs and symptoms
- early warning systems, notifications and or advices.

Any of these events should trigger activation of the relevant local facility plan. In addition to the usual activities associated with disaster plan activation, the following may also be required:

- alerting security personnel and liaising with police or other agencies as required
- sourcing PPE

- preparatory briefing of staff to familiarise them with the processes of triage, decontamination and treatment outlined in the facility plan
- contacting medical physicist or radiation personnel so that arriving patients may be screened for the presence of radioactive contamination (if required).
- Public Health input to assist with response and recovery.

2.4. Facility lockdown

In order to protect Queensland Health facilities, staff, patients and visitors from contamination it is necessary to secure critical areas within the facility, in the event of a CBR incident. Movement between critical areas must not be impeded; however, access into critical areas from outside must be controlled. Specifically, no patient or personnel from the incident site should be granted access without being assessed under the universal decontamination algorithm (See Appendix 2) and decontaminated if necessary.

Facility staff must all be familiar with the facility lockdown procedure if security breaches, such as doors being reopened and left open, are to be avoided. Use of a facility public address system may also facilitate this staff awareness.

Clearly, it must be possible for staff who have been called in to assist to access the facility, but such entry should be via an access control point, and no one should be admitted without correct identification being provided.

Critical areas are those areas necessary for the treatment of patients. They include, but are not limited to:

- emergency department
- intensive care unit / high dependency unit
- theatres
- diagnostic facilities (x–ray, CT scan)
- pathology labs
- pharmacy
- ward
- central plant.

It follows, therefore, that an essential feature of any healthcare facility CBR plan is the capability to carry out an effective lockdown of the facility in the event of a CBR mass casualty incident. Past exercises have demonstrated the critical importance of good perimeter security for healthcare facilities in the event of a CBR incident involving mass casualties[10].

A previous high fidelity simulation of the hospital consequences of a CBR mass casualty incident in Adelaide makes the following points about perimeter security and lockdown:

- Most perimeter breaches were due to staff being unaware of the lockdown, and reopening doors. Staff education and tannoy announcements may mitigate this risk.
- Many windows may provide easy access if broken, and may require reinforcement.
- Staff policing the perimeter may encounter contaminated patients, and should have access to appropriate PPE and training in its use.
- Formal barriers to movement are cumbersome and hard to handle for staff in PPE. Simple barrier tape hung from bollards was found to be better at defining boundaries and was easier to use.

Prior planning and preparation of appropriate crowd control measures should incorporate the fact that items such as boundary tape, bollards etc. may require handling and assembly by staff who may be encumbered by varying levels of personal protective equipment, and, therefore, be capable of less

physical activity than usual[13].

If it is anticipated that facility security staff might become easily overwhelmed in such an incident, then discussion with the local Queensland Police Service (QPS) should occur as part of contingency planning in order to develop a support plan which seeks to mitigate this risk.

In order to achieve lockdown safely, facility security staff will require to have received prior training in use of appropriate personal protective equipment. Perimeter security is likely to be the responsibility of HHS Protective Services Officers, or possibly QPS, depending upon local arrangements.

2.5. Personal protective equipment

CBR events engender significant fear in the general population, and a similar phenomenon may be exhibited in healthcare staff if they are inadequately trained and do not have sufficient faith in their PPE.

The United States Environmental Protection Agency (EPA) defines 4 levels of PPE, as outlined in table 2.

Level	Requirement	Examples
A	Required when the greatest potential for exposure to hazards exists, and when the greatest level of skin, respiratory, and eye protection is required.	• positive pressure, full face-piece self-contained breathing apparatus (SCBA) or positive pressure supplied air respirator with escape SCBA; • totally encapsulated chemical- and vapour-protective suit; • inner and outer chemical-resistant gloves; and • Disposable protective suit, gloves, and boots.
B	Required under circumstances requiring the highest level of respiratory protection, with lesser level of skin protection.	• positive pressure, full face-piece self-contained breathing apparatus (SCBA) or positive pressure supplied air respirator with escape SCBA; • inner and outer chemical-resistant gloves; • face shield; • hooded chemical resistant clothing; • coveralls; and • Outer chemical-resistant boots.
C	Required when the concentration and type of airborne substances is known and the criteria for using air purifying respirators is met.	• full-face air purifying respirators; • inner and outer chemical-resistant gloves; • Disposable chemical-resistant outer boots. • hooded chemical resistant clothing; or coveralls

D	The minimum protection required. Level D protection may be sufficient when no contaminants are present or work operations preclude splashes, immersion, or the potential for unexpected inhalation or contact with hazardous levels of chemicals.	• gloves; • coveralls; • safety glasses; • facemask (N95 or surgical); and • Chemical-resistant, steel-toe boots or shoes.

Table 2. Levels of Personal Protective Equipment

The literature contains several examples of adverse health effects in responders and health care workers who have handled patients in chemical incidents whilst wearing no or inadequate PPE[11–18].

The simplest solution to the issue of healthcare staff PPE may initially appear to be to equip all responding staff with level A PPE, on the basis that it provides the highest possible level of protection. There are, however, significant disadvantages to this approach. Self-contained breathing apparatus, as required for a level A protective ensemble, is highly technical, and requires very high levels of both maintenance and training if it is to be used safely and effectively by staff. Operators who are unfamiliar with such equipment may paradoxically expose themselves to situations of increased risk by failing to utilise such equipment properly. Such units are also heavy, and place significant physical demands upon users, as well as rendering users perhaps more vulnerable to such hazards as heat stress. In addition, all PPE confers a loss of mobility, dexterity, vision and ability to communicate freely[19].

Some authors have advocated for the other extreme, i.e. use of Level D ensembles by all healthcare providers[20]. As with most such issues, the reality is likely to lie somewhere between the two extremes.

Advice from QFES Scientific Branch, as well as consensus statements from the Australian Government suggests that personnel operating inside the hot zone need to use level A or B ensemble, whilst personnel operating in ambulances and at sites remote from the actual incident scene (i.e. outside the hot zone) should wear level C PPE[21,19].

It is anticipated that the vast majority of health staff who might be involved in the response to such an event will fall into the latter, level C, category.

Whilst appropriate PPE serves to protect health staff from contaminants, it is also vital that staff wearing such ensembles are protected from the not insignificant risk of hyperthermia precipitated by physical work in such PPE. Appropriate work/rest cycles are essential, as well as adequate access to shade, fluids and rest. One paper from the Northern Territory which assessed heat stress in CBR responders performing a 30 minute rest/work cycle in an ambient temperature of 31.4^{o}C recorded peak core body temperatures above 40.4^{o}C in three out of sixty participants[22].

Whatever PPE is selected, it is obviously vital that staff are fully trained in its use and that the equipment is used in full accordance with the manufacturer's instructions and properly fit tested etc.

2.6. Patients

Patients will fall into the following broad categories:

1. "Walking wounded". These patients are capable of self-decontamination in the designated decontamination facility.
2. "Worried well". In the emotive context of a CBR incident, facilities may experience the arrival of potentially large numbers of concerned citizens who are asymptomatic and have little or no history of exposure to any agent. Facilities should have contingency plans to separate and observe such patients for evidence of deterioration. Such plans may involve close cooperation between security staff and the QPS.

3. Non-ambulant patients. These patients will require decontamination by health personnel in appropriate PPE.
4. Non-incident patients. Seriously ill non-incident patients may well continue to arrive during the course of the emergency response. Such patients should be kept separate from potentially contaminated patients.

2.7. Triage

Patients presenting after a CBR incident may have both traumatic injuries in addition to injuries caused by the CBR agent. In general, standard triage principles will apply, with arriving casualties triaged according to the Triage SORT algorithm as taught in the Major Incident Medical Management and Support (MIMMS) and Hospital MIMMS courses[23,24]. As a general principle, CBR injuries, when combined with conventional traumatic injuries, tend to have a synergistic effect, meaning that morbidity and mortality from combined injuries tend to be greater than the sum of the parts[25]. This is especially true of CBR injuries combined with thermal burns[26,27].

Patients should be triaged with the intent of doing the most good for the highest number of people with the available resources. Aspects of triage unique to chemical, biological or radiological injury are further discussed in the relevant section.

It should also be remembered that such patients may well be suffering from very high levels of emotional distress. Care should be taken to ensure that these patients are provided adequate access to appropriate interventions such as crisis counselling.

Patients should be triaged outside the facility, away from the Emergency Department entrance in order to prevent contamination of the interior of the building. It should form the single point of patient entry for the facility during the incident.

2.8. Layout of the decontamination area

The decontamination area should be identified in advance, with the necessary infrastructure to configure it either fixed in place or readily available from storage. This infrastructure may vary from extensive dedicated facilities to simple improvised decontamination using items such as screens, buckets and clinical waste disposal bags.

It should consist of the following features.

- **A patient undressing area.** This area should be screened from view to provide privacy. Seating and waste bins with plastic waste bags should be provided to facilitate undressing. The undressing area should lead into;
- **A shower area.** This should be appropriately drained and should incorporate flow stops to prevent contaminated effluent from flowing into adjacent areas. Adequate supplies of soap should be provided. The shower should exit into;
- **A re-robing area.** This should ideally be temperature controlled to avoid hypothermia. Seating should be provided, as well as adequate stocks of re-robing packs.

The exit from the shower into the re-robing area is the edge of the warm zone, and should be regarded as a clean-dirty line. Any staff moving from the clean side to the dirty side must wear appropriate PPE. All staff and equipment passing from the dirty to the clean side should undergo appropriate decontamination.

2.9. Decontamination

Decontamination is the process of removing or reducing the concentration of harmful substances. A person may become contaminated by contacting toxic substances in the form of a vapour, gas, mist,

solid or liquid from the actual source, or in cross contamination, from others who are already contaminated[28].

The generic process of decontamination is outlined here. The specifics of the decontamination process with respect to individual substance types will be outlined in the relevant chemical, biological or radiological section of the document.

Contamination of patients may be external, where the noxious agent is either in close proximity or adherent to the patient's body, or internal, where the noxious agent has been physically ingested. Decontamination processes exist to deal with both of these eventualities, but for the purpose of this document, decontamination refers to the process of external or surface decontamination.

The aims of decontamination are to[29]:

- Achieve a measurable improvement in patients' acute health outcomes by reducing short-term morbidity and mortality.
- Achieve a measurable improvement in patients' long-term health outcome by preventing delayed morbidity.
- Protect the health of responders and receivers by preventing their secondary contamination.
- Assure the best health outcome for the most patients.

The decision whether or not to decontaminate a patient, and their priority for decontamination should take into account the following:

- **Patient symptomatology:**
  - Evidence suggests that toxidromes, or constellations of symptoms, can be utilised to distinguish between affected and unaffected patients[30–32]. It should also be remembered, however, that there may be significant overlap between symptoms described by those who have been poisoned and those who are experiencing an acute stress reaction[32].
  - Children should be decontaminated before adults within the same priority group since their high surface area to volume ratio compared to adults may lead to higher absorption through dermal contact than adults[33].
- **Visible contamination:**
  - Visible evidence of contamination on the patient of their clothing. Such evidence indicates ongoing exposure with a prolonged contact time[32,34].
- **Proximity:**
  - Individuals who are in close proximity to the release may well have already been identified by QFES and QAS, and been decontaminated at the scene. For the contaminated patient, however, proximity to the release may be directly proportional to contaminant dose, and therefore may increase their need for decontamination[32–35].
- **Detection:**
  - There is little mention within the literature of detection devices, but appropriate devices operated by trained staff could also be used to guide need for decontamination.
- **Nature of agent:**
  - In a HAZMAT incident, the name and nature of the chemical may be known at the scene and passed back to the health facility. Some agents may not require the patient to be decontaminated at all. In a CBR incident, however, it is unlikely that an agent will be identified rapidly, and, even then, the information may be incorrect[2,16]. Knowing the characteristics of the agent may help guide decontamination decisions, for example a liquid versus a gaseous agent[36].
- **Patient request:**
  - Prior thought should be given to whether or not a demand from a patient to be

decontaminated will result in their being automatically offered decontamination. Prior CBR incidents have resulted in significant numbers of "worried well" attending healthcare facilities, so careful consideration should be given to this scenario during planning[4].

2.9.1. Who NOT to decontaminate

Patients meeting the following criteria are unlikely to pose a significant risk of secondary contamination:

- Those who are asymptomatic.
- Those who have no visible contamination on clothing or skin.
- A history which makes exposure unlikely (for example, not near the location of release of the agent).

The exact requirements and procedure for patient decontamination are described in Appendix 1 however, the following general principles apply:

- Those who can self-decontaminate should do so.
- Adult only facilities should still maintain a capability to decontaminate paediatric patients
- Decontamination should occur away from the entrance to the Emergency Department in a designated, dedicated area.
- The most important principle is speedy removal of the agent[37].
- 80-90% of contaminants are removed simply by the patient disrobing.
- The mainstay of decontamination is the use of large volumes of low pressure tap water.
  - Showering with water results in contaminant removal via mechanical action rather than neutralisation[38–41].
- Ideally water should be at a tepid temperature[40,41].
  - Water that is too cold may result in hypothermia, whilst water which is too hot may result in enhanced dermal absorption of contaminant.
- Addition of soap enhances the efficacy of decontamination, but if not easily available, the process should continue using just water[42–47].
- Decontamination should involve thorough soaking of the patient with water, and showering should last no more than three minutes, unless expert advice is received to the contrary.
  - Studies have demonstrated a "wash-in effect" from excessive decontamination, in which prolonged skin washing results in a paradoxical increase in absorption of contaminants[48–50].
- Decontamination may be facilitated by the use of a nonabrasive sponge or washcloth[48].
  - This should be discarded as contaminated and replaced for each patient
- Patients should only be decontaminated if:
  - they are symptomatic

  or
  - they are visibly contaminated

  or
  - radiological screening indicates a radiation level of at least twice background levels.
- If only a portion of the patient is visibly or detectably contaminated, then it is only necessary in normal circumstances to decontaminate that part of the patient, e.g. if only the patients arm is visibly contaminated, then it is reasonable to simply decontaminate the patient's upper limb, rather than the entire body.
- If the patient is clinically symptomatic, and has no visible contamination, then it is necessary for their entire body to be decontaminated.
- Care must be taken to reassure and support people who have personal articles such as spectacles or hearing aids removed from them[51].

- Removed clothing should be placed in a sealed plastic bag, since studies show clothing to retain significant quantities of agent and to pose a residual threat to health through off gassing, or evaporation of agent into the atmosphere[11,52–55].
- Decontamination should be viewed as an integral part of the treatment process, since it limits the patient's exposure and consequent toxicities that follow from contamination.

Decontamination is a labour intensive process and may require significant numbers of staff for it to be performed effectively. Since all patients will require care and/or assessment from the staff of the emergency department after decontamination and will be likely to absorb significant emergency department resources, it is important that decontamination is not simply regarded by facilities as being exclusively the role of the emergency department. In order to make efficient use of resources, the decontamination process should be regarded instead as a whole of facility role, and consideration should be given to utilising non-emergency department staff in decontamination roles, thus freeing ED staff to perform clinical roles such as triage and treatment.

2.9.2. Privacy during decontamination

Efforts to provide privacy for patients during decontamination may not only protect the dignity of the patient, but also facilitate increased patient compliance during the process.

Every effort should be made to use curtains or barriers to segregate patients, if not individually, then at least by gender. Some institutions have attempted to staff the decontamination process using only staff of the same gender as the patient. This is unlikely to be a viable option during an emergency response[5,56].

2.9.3. Communication during decontamination

Decontamination may be a stressful experience for any casualty, especially in the context of a mass casualty incident. Clear and precise communication with casualties will both facilitate the process of decontamination as well as alleviating their anxiety. Clearly explaining to casualties what is expected of them in the self-decontamination process as well as safeguarding their dignity by providing privacy during the undressing, decontamination and re-robing process will reassure and facilitate compliance with decontamination procedures. Published feedback from previous decontamination exercises have emphasised how poor communication in incidents increases the probability of patients attempting to bypass the decontamination process[7,57].

- The efficiency of the process of self-decontamination by patients is greatly enhanced by provision of adequate signage, ideally based on pictograms, which explains each step of the process to the patient.[58]
- License free pictographic signs are available from the Cambridge Health Alliance at http://www.cambridgepublichealth.org/services/emergency-preparedness/products/mass-decontamination-signs.php

If available, there may be an early role for mental health professionals in the post-decontamination process in dealing with psychological distress amongst patients.

2.9.4. Decontamination of children

Every effort should be made to keep children with a parent or carer throughout the process. If the child is unaccompanied then every effort must be made to reassure the child and to explain the process to them in age appropriate language. The child should also be assisted through the decontamination process. Social worker input should be sought as a matter of priority for unaccompanied minors.

Given their greater vulnerability to hypothermia, it is essential that children are closely observed during decontamination for any ill effects from cold.

Facilities must be prepared to and have a plan for the decontamination of infants. Documented methods include use of laundry baskets and infant baths to carry and decontaminate the child.

2.9.5. Assistance with decontamination

Decontamination is a labour intensive and specialised task, which requires training and correct PPE. Whilst it is important that Queensland Health facilities retain the ability to decontaminate patients, true external decontamination of mass casualties is the realm of the emergency services, specifically the QFES. QFES have specialist equipment and techniques which can be used to quickly decontaminate large numbers of people quickly; however these assets take a finite time to deploy. As part of the local plan, facilities should endeavour to reach local agreements with QFES regarding assistance and access to QFES decontamination capabilities

Should it become apparent to clinicians in the course of an incident that their facility is becoming overwhelmed, then a 000 call should be made to request QFES assistance, whilst the facility continues its best efforts to decontaminate as many patients as possible. Queensland Health facilities should plan to be capable of a minimum of one hour of independent and self-contained operation without QFES assistance.

It is possible that patients may have already undergone formal and complete decontamination at the scene of the incident. If these decontaminated patients are then transported to a health care facility, they may be considered to have been decontaminated and do not require further decontamination.

If there remains any doubt as to the adequacy of the initial decontamination measures, further decontamination is indicated prior to entry into the ED.

Further specific decontamination efforts may be indicated based upon an individual assessment (e.g. further lavage of painful eyes after exposure to a chemical irritant).

Contemporaneous documentation of triage information, labelling and management of personal effects, decontamination procedures and medical interventions for each patient is also essential[21].

2.10. Re-robing

Safeguarding the dignity of patients by providing fresh clothing after decontamination is essential. Re-robing should occur as soon after decontamination as possible, and ideally as the patient leaves the decontamination shower and crosses the clean-dirty line. Observed simulations have demonstrated that the patient re-robing process, after decontamination, may become a significant bottleneck. Having easily available pre prepared patient re-robing kits may significantly mitigate this risk.[7]

Re-robing should occur in a private, shielded area, where the patient is not exposed to direct view from other healthcare staff or patients. Young children will need assistance in this process, ideally from a parent or sibling.

Healthcare staff supervising the re-robing process should take care to replace any SMART Tag triage tags which may have been lost during the decontamination process. This may involve re-triage of the patient.

Re-robing may involve provision of hospital gowns or paper overalls. Some facilities in the United States have, in situations of overwhelming demand, successfully improvised re-robing kits by simply cutting a head hole and two arm holes into a large, opaque plastic bag[59]. Clearly, field expedient re-robing packs such as this should only be resorted to if a facility becomes overwhelmed with casualties and supplies of traditional re-robing packs have become exhausted.

2.11. Forensic aspects of CBR incidents

For obvious reasons, it is entirely possible that a CBR incident may be the consequence of a criminal act. For this reason, an investigation by the QPS may well commence in the immediate aftermath of, or even during the course of a CBR event. It is useful, therefore, for health staff to have an awareness of this possibility, as well as knowledge of how correct procedures may assist any QPS investigation without impacting on patient care.

The following basic principles should apply:

- In the event of a conflict between patient care and preservation of evidence, then patient care has absolute primacy.
- All contaminated patient possessions should be placed and sealed in a hazardous waste bag after removal by/from the patient.
- This bag should be labelled with patient name, date of birth and Unit Record Number (UR Number), as well as the time and date of bagging. If the patient's identity is unknown, then the unknown patient standard operating procedure should be used to provide details to label the bag.
- Sealed hazardous waste bags containing patients' clothes and possessions should be:
  – stored in a secure, locked area
  or
  – stored under either direct observation of a nominated individual e.g. a protective services officer.
- In the event of an object from the incident penetrating a patient's body, e.g. a shrapnel fragment, then the object, when removed, should be placed in an appropriate sealed container, and the above processes also applied to it.
- In the event of the incident being deemed to involve radioactivity, early advice on appropriate storage of the above items should be sought from Radiation Health immediately.

2.12. PPE removal

- PPE should be removed carefully to avoid touching contaminated areas.
- After removal it should be removed in a designated location and disposed of as hazardous waste.

2.13. Management of deceased patients

Deceased patients from the scene should not be taken to ED for certification of death. A holding area for deceased patients separate to normal mortuary facilities should be established with patients who die in the pre-hospital setting being taken directly to the dedicated receiving facility, ideally after decontamination at the scene. Any deceased patients arriving in error from the scene at a Queensland Health healthcare facility should be assumed to be CONTAMINATED until proven otherwise.

Patients who die in the hospital should not be transported to the hospital's normal mortuary. Instead, the bodies should be transported to a dedicated temporary facility. Large hospitals may establish such a temporary facility on site. At smaller hospitals, however, provisions may need to be made to transport the bodies of deceased patients to a dedicated facility off-site. All facilities should have a pre-prepared Body Process Pathway[60]. The handling of the bodies of deceased patients will depend on the suspected agent involved. Advice should be sought from the State Health Disaster Coordinator or QFES Scientific Branch.

2.14. Public messaging

A CBR or HAZMAT incident resulting in a significant enough numbers to challenge the healthcare system would almost certainly be regarded as an emotive and traumatic event by the general population and such an event would almost certainly be regarded as one of national or even international significance.

Careful coordination of communication with the general public would be vital in order to alleviate community concerns and uphold confidence in the healthcare system. It is essential that coordination of all public statements and communication is achieved by use of the State Health Coordination Centre (SHECC).

Focus group work in an American population by the Centre for Disease Control found that, in the event of a CBR incident, most participants would actively seek information on how to protect themselves and their families[61]. After initially seeking information from local and national authorities, a majority of participants would seek more in-depth information from newspapers and the internet[62]. The importance of communicating a consistent message across several disparate communication modalities is therefore apparent.

2.15. Patient discharge

Printable patient information sheets relating to CBR exposures are available from the Agency for Toxic Substances and Disease Registry in the United States. At the time of writing, these are available at http://www.atsdr.cdc.gov/MMG/index.asp.

It is essential that up to date patient contact information is obtained before discharge.

Part III: Response and recovery

3.1. Chemical Incidents

QFES is the lead agency for any incident involving chemicals.

3.1.1. Identification

QFES will receive specialist advice from QFES Scientific Branch in Brisbane, South East Queensland, and from a network of Scientific Branch volunteers in other areas of Queensland.
The Scientific Branch responds to any HAZMAT or CBR emergency, and is tasked with providing information, advice and the operational capability to provide:

- the identity of hazardous materials
- the hazards they present, now and into the future
- testing and identification, including solids/liquids and gases
- possible chemical reactions
- hazardous material properties, such as reactivity, toxicity and flammability
- public safety and environmental protection strategies.

It is highly probable that Queensland Health facilities would become aware of the chemical nature of an incident via direct notification of QAS or the facility by QFES Scientific Branch.
Other clues to the nature of a HAZMAT/CBR incident which may become apparent to pre-hospital or health facility staff are detailed in table 2 below. Once the chemical agent is identified then appropriate clinical resources, such as the Poisons Information Service should be used to guide patient management.

Dead animals/birds/fish	Not just an occasional road kill, but numerous animals (wild and domestic, small and large), birds and fish in the same area.
Lack of insect life	If normal insect activity (ground, air, and/or water) is missing, then check the ground/water surface/shore line for dead insects. If near water, check for dead fish/aquatic birds.
Physical Symptoms	Numerous individuals experiencing unexplained water-like blisters, wheals (like bee stings), pinpointed pupils, choking, respiratory ailments and/or rashes.
Mass casualties	Numerous individuals exhibiting unexplained serious health problems ranging from nausea to disorientation to difficulty in breathing to convulsions to death.
Definite pattern of casualties	Casualties distributed in a pattern that may be associated with possible agent dissemination methods.
Illness associated with confined geographic area	Lower attack rates for people working indoors versus outdoors, or outdoors versus indoors.
Unusual liquid droplets	Numerous surfaces exhibit oily droplets/film; numerous water surfaces have an oily film. (No recent rain.)
Areas that look different in appearance	Not just a patch of dead weeds, but trees, shrubs, bushes, food crops, and/or lawns that are dead, discoloured, or withered. (No current drought.)
Unexplained odours	Smells may range from fruity to flowery to sharp/pungent to garlic/horseradish-like to bitter almonds/peach kernels to new mown hay. It is important to note that the particular odour is completely out of character with its surroundings.
Low-lying clouds	Low-lying cloud/fog-like condition that is not explained by its surroundings.
Unusual metal debris	Unexplained bomb/munitions-like material, especially if it contains a liquid. (No recent rain.)

Table 3. Clues to the nature of a HAZMAT/CBR incident

In addition, containers storing and vehicles involved in the transportation of chemicals may display a hazardous materials placard as detailed in figure 1 below.

Figure 1. Examples of Hazardous Material Placards

3.1.2. Annex activation

The Queensland Health CBR annex may be activated, in a chemical context, in the event of a chemical incident:

- causing sufficient number of casualties to place an extraordinary strain on the day to day function of the public healthcare system, and therefore requiring special arrangements in order to meet healthcare demand

or

- falling into the category of a potential or actual deliberate release.

3.1.3. Response

Facility response to a chemical incident will consist of facility lockdown, triage of patients, decontamination as outlined previously, and then subsequent treatment and transportation of casualties either within the facility or to other QH facilities. As with trauma, should inter-facility transfer be necessary, then early notification of transportation services, such as QAS and Retrieval Services is essential.

In the event of an incident producing overwhelming numbers of casualties, then a proactive request for assistance from QFES should also occur.
QFES will also function as an information resource in terms of early identification of the agent involved, allowing other clinical resources, such as Poisons Information Centres to be used to guide clinical management.

3.2. Biological incidents

QH is the lead agency for incidents involving biological agents.

For the purposes of this annex, a biological incident should usually be considered to be an incident or outbreak which could be or is compatible with the deliberate release of a biological agent. In the exceptional circumstance of a naturally occurring biological outbreak of such severity that extraordinary health arrangements are necessary in order to control and coordinate the health response, then activation of an adapted version of the Queensland Health Pandemic Influenza plan is likely to be appropriate.

Outbreaks of naturally occurring biological phenomena, with no suggestion of deliberate release, should normally be dealt with under standard procedures, and with the early involvement of appropriate expertise, including health protection and communicable disease experts.

A biological agent is a micro-organism or product which causes disease in man, plants or animals, or causes the deterioration of material[63].

Biological agents may consist of bacteria, viruses, fungi or toxins. Many organisms and toxins are capable of being used as biological weapons, however the World Health Organisation lists sixteen as being of particular concern due to their having been subjected to extensive research by some nation states. In addition to this, non-state actors could potentially seek to capitalise on a naturally occurring outbreak somewhere else in the world by subverting national border controls and introducing an agent, such as diphtheria or a viral haemorrhagic fever, into the Australian population. Biological Agents Listed as being of concern by WHO[64] are detailed in table 4 below.

Toxins	Ricin
	Saxitoxin (Paralytic Shellfish Poisoning)
	Clostridium botulinum toxin (Botulism)
	Staphylococcal enterotoxin (Food Poisoning)
	Aflatoxin
Bacteria and Rickettsiae	Bacillus anthracis (Anthrax)
	Francisella tularensis (Tularaemia)
	Brucella suis (Brucellosis)
	Burkholderia mallei (Glanders)
	Burkholderia pseudomallei (Melioidosis)
	Yersinia pestis (Plague)
	Rickettsia prowazeki (Epidemic Typhus)
	Coxiella burnetii (Q Fever)
Viruses	Venezuelan Equine Encephalitis virus
	Variola major (Smallpox)
Fungi	Coccidioides (Valley Fever)

Table 4. Biological Agents Listed as being of concern by WHO[63]

Biological weapons are attractive to the terrorist because of several characteristics. Aerosols of biological agents are invisible, silent, odourless, tasteless, are relatively easily dispersed, and are undetectable without highly specialised equipment. They are 600 - 2000 times cheaper than other weapons of mass destruction. It is estimated that the cost would be about 0.05% the cost of a conventional weapon to produce similar numbers of mass casualties per square kilometre. The production is relatively easy, using the common technology available for the production of some antibiotics, vaccines, foods, and beverages. The delivery systems such as spray devices from an airplane, boat or car are commonly available. The natural lead time provided by the organism's incubation period (3 to 7 days for most potential organisms) would allow for the terrorists' escape before any investigation starts. In addition, the use of an endemic infectious agent may cause

confusion because of the inability to differentiate a biological warfare attack from a natural epidemic. For some agents potential exists for secondary or tertiary transmission by person-to-person transmission or natural vectors[65, 66].

Given the emotive force of even an alleged threat of a biological release, preparedness plans can reassure the public and reduce panic should genuine threats or hoaxes occur. Historical precedent further suggests that the risk of a deliberate release is considerably reduced by the existence of an effective ability to respond to and manage an incident[67].

3.2.1. Identification

A biological incident may manifest itself in one of two ways. Release may be overt or covert.

Overt release

Overt biological attacks may be recognised if the attack is announced before the release, the attack is witnessed, or responsibility is claimed immediately after an initially unrecognised agent release. Examples include the envelopes containing threatening notes and anthrax spores distributed through US Postal Service in 2001.

Overt release of a biological agent should initially be managed in a similar fashion to a chemical incident, including facility lockdown, access control, triage, PPE and decontamination. In “White Powder” type incidents, health staff involved in decontamination should pay particular attention to minimising secondary aerosolisation of powder by avoiding delivering kinetic energy to contaminated items such as clothing[68,69].

In an overt release, initial sampling of the agent would be performed by QFES. A small sample would be diluted or dissolved in water, and tested for noxious gaseous emissions. The sample would then be transported by QPS to Forensic and Scientific Services, who would run the necessary tests to identify any biological agent. The results of such tests would be reported to SHECC, for onward dissemination. Such results, in a **best case scenario**, are likely to take 4-6 hours to become available.

Covert release

The covert release of a biological agent will, in most cases, take several days or even weeks to become apparent. Suspicions that an attack has occurred will emerge only when patients begin appearing in health care facilities or emergency departments with unusual symptoms or an inexplicable disease[70,]

Mitigation of the effects of a covert release will require early recognition of these cases and an understanding of the spatial and temporal links between them in order to allow rapid and targeted administration of prophylactic treatment to those exposed so that further cases and the spread of contagious organisms can be prevented. This requires clinicians to be aware both of the presentations of disease caused by likely agents of deliberate release, and of the process for activating a public health response.

Early recognition of a covert release of a biological agent will be achieved only if clinicians remain aware of the possibility, and are willing to alert and consult with their colleagues in Microbiology, Infectious Diseases and Communicable Disease units on suspicion, and before a definitive diagnosis has been reached in order for the appropriate clinical and epidemiological expertise to be brought to bear.

After a successful covert attack, the most likely first indicator will be increased numbers of patients presenting to individual healthcare providers or emergency departments with similar clinical features, caused by the disseminated disease agent. The possibility exists that other medical professionals, such as pharmacists or laboratory staff, who may receive more than the usual numbers of prescriptions or requests for laboratory tests may be the first to recognize that something unusual is

occurring. Because animals may be sentinels of disease in humans and many of the high-threat biological agents are zoonosis, or infectious diseases capable of transmitting between species, it is possible that veterinarians might recognize an event in animals before it is recognized in humans.

Pathologists, coroners, and non-medical professionals, such as morticians, may also be important sentinel event reporters[71].

Queensland already has an extremely robust and effective disease surveillance system, providing a good assessment of background disease activity, against which epidemiological information on any outbreak can be assessed.

Clinicians and healthcare staff must, therefore, be encouraged to be alert to the unusual, the unexpected, and any case that 'just doesn't fit', especially in times of heightened alert or perceived threat[72].

For example:

- an unusual illness (eg sudden unexplained febrile death, critical illness or pneumonia death in a previously healthy young adult)
- an unusual number of patients with the same symptoms
- an illness unusual for the time of year (eg 'flu' in summer)
- an illness unusual for the patient's age group (eg 'chickenpox' in a middle-aged adult)
- an illness in an unusual patient (eg cutaneous anthrax in a patient with no history of contact with animals, animal hides or products)
- an illness acquired in an unusual place (eg Venezuelan Equine Encephalitis acquired in Australia)
- unusual clinical signs (eg mediastinal widening on CXR; sudden onset of symmetrical flaccid paralysis)
- unusual progression of an illness (eg lack of response to usually effective antibiotics).

3.2.2. Annex activation

Any Queensland Health clinician who suspects that a patient whom they are treating may be a victim of a biological release should immediately discuss the case with their local responsible Public Health Unit via their usual notification mechanism. If the expert conclusion drawn by the Public Health Unit is that the incident is compatible with deliberate release of a biological agent, then the Chief Health Officer (CHO) should be informed, and the annex activated at his or her discretion.

Activation of the annex may also occur in a "top down" fashion on the basis of intelligence suggesting that a credible threat of a deliberate release exists. Such information is most likely to first come to the attention of federal or state intelligence gathering agencies. The lead agency for counter terrorism in Queensland is the QPS, and such information would be passed to them in the first instance. In the event of this information being both credible and pertinent to health, it would be passed by QPS to the CHO. Depending upon the information received, the CHO may, at their discretion, choose to activate the Queensland Health CBR annex proactively in anticipation of a deliberate release. Since, by its very nature, such intelligence is frequently incomplete, only partially accurate and highly sensitive, the CHO may choose not to reveal the exact nature of the information received both within Queensland Health and to the wider community. It is therefore, important, that HHSs are in a position to respond in spite of potentially being in possession of only limited information.

A deliberate release of a biological agent would constitute an extremely significant threat to the health and wellbeing of the public, and therefore, the threshold for activation of the CBR plan in this context should be low.

Activation of the plan does not exempt healthcare facilities from meeting their disease notification obligations under the *Public Health Act 2005*.

3.2.3. Response

The key elements of an effective biological response include [73]:

- Rapid detection of the outbreak or introduction of a biological agent into the environment.
- Rapid dissemination of key safety information, appropriate personal protective equipment, and necessary medical precautions.
- Rapid agent identification and confirmation.
- Identification of the population at risk (to include animals, marine life, and plants).
- Determination of how the agent is transmitted, including an assessment of the efficiency of transmission.
- Determination of susceptibility to prophylaxis and treatment.
- Definition of the public health and medical services, human services, and mental health implications.
- Control and containment of the epidemic when possible, and use of mitigation strategies when containment is not possible (e.g., in the event of an influenza pandemic).
- Interface and information sharing with law enforcement and State/Commonwealth agencies.
- Augmentation of local health and medical resources.
- Protection of the population through appropriate public health and medical actions.
- Dissemination of information to enlist public support and provide risk communication assistance to responsible authorities.
- Assessment of environmental contamination and clean-up/decontamination/proper disposal of biological agents that persist in the environment, and provision of consultation on the safety of drinking water and food products that may be derived from directly or environmentally exposed animals, crops, plants and trees, or marine life.
- Tracking and preventing secondary or additional disease outbreak.
- Administration of countermeasures where appropriate.

Vaccination and prophylaxis

If a targeted or mass vaccination program is required as part of the response to a deliberate biological release, then this would be ordered and coordinated by the CHO in conjunction with the Senior Director of the Communicable Diseases Unit (CDU).

Queensland Health maintains a minimum of two months supply of the National Immunisation Program vaccines in a central supply. Upon authorisation of release, these vaccines are accessed via the Manager of the Queensland Health Immunisation Program. In the event of a supply requirement not being able to be met from current stock, then the Manager, Queensland Health Immunisation Program is responsible for liaising with the members of the National Immunisation Committee and relevant pharmaceutical companies in order to source and distribute relevant products. The status of supply, stock available and timescales for purchasing will then be fed back to CHO and the Senior Director, CDU.

Should a program of either mass or targeted antibiotic prophylaxis be required, then this would also be ordered and coordinated by the CHO and Senior Director of CDU.

Appropriate chemoprophylaxis would be procured via central pharmacy, either through current stocks, stockpiled medications or “Just in Time” supply from pharmaceutical companies.

Upward liaison to the federal level would also occur via the National Incident Room (NIR) in Canberra, since a deliberate biological release would undoubtedly constitute an event of national significance.

3.3. Radiological incidents

Queensland Health is the lead agency for incidents involving radiation hazards.

Ionising radiation

Radiation is energy that comes from a source and travels through some material or through space. Ionising radiation is a type of radiation which is capable of causing ions (charged particles) in matter, and is produced by unstable atoms. In order to become stable, these atoms give off, or emit, their excess energy or mass as radiation[75].

This radiation may take the form of:

- electromagnetic waves, such as X-rays and Gamma rays
- particles of matter, such as alpha and beta particles and neutrons.

Each type of radiation has different properties, differing ability to penetrate matter, and differing ability to cause biological damage, as outlined in table 5 below.

Radiation	Range in air	Range in tissue	Hazard
Alpha	Few cm	50 micron	Internal
Beta	Few metres	Few mm	External and internal
Gamma	Many metres	Many cm	Mainly external
X-ray	Many metres	Many cm	Mainly external
Neutron	Many metres	Many cm	Mainly external

Table 5 Summary of types of ionising radiation (from Australian Clinical Guidelines for Radiological Emergencies, September 2012)

The health threat from any radiation source may be ameliorated by:

- Maximising distance between the source and personnel, since radiation exposure will decrease proportionally to the square of the distance.
- Minimising time in which personnel are exposed to the source.
- Utilising appropriate shielding, for example the energy of a beta particle is insufficient for it to penetrate clothing.

Radiation Exposure

Exposure to radiation may occur via three main routes:

- external irradiation
- contamination with radioactive materials, either internal or external
- incorporation of radioactive material into body tissues.

External irradiation means exposure to penetrating radiation from a radiation source. Anyone exposed to a radiation source may suffer radiation illness if their dose is high enough. Such patients do not become radioactive.

Radioactive contamination occurs when material that contains radioactive atoms is deposited anywhere that it is not desired. If the radioactivity is on a person's skin or clothing then they are described as "externally contaminated". If the radioactivity has been ingested, inhaled or absorbed through an open wound, then the patient is described as being "internally contaminated".

If ingested or absorbed radioactive material is taken up by body cells, tissues and target organs (e.g. bone, liver, thyroid or kidney) then it is described as being incorporated.

3.3.1. Identification

Since emission of radiation from radioactive materials cannot be seen, smelt, heard or felt, the radiological nature of a major incident may not be immediately apparent to the responders. The QFES Response Advice to Chemical Emergencies (RACE) team may provide the initial response to the incident, and will notify Queensland Health (Radiation Health) immediately they suspect or identify the radiological nature of the incident.

Queensland Health is the lead agency for incidents involving radiation sources and radioactive materials where persons may be subject to radiation doses in excess of dose limits prescribed in the Radiation Health Regulation, 2010[74].

3.3.2. Annex activation

Should a Queensland Health facility suspect or become aware that the incident to which they are responding involves exposure of patients or staff to radioactivity, they should immediately notify Radiation Health of their concerns. Appropriate local activation of facility CBR plans should also take place.

The Queensland Health CBR Response Plan may be activated, in a radiological context, in the event of an incident:

- involving radioactive substances which are not under the control of a person who holds a possession licence under the *Radiation Health Act, 1999*[75]

or

- described as a “dangerous event” under the *Radiation Health Act, 1999*

or

- of accidental origin involving radioactive material

or

- from a terrorist or criminally inspired act

or

- involving radioactive materials outside the State or Country with trans-boundary effects

or

- involving re-entry of a nuclear powered satellite.

Depending upon the nature of the incident the National Counter Terrorism Plan may also be invoked.

3.3.3. Response

Role of Radiation Health

Radiation Health is responsible for:

- assessment of radiological hazards
- provision of radiation protection advice to emergency responders and those affected
- initiation and management of radiation-related remedial actions
- custody of all radioactive things and things that are contaminated with radioactivity.

In the event of QFES becoming aware of the presence of a radiation hazard in the course of their operations, then their standard operating procedure is to seek immediate advice from Radiation Health.

In addition, Radiation Health will work with the assistance of other government agencies to manage the recovery of radioactive materials involved in the incident, radiation monitoring and decontamination operations.

The Director, Radiation Health will take on the responsibilities of the State Radiation Officer (SRO). The SRO will oversee all incidents which only require a response by Radiation Health.
The SRO is responsible for:

- assessment of the radiological hazards
- recommending, where appropriate, sheltering or evacuation of persons directly affected by the incident
- recommending the issue of stable iodine tablets to persons
- providing Radiation Health advice in relation to the establishment of HAZMAT Control Zones
- providing radiation protection advice to emergency workers and other persons
- overall management of radiation monitoring and decontamination operations
- overall management of radiation dose assessment of persons who may have been exposed to radiation
- overall management of the recovery or disposal of the radioactive substances.

The response of the SRO to such a notification, depending on their expert assessment of the radiation hazard, may range from deciding that no further action is required from a radiological point of view and simply recording the details of the incident right up to the initiation of a full multi-agency coordinated response.

Upon annex activation, the SRO takes on the role of Specialist Advisor on radiation to the State Health Coordinator.

Facility response

An incident involving even a single casualty from an incident involving radiological materials is likely to trigger concern amongst other casualties, bystanders, emergency responders, treating staff and potentially the broader community. Significant numbers of individuals may seek assessment and reassurance about potential health effects, from hospitals and other clinical providers.

Until confirmation is obtained that radiation is the only hazard, it should be assumed that other potential hazards exist, including chemical and biological threats. In the event of a healthcare response being required to an explosion, serious consideration should be given to the possibility of the explosion being the consequence of a malicious act and mounting the initial response in appropriate PPE. Early radiological screening of casualties, where possible, should then be initiated on arrival. Confirmation should then be actively sought from QFES as to the existence of any CBR type hazard, enabling PPE to be downgraded at an early stage.

Until the exact nature of the hazard is delineated, it may be appropriate to initiate a decontamination response with staff wearing Level B/C PPE, before downgrading the response as more information becomes available.

In a radiological incident, the medical stabilisation of casualties has first priority and takes precedence over any radiological consideration. Radiation does not cause immediate death, burns or wounds. Only in extremely high doses, does exposure to radiation cause incapacitation. Irradiation may not cause manifest illness for hours, days or weeks and does not make casualties radioactive. Efforts to control and contain external contamination are chiefly directed at avoidance or minimisation of internal contamination. However, traumatic injuries associated with an explosive radiation dispersal device may be life-threatening and require immediate intervention to stabilise. Concern about radiological contamination should not delay these interventions, as delay may result in preventable deaths due to trauma.[76]

Staff should be actively encouraged to remember that, whilst there may be significant emotion around any incident involving radiological contamination, the contamination on casualties can be controlled and contained. Simple measures such as the establishment of control lines, use of personal dosimeters, rotation of treating personnel, appropriate personal protective equipment, and casualty decontamination will minimise risk to healthcare workers from radiological contaminants. Strong and effective leadership may be required to assist staff in conquering their preconceptions. Prior staff training will provide significant assistance in achieving this goal. Early contact with Radiation Health will also help in assessing risk and alleviating concerns about the nature of any radiation hazard.

An ARPANSA Technical Report states that *"The only survivors of a radiation accident who have been so badly contaminated as to be a threat to those involved in treating them were some of those involved in the accident at Chernobyl. No other accident victims, including those at Goiânia, Brazil, where gross contamination of the victims occurred, have presented ANY threat to responders, due to the precautions and procedures they followed in managing those victims."*[76]

The Radiation Liaison Officer

Every health facility, as part of their routine CBR contingency planning, must include in their plan the appointment of a Radiation Liaison Officer (RLO). This role is best filled by the local health staff member who has the best working knowledge of radiation issues and radioactive materials, and should ideally be an individual who already has a working relationship with Radiation Health Queensland. If available, then a Diagnostic Imaging Medical Physicist is an ideal candidate, but in smaller facilities, members of other craft groups, such as a radiographer, senior nurse or senior medical practitioner may be appropriate. These personnel should be actively encouraged to seek out opportunities for exposure to and work experience in departments in which radioactive materials are routinely safely handled and used, such as nuclear medicine and radiation oncology departments, in order to gain experience in the properties of radioactive materials.

The role of the RLO is to provide a vertical chain of command up to Radiation Health Queensland, and specifically to:

- Notify Radiation Health Queensland of any radiological incident requiring activation of a facility CBR plan.
- Offer, on a temporary basis, and in consultation with Radiation Health Queensland, advice on management of radiological events.
- Feedback pertinent information from the facility to Radiation Health Queensland as the situation evolves.
- Provide a concise and accurate handover to the designated Radiation Health Queensland personnel responding to the incident on their arrival at the facility.
- Maintain local liaison on behalf of the facility whilst Radiation Health Queensland are in attendance.

This individual must be provided with opportunities to build relationships with Radiation Health Queensland as part of the routine facility training and education in disaster response, and their role should be clearly articulated in the facility CBR plan. They should also be provided with a role description and action card for use upon activation of the plan.

Upon activation of any local response plan, they are also able to fill the role of Specialist Advisor on Radiation to the local Health Emergency Operations Centre (HEOC).

Reception of contaminated patients

Triage

Patients with life threatening traumatic injuries may be safely treated prior to decontamination by staff wearing appropriate PPE.

It should be remembered that radiation interacts synergistically with trauma. Patients with medical or traumatic injury who also have whole-body or significant partial-body irradiation (combined injury) have a substantially worse prognosis and will require a higher triage priority[27].

Ideally, patients should also undergo a brief radiological triage using an appropriate survey meter in order to briefly scan for any high activity shrapnel fragments which may present a greater risk to staff. In the event of a high activity fragment being identified, then the High Activity Foreign Body Procedure should be followed. This procedure is described in detail below.

Items such as radiological survey meters are relatively specialised pieces of equipment, and so staff should have prior training and education in both the care and appropriate use of these items of equipment.

High active foreign body procedure

This procedure should be followed in the event of a radiological survey of a patient identifying a potential high activity foreign body inside a patient.

The possibility of a high activity foreign body may be raised during the process of radiological triage, and may be indicated by a sudden, inexplicable spike in radioactivity detected over a patient or a wound.

Should such a spike be detected, then the facility RLO must be immediately notified, in expectation that Radiation Queensland will be consulted. Should Radiation Health Queensland already be in attendance, then they may be directly notified.

All non-essential staff and other patients should leave the immediate area of the patient

The principles of distance, time and shielding should be utilised to minimise the risk to the caring clinicians from a high activity foreign body.

- **Distance:**
  - Radiation dose will fall with the square of the distance. The caring clinicians should, therefore, place themselves at the maximum distance from the patient which enables them to deliver effective care.
- **Time:**
  - Caring clinicians should minimise the time in which they are in direct contact with the patient. This may require regular and frequent rotations of staff in order to minimise the dose of radiation received by any one individual. Advice on appropriate rotation of staff should be sought from the RLO in the first instance.
- **Shielding:**
  - Appropriate shielding, such as lead aprons may be appropriate in order to further protect staff, and advice should be sought from the facility RLO over their use.

If the foreign body is visible and can be easily removed without danger to the patient, then it should be removed at arm's length by a clinician using an appropriate surgical instrument and immediately placed in a prepositioned lead lined container. This container should then be sealed, labelled and moved to an appropriate storage area. If the foreign body is not visible, then the patient may require surgical removal of the fragment.

If possible, the procedure of fragment removal should be videoed from beginning to end (a standard smartphone providing an ideal device). This allows an accurate assessment of time and distance from the source to be made, and dramatically improves the accuracy of any subsequent exposure calculations.

Radioactive fragments will almost always be radiopaque, and may be localisable on plain X-Ray or CT scanning if available. Such patients should be managed in close liaison with Radiation Health

Queensland and an appropriately trained medical physicist. Successful care of the patient will require close collaboration between the anaesthetic team, the surgical team and Radiation Health, and such procedures should be carefully planned in advance in order to ensure the safety of both patient and staff. Removal of a high activity fragment will usually take precedence over decontamination of the patient.

Decontamination

The generic decontamination process for patients from CBR incidents is as outlined in Appendix 1.

Non ambulant patients should first have open wounds decontaminated by irrigation with saline, followed by orifices such as mouth and ears (although victims of explosions should have their tympanic membranes visually inspected for evidence of barotrauma prior to irrigation), and finally their intact skin surfaces.

Patients should be screened with a survey meter after decontamination in order to confirm adequacy of the process. It is unlikely that decontamination will successfully reduce the patient's radiological burden down to a background level, and any result which is less than twice the background level should be considered to represent successful decontamination.

Treatment areas

Normal management principles apply to patients who have undergone successful decontamination. An area should be set aside for treatment of patients with immediately life threatening injuries prior to decontamination.

This area should have the following characteristics:

- It should be large enough to accommodate the anticipated number of victims.
- If safely possible, it should be located outside the facility, and protected from the elements, especially wind and rain.
- Non-essential equipment should be removed from the area.
- There is minimal aerosolisation of radioactive material, and so there is no requirement to control air ventilation of this area.
- Large bins with disposable plastic bag liners should be available for disposal of contaminated waste. The bags should be sealed and labelled for subsequent screening by the RSO
- Simple bacterial swabs should be available for collection of samples from nose etc. for screening.
- All samples should be labelled as RADIOACTIVE.
- Patient charts with outlines of body front, back and sides for recording wounds and areas of contamination.

External assembly point

An external assembly point for ambulatory casualties should also be established external to the hospital. The purpose of this point is to:

- Provide a collection point for ambulatory casualties.
- Provide a location where they may be radiologically screened.
- Provide access to a location where contaminated individuals may undergo self-decontamination.

PPE

In the response to an incident involving a known radiological threat, the following PPE is appropriate[17]:

- fresh surgical scrubs
- waterproof trauma gown/apron

- theatre cap covering all hair
- waterproof shoe covers
- two pairs of nitrile gloves
- n95 mask
- eye protection/goggles
- personal dosimeter

The first pair of nitrile gloves should be worn with the cuffs UNDER the gown sleeves. The gown sleeves are then taped to the inner pair of gloves.
An outer pair of gloves is then donned with the cuffs OVER the gown sleeves. Outer gloves should be changed frequently during patient care.
Lead aprons are ineffective, unnecessary and likely to increase fatigue.

This level of PPE roughly correlates with an EPA level D ensemble. Dosimeters should be worn outside clothing, by key treatment personnel working in close proximity to casualties. The dosimeter should also be worn correctly oriented. If the dosimeter has an alarm function, it should be set to an appropriate level in consultation with the facility RLO or Radiation Health. This level would permit the staff member to work at that exposure level for a very protracted period before they exceed the annual normal background exposure for Australia.
If dosimeters alarm, staff should be rotated with increased frequency whilst advice is sought from a health physicist, the facility RLO or Radiation Health.

PPE removal

The following procedure should be followed for removal of PPE

- Remove protective garments and gloves standing adjacent to the control line, on the contaminated side. Bag and tag collected waste.
- Remove outer gloves, turning them inside out, and deposit into a plastic bag lined bin.

Remove the dosimeter and deposit into a bag held by another staff member, avoiding contaminating the outside of the bag.

- Remove all tape and deposit into a lined bin.
- Remove the gown, turning it inside out. Minimise shaking of the gown. Deposit into a lined bin.
- Remove cap, mask and goggles. Deposit into a lined bin.
- Stand or sit adjacent to the control line on the contaminated side. Remove one shoe cover and deposit into lined bin. The sole of the inner shoe should be scanned for contamination before placing on the floor/ground on the clean side of the control line. Repeat for other side.
- Remove inner gloves and deposit into lined bin.
- The staff member should be scanned for contamination prior to showering.
- The staff member should then take a shower, taking care to wash their hair and body thoroughly
- Staff members should be instructed not to eat, drink or smoke until after they have been surveyed and showered.

Discarded PPE should be bagged, sealed and labelled. The bags should be retained until permission for their disposal is given by the Radiation Safety Officer (RSO)

Assessment and management of internal contamination and radiation injury

The first priority for care is the stabilisation of any life-threatening injury, followed by removal of external contamination. Assessment of internal contamination will be dependent on the history of the incident, consideration of potential routes of exposure, and information regarding the identification and chemical form of the radionuclide. There may be delays to obtaining confirmation of the nature of the radionuclide.

Treatment decisions need to be based on an understanding of the properties of the identified radionuclide including metabolic behaviour, the route of exposure and absorption characteristics, estimates of body burden, available treatments (including effectiveness, contraindications and risks) and individual patient status. Treatment is maximally effective if commenced early. A clinical decision may need to be based on an estimation of whether exposure potential is low, medium or high and an understanding of the risks of treatment. Detailed dosimetry can be completed subsequently.

The process of identification of potential intakes, assessment of their biological significance, and recommendations on treatment are all highly specialised processes, and require expert input as they will almost certainly fall outside the treatment experience of the clinicians involved in direct care of the patient. Pertinent information in this process is likely to be provided both by QFES and Radiation Health Queensland.

Since ongoing management of these patients is likely to fall outside the experience of most ED clinicians, the following is a reasonable initial management framework **whilst specialist advice is being sought**.

- decontaminate patient
- treat any conventional/traumatic injuries
- draw blood samples for Full Blood Count, Amylase and (if available) CRP[27] if any possibility of irradiation having occurred
- further Full Blood Counts six hourly if any possibility of irradiation having occurred
- document time of onset of any vomiting.

Specialist advice on the management of patients with suspected or proven radiological injury should be sought from Radiation Health in the first instance.
It is also important to remember that radiation elicits significant fear in many people. Significant psychological support is likely to be required by individuals with suspected or proven radiological injury, as well as large numbers of people who, whilst not actively contaminated, may have been impacted by the incident.

Contamination monitoring

Portable contamination monitors are often located in nuclear medicine departments of major hospitals for management of spills. However, it is recommended that EDs should consider acquiring or gaining access to at least one Geiger-Müller counter in order to ensure ready access to this equipment at all times. It is vital that this piece of equipment is properly maintained by appropriately qualified personnel.

Checking for External Contamination of skin and clothing:

- Cover the probe, with a surgical glove or plastic bag to prevent inadvertent contamination of the probe. The glove can be changed if contamination occurs.
- Ensure that the instrument is used in fast response mode, where this is possible.
- Set the instrument selector switch to the most sensitive range of the instrument.
- Measure background radiation prior to commencing survey of the patient.
- Holding the probe approximately 1 to 2 cm from the person's skin and systematically survey the entire body from head to toe on all sides, as illustrated in figure 2.
- Move the probe slowly (a few cm per second).
- Do not let the probe touch anything.
- Try to maintain a constant distance.
- Pay particular attention to body orifices, skin folds, hands, face and feet.
- An increase in count rate or dose rate above background indicates the presence of radiation.
- Document areas of contamination on a body map together with monitor details, monitor readings for the various body areas that are contaminated, and details of the casualty.

- When necessary, adjust the range of the instrument by moving the range selector switch.
- assessment of body orifices and wounds
- nasal and oral swabs, if taken, should be collected using moist, clean cotton tipped applicators.
- any sputum, vomitus, or tissues from nose blows should be collected.
- any initial wound dressings should be collected
- swabs, dressings, etc. should be placed in separate plastic bags and labelled with patient details, site, and time for later analysis
- an estimate of possible lung deposition may be obtained from the rule of thumb that the combined activity of swabs from each nostril corresponds to roughly 5% of lung deposition[75].

Therefore:
Estimated Lung Deposition = Combined Nasal Swab Activity x 20.
It should be noted, however, that nasal swabs taken more than 30-60 minutes after patient exposure may show artificially low levels of contamination due to physiological nasal clearance. Results may also be distorted by facial washing and nose blowing.

Assessment of the degree of internal contamination of any patients is the responsibility of Radiation Health, who may well liaise and seek advice from other national and international bodies.

Note that some instruments cannot detect alpha radiation and some low-energy beta radiation. Because alpha radiation is non-penetrating, it cannot be detected through even a thin film of water, blood, dirt, clothing, or through the probe cover.

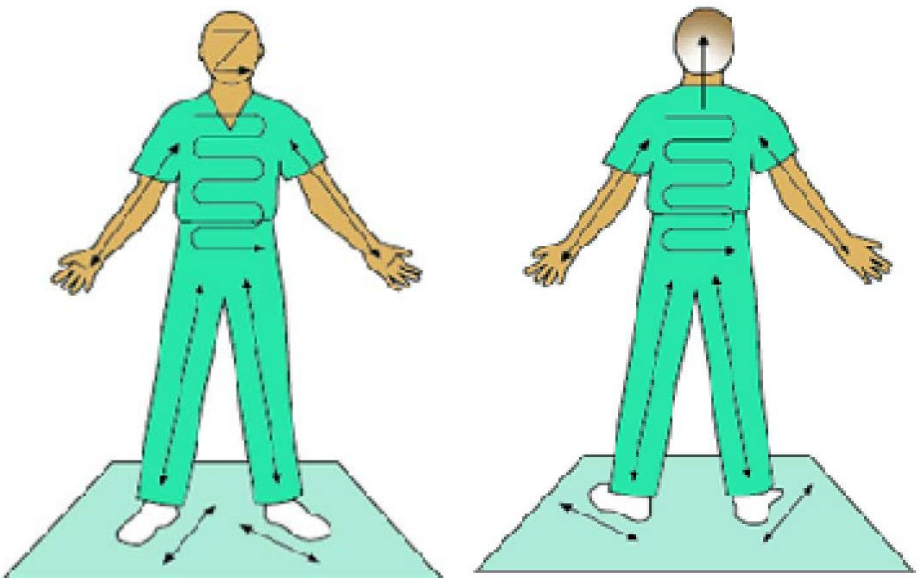

Figure 2. Checking for External Contamination
Radiation Emergency Assistance Centre / Training Site (REAC/TS) – Guidance for Radiation Accident Management

Ongoing specialist care of radiation injury

- Clinical advice on the care of victims with acute radiation injury or illness can be obtained from a radiation oncologist.
- The Peter MacCallum Cancer Centre, Melbourne, is the clinical part of the Australian Collaborating Centre for Radiation Protection and Radiation Emergency Medical Assistance, and a member of the World Health Organisation Radiation Emergency Medical and Assistance Network. 03 9656 1111. Callers should request the on call radiation oncologist.
- Inpatient care may require the coordination of a multidisciplinary team of medical and support specialists including, but not limited to:
- Medical health physicist.
- Nuclear medicine physicians.
- Radiation oncologists.
- Haematologist / oncologist.
- Intensivist.
- Trauma surgeon.
- Clinical toxicologist.
- Infectious Disease specialist.

3.4. Recovery

Recovery from a CBR incident from a health perspective may be unusually prolonged, as the health sequelae may take an extensive and prolonged period to become fully apparent and quantifiable. Examples of this include assessment of food safety, long term impacts on psychosocial health, and assessment of the health effects of ground contamination.

By way of example, in 2015 the Victorian government commissioned Monash University to perform a 20 year study known as the *Hazelwood Health Study*[83], with the aim of *"identifying potential health outcomes for people who may have been impacted by the smoke from the Hazelwood mine fire. These might include heart and lung disease, cancer or mental health problems. It will also look at the effects on vulnerable groups such as infants and children, young people, and older people."*

Details of Public Health and Mental Health recovery procedures and processes are both highly specialised and out of scope for this annex. For details on these processes please contact Public Health and Mental Health Units.

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Appendices

5.1. Appendix 1 – Decontamination Process [19,21,77,78]

AMBULANT casualties should be encouraged to self-decontaminate.

Ambulatory patients, or the "walking wounded", who have not been decontaminated at the scene of the incident by HAZMAT personnel, may exhibit only mild or no effects of the agent. They must be decontaminated prior to entry into the ED.

This usually involves showering of multiple patients at a facility outside the ED. It is usually recommended that the sexes are segregated and the area is screened from passers-by.

Appropriate pre-prepared signage, ideally including pictograms for children and non-English speakers should be available to facilitate patient self-decontamination.

Hospital personnel should supervise and assist as required.

The showering facility should have a walk-through arrangement to facilitate rapid patient throughput.

The following steps are required:

- Patients need to be identified and registered using the disaster patient record packs.
- Patients fully undress.
- Patient's clothes and valuables placed in a sealed plastic bag with an identification label. Facilities should consider a requirement for 2 bags per person, i.e., one for clothes and other things; another one for items that are indispensable such as car keys, mobile phones, home keys etc.
- Patients shower with soap and water.
- Following decontamination, patients proceed provided with gowns /other clothing to secondary triage.

NON AMBULANT casualties will require decontamination by a hospital team. The following steps are required:

- Rinse-wipe-rinse Method of Skin Decontamination[77]
- Basic Equipment Required for Decontamination
  - scissors and/or seatbelt cutters
  - buckets (5-10 litres size)
  - sponges/soft brushes/washcloths
  - clean water source (ideally lukewarm water)/ hosepipe for most rinsing; saline solution for wound irrigation, eyes and other mucous membranes; distilled water for mustard agent if possible
  - liquid soap/washing up liquid/shampoo without conditioner
  - disposable towels/drying cloths
  - large plastic bags (for clothing and double bagging)
  - small clear plastic bags
- ID/Triage labels/tags/pens
  - sturdy containers for used decontamination equipment
  - replacement clothing or sheets/blankets
  - stretchers

PROCEDURE

1. Remove clothing

- REMOVE CONTAMINATED CLOTHING AS SOON AS POSSIBLE. THIS SIGNIFICANTLY REDUCES CONTAMINATION.
- Explain what you are going to do before you start and as you go along.
- Remove/cut off clothing gently and speedily. Do NOT pull clothing off over the head. If clothing is adherent to patient, do not rip, pull or tear: soak gently and thoroughly with water until clothing can be separated from underlying tissue.
- Gently handle scissors or seatbelt cutters to cut off clothes, avoiding sensitive or wounded body areas. Lift clothes carefully so as not to harm.
- Remove shoes as they may hold contaminated soil.
- Remove all accessories: jewellery, watches, rings, hearing aids, contact lenses.
- Fold clothing inside out to contain contamination. Glasses may be decontaminated and returned to the patient once clean.
- Place clothing and accessories in a large plastic bag and label as hazardous, as well as patient details.
- Lift the person from the cut-off clothes to a clean stretcher and blanket.
- Decontaminate affected areas (see below).
- Practical challenges associated with disrobing are maintaining the privacy of casualties and the adequate supply of replacement garments.

2. Decontaminate

- Use RINSE-WIPE-RINSE technique.
- Emergency wet decontamination using the ‘rinse – wipe - rinse’ technique is simple, effective and requires minimal equipment and training. This technique may be adapted to the situation and available resources.
- If soap is not available decontamination should still be carried out using water.
- Similarly if cloths/soft brushes etc. are not available rinsing with water or soapy water is preferable to doing nothing.
- A specialised decontamination solution (e.g. RSDL) may be used if available.
  - Blot off any liquid on the skin with clean absorbent material e.g. a wound dressing or incontinence pad. Gently brush off any solids, e.g. powder.
  - Gently rinse/wash affected areas with soapy water (0.9% saline for open wounds).
    - This dilutes the contaminant and removes particles and hydrophilic chemicals.
    - Start with face/airways first and work down to toes.
    - Pay special attention to skin folds, skin creases, nails, ears, and hair.
    - Flush eyes copiously with 0.9% saline (or distilled water for sulphur mustard) as needed.
    - If possible, use copious amounts of water as small amounts of water could facilitate the spread and absorption of some chemicals.
  - Wipe affected areas gently but thoroughly with sponge or soft brush or washcloth:
    - This removes organic chemicals and petrochemicals (not water soluble).
    - Sponges and washcloths must be replaced regularly.
  - Gently rinse affected areas.
  - Gently dry cleaned areas with disposable towels.
    - Consider dressing open wounds.

  - Transfer patient to a new stretcher in the clean zone and wash ‘dirty’ stretcher for future use.
  - Make sure all staff self-decontaminate before leaving the decontamination area.
    - This may require a change of clothing, so additional clothes should be available for staff.

In later care of the patient, consider any debris removed when treating trauma injuries as contaminated.

Additional notes[21,50,79]

- It might not always be possible to guarantee that a casualty will be totally decontaminated at the end of this procedure. Remain cautious and observe for ill effects in the decontaminated person and in unprotected staff.
- The rinse water itself may be contaminated, and therefore hazardous, and a source of further contamination spread. QFES advice should be sought concerning its disposal.
- Brushes and sponges used in this process will also be contaminated and should not be used on a new patient.
- On average, stretcher casualty decontamination can take between 10 to 12 minutes to complete.
- The risk from hypothermia should be considered when any form of decontamination is carried out.
- The use of a contamination/dose rate monitor may assist in determining if the decontamination of radioactive material has been successful. Dry wipe may also be effective for radiation contamination.
- In chemical incidents, use of a photoionisation detector, if available, may confirm adequacy of decontamination by indicating absence of vapour from volatile chemicals above the patient’s skin.

5.2. Appendix 2 – Universal Decontamination Algorithm [19,77]