

Chapter 8

CASUALTY MANAGEMENT IN A CONTAMINATED AREA

Overview

In a contaminated environment, casualties enter a medical treatment facility (MTF) through the patient decontamination site (PDS). This occurs at all levels of medical care where contaminated casualties might be received. The purpose of the PDS is to remove all contamination, or as much as possible, from the casualty before he or she enters the clean MTF; this ensures that unprotected medical staff inside the facility are not made ill or become cross-contaminated by agent on the arriving patient. The key military reference for the decontamination of patients is US Army Field Manual 4-02.7, *Health Service Support in a Nuclear, Biological, or Chemical Environment*, which provides detailed instructions on establishing and operating a PDS. The key reference for the establishment of stateside MTF patient decontamination is the Occupational Safety and Health (OSHA) *Best Practices for Hospital-Based First Receivers of Victims from Mass Casualty Incidents Involving the Release of Hazardous Substances* (January 2005). This section outlines the key points found in those documents. PDS diagrams are also found in Appendix A.

Zones of Contamination

Zones of contamination (hot, warm, and cold) are established at both the incident or attack location and the PDS. The zones at each location are entirely separate. All casualties arriving at a PDS should be presumed contaminated until confirmed otherwise.

- **Hot Zone.** The area directly contaminated by chemical, biological, radiological, or nuclear agents. In combat, it is the

contaminated battlefield or toxic industrial material release site (eg, factory storage tank or terrorist bomb). Casualties usually undergo immediate decontamination in the hot zone or on the periphery of it.

- **Warm Zone.** An area where low levels of dry, liquid, and vapor contamination can be expected once contaminated individuals enter. The contamination hazard is essentially the agent that remains on patients brought into this area. In this zone immediate, patient operational, and patient thorough decontamination take place. The PDS is initially set up in an area free of contamination, which becomes part of the warm zone once contaminated casualties begin to arrive.
- **Cold Zone.** An area free from liquid, dry, and vapor contamination. All personnel and patients entering this zone have been decontaminated. Protective ensemble and mask are usually not required for personnel in the cold zone unless the area becomes contaminated. Standard precautions must be practiced if a patient is infectious with a biological agent.

In some contexts the PDS terms “warm” and “hot” can be used synonymously with “dirty,” and the term “cold” be used interchangeably with the term “clean.”

The principal components of the PDS are:

- entry control point and arrival point
- triage area
- emergency treatment area
- decontamination areas
- “hot line”(separating the contaminated from the clean areas)

After crossing the hot line, the casualty enters the clean triage and treatment area. From there, the now contamination-free casualty is brought into the MTF or prepared for “clean” disposition to another MTF. The size of the MTF will dictate the personnel support needed to staff a functional PDS. At a battalion aid station, for example, staffing is limited and the same senior medical noncommissioned officer serving as the triage officer may also provide emergency care. The decontamination areas will be staffed by a limited number of augmented personnel, and very limited medical care can be provided in the clean treatment

area. At larger MTFs a medical professional will be available to perform triage and others to provide emergency care. There will be more decontamination lanes and more augmentees to staff them. If augmented personnel are not plentiful, the decontamination team can be supplemented by nonmedical personnel from the hospital staff. Staffing a PDS can take 8 to 39 people, depending on its size and the time it needs to remain in operation. The following is intended as an introduction to each of these stations. More detailed information can be found in USAMRICD's *Field Management of Chemical Casualties Handbook* (the "gold book"; 4th ed, 2014) or the references noted previously.

Key Components of a Patient Decontamination Site

All PDS operations must have the following key components to operate effectively.

Dirty Side

Protection. All staff on this side of the PDS wear MOPP (mission-oriented protective posture) level IV or OSHA personal protective equipment level C.

Entry control point and arrival area. Patients pass through the entry control point, where access to the PDS is controlled. Vehicles with casualties then proceed to the arrival point, where they are unloaded. This area is staffed by augmentees. Key activities here are (1) routing of vehicles, (2) unloading of vehicles, and (3) quick pat down searches to remove ordinance from patients. All staff are in MOPP level IV when contaminated patients arrive.

Warm side triage area. The triage area is located near the arrival area; patients are moved here from the arrival point. Here casualties are simultaneously triaged according to their need for medical care, their priority for patient thorough decontamination, and their priority for evacuation to the next role of care. Within the triage area casualties are moved to either the immediate (warm side emergency medical treatment [EMT] area), delayed, minimal, or expectant treatment areas. Patients are retriaged as

they progress through the EMT and decontamination and as their condition changes. The following placement of treatment areas in relation to the decontamination lanes is suggested to improve patient flow through the PDS.

- *Immediate* patients are moved to the warm side EMT area. This area is located between patient triage (closer to triage to minimize the time it takes to move from triage to dirty EMT) and the entrance to the litter decontamination lanes. This way a patient can be moved to litter decontamination without interfering with the traffic flow from other patient groups.
- The *delayed* patient area should be positioned nearer to the entrance to both the litter and ambulatory decontamination lines. This way delayed patients can be processed through either the litter or ambulatory lanes as they become available.
- *Minimal* patients should be positioned near the ambulatory patient area so that if medical care on the clean side of the hot line is needed, they can be processed through the ambulatory lane when it becomes available without interfering with the flow to the litter lanes.
- *Expectant* patients should be located near the EMT area, but farther away from the decontamination lanes so they can be retriaged and stabilized for decontamination if the EMT area no longer has patients in it.

Warm side EMT area. Patients triaged as immediate for medical treatment are sent to this area until their condition is stabilized for patient thorough decontamination or for dirty evacuation to another medical facility. An initial quantity of medical supplies is located in this area to provide antidotes to chemical agents, bandages for wounds, equipment to establish intravenous (IV) access, intubation equipment to establish emergency airways, and decontamination kits to provide immediate or operational decontamination to patients. It is important to place only enough supplies here for the anticipated number of patients so that unused supplies are not in danger of contamination. The warm side EMT area should be large enough to expand and handle an influx of patients. Staffing should consist of trained and experienced medics (eg, emergency medical technicians, corpsmen), nurses, or physician assistants.

Warm side disposition (dirty evacuation). Located in the vicinity of the warm side EMT, here patients remain in protective ensemble and undergo operational decontamination and staging for dirty evacuation (by ground, water, or rotor-wing aircraft) to another MTF where adequate resources are available to care for them.

Contaminated waste dump. This area is located at least 75 m downwind from the hot line. Bags of contaminated clothing and bandages are taken to the dump, where they are buried and marked with appropriate hazard markers. The position is communicated to headquarters so that the waste can be disposed of properly.

Temporary morgue. A shaded area located on the warm side is set up where the contaminated remains of those who die while being processed through the PDS are stored. These remains stay on the warm side of the hot line and are handled in accordance with theater policy until they are retrieved by the services unit that turns them over to mortuary affairs.

Litter patient decontamination lane. Located between the warm side EMT and the hot line, this area is where litter patients have their clothing removed, contaminated bandages and splints replaced, and personal effects and field medical card (FMC) placed in plastic, zip-lock bags, and where they are decontaminated. Patients must be medically stable enough to undergo decontamination before they are brought to this area. Those performing decontamination also wear a toxicological agent protective (TAP) apron over their protective ensemble to keep the ensemble dry and allow the aprons to be decontaminated before conducting patient transfers. With the exception of the Air Force and some Navy units who have trained medical teams throughout the decontamination process, this area is staffed by augmentees who are closely supervised by an medic.

Ambulatory patient decontamination lane. This area is usually located parallel to the litter patient decontamination lane. Ambulatory patients who need to see the physicians at the MTF are processed through this area, where they have their

clothing removed, contaminated bandages and splints replaced, and personal effects and FMC placed in plastic, zip-lock bags, and where they are decontaminated. Ambulatory individuals without medical complaints requiring care at the MTF are treated in the treatment area and returned to their unit without undergoing decontamination or crossing the hot line, or they are processed through troop decontamination lanes and not through the medical ambulatory decontamination lane. Those performing decontamination also wear a TAP apron to keep their protective ensemble dry. This area is usually manned by at least one medic, and other augmentees if available, to supervise ambulatory patients as they are processed through the line and assist one another.

Contamination check area. This area is located between the decontamination lanes and the hot line. Here, completeness of decontamination is checked using the appropriate monitoring devices (eg, Improved Chemical Agent Monitor [ICAM] or M8 paper). Zip-lock bags containing the patient's personal items can also be unzipped and the monitors used to check for contamination of the items inside. The decontamination check of patients may not be necessary where fully plumbed decontamination tents provide adequate soap and water for a thorough wash.

Litter decontamination station. Here, warm side litters are washed and readied for reuse. Buckets and sponges with 5% hypochlorite solution are available as well as water to rinse litters. With a shower/roller system, litters need only to be sent back through the decontamination station for a wash with soap and water.

Weapons and contaminated personal effects storage area. Here, patient weapons and personal effects are secured and inventoried. Items from this area are decontaminated and moved through the contamination check area before being sent across the hot line. If personnel are limited, this area may need to be well organized and under the observation of personnel serving as security augmentees.

Warm side rest area. A shaded area where the PDS team can rest and drink water while remaining in their protective ensemble.

Hot line and shuffle pit. The hot line separates the PDS warm zone (dirty side) from the cold zone (clean side) where the MTF is located. *No liquid or solid contamination may cross the hot line.* The line must be indicated in some way (eg, by a barrier, tape line, or air lock) so that all personnel know they cannot cross the line until they are properly decontaminated. In the battlefield it is best to indicate this area with a specific barrier, such as concertina wire, to protect the medical facility. Shuffle pits or boot rinses are located at openings along the hot line to ensure that footwear worn by individuals moving across the hot line is decontaminated. At the hot line, information on the patient's FMC is transferred to a clean card, and litter patients are transferred to a clean litter to ensure that no contaminated cards or litters cross the hot line. A blanket is also placed on the patient once they are transferred to a clean litter. Team members on the clean side receive the patient. Staffing on the dirty side consists of the team in TAP aprons who decontaminated the patient and the warm side medic, if available. Receiving members consist of one medic and at least two augmentees for litter patients and one augmentee for ambulatory patients.

Vapor control line. This line is typically upwind of the hot line by approximately 10 meters. Patients and PDS team members remain masked until they cross this line. The line can be established using chemical vapor detectors such as the Automatic Chemical Agent Detection Alarm.

Clean Side

Protection. Personnel assigned to this area do not need to wear protective equipment because the patients in here are free from contamination. When processing infectious biological casualties, staff should practice universal precautions and wear appropriate respiratory protection.

Triage/EMT area (cold zone). Located beyond the hot line and vapor control line, this contamination-free area is where patients are retriaged and treated. It can be a holding and staging area for admission to the MTF, for clean evacuation to another MTF,

or for ambulance transport from a co-located (troop and patient) PDS to a nearby MTF.

Disposition/clean evacuation (cold zone). This area is adjacent to the cold zone triage / EMT. From this area, contamination-free patients who have been stabilized are staged for transport to another treatment facility.

Supply point. This point is located outside the vapor control line. PDS supplies are kept here and are handed across the hot line to the warm side when needed.

Patient Decontamination Site Critical Concerns

Warm Side Triage

It is important that the triage officer be practiced enough to effectively triage patients so that the PDS is not overwhelmed with patients who can be treated on the warm side and returned to their unit; who should be “dirty evacuated” to a larger MTF (if possible); or who can be stabilized in the warm area until they are ready for decontamination. The triage officer might be a senior medic in a battalion aid station. In larger medical units the triage officer might be a physician or physician’s assistant. The triage officer’s ability to evaluate the casualty will be limited because both the officer and the casualty will be in MOPP Level IV.

Warm Side Emergency Medical Care

Those casualties needing immediate care will be sent to the warm side EMT. Casualties classified as minimal might also be sent to this area, if the appropriate care can be provided in a contaminated environment, so that they can be returned to duty quickly and lessen the workload on the decontamination teams. However, the types of injuries that can be treated without breaking the integrity of the protective garment are small (although antidotes may be administered without breaking a garment’s seal). Once the garment’s integrity is violated, the minimal casualty will need to be treated and sent through troop decontamination to don replacement individual protective equipment (IPE) before being returned to the battle

area. Arrangements must be made with supported units to have replacement IPE available for these casualties. Decontaminated litter patients should be placed in a patient protective wrap if they need to be transported on dirty evacuation assets or through contaminated areas.

Casualties classified as delayed will be sent through the PDS for decontamination if they require care in the clean treatment area. Otherwise, they will be dirty evacuated to the next level of care that can better handle them. The expectant casualty will be temporarily set aside, adjacent to the warm side EMT, for later reevaluation when there are no more patients in the EMT station.

The amount of vapor arising from patient IPE should not be enough to preclude an apneic patient from being ventilated. Ideally, in a battlefield environment a resuscitation device, individual chemical (RDIC), with its filtered “ambu-bag” should be used. Ventilation of a newly apneic patient will be limited more by the lack of personnel to squeeze the ambu-bag than by the risk of forcing more chemical vapor into the casualty’s lungs. IV injections can be given and fluids started after decontamination of the skin at the IV insertion site and the care provider’s gloves. Minor suturing can be done in this area using the same precautions. The time needed by the single medical care provider to perform these procedures is probably the limiting consideration, rather than the risk of further contamination.

Preventing Musculoskeletal and Heat Injury

Patient triage, treatment, and decontamination involve moderate and heavy work. This can create heat injury and increase accident frequency as overheated workers overlook safety procedures. A safety officer must be appointed for operations on the warm side of the PDS. This can be the officer in charge, noncommissioned officer in charge, or some other individual. It must be someone who can observe the PDS workers, travel freely around the PDS, and manage work/rest cycles.

Worker musculoskeletal injury can easily occur from lifting patients, carrying litters, or falling while wearing protective ensemble. To reduce these injuries, clear routes within the PDS to reduce tripping hazards; establish decontamination lanes far apart to reduce clutter; enforce frequent garbage bag removal

to reduce trip hazards; train and enforce safe lifting techniques; ensure there are adequate rest breaks; and use work-saving equipment such as NATO litter carriers, if available.

Work/rest cycles (Table 8-1) should be carried out on the warm side of the hot line. Enforcing adequate worker rest helps ensure adequate hydration, gives the body an opportunity to get rid of excessive heat, slows down the production of internal body heat created during physical work, and provides greater blood flow to the skin. Wearing IPE generates heat that is not easily dissipated by the process of sweating because the wearer's skin does not contact the air. Wearing protective overgarments adds 10°F (5.6°C) to the wet bulb globe temperature (WBGT) index, and wearing body armor increases it by another 5°F (2.8°C). The

Table 8-1. Work/Rest Cycles

Heat Category	WBGT Index (°F)	Moderate Work		Hard Work	
		Work/Rest (Min)	Water Intake Qt/H	Work/Rest (Min)	Water Intake Qt/H
1 (White)	78–81.9	NL	3/4	40/20	3/4
2 (Green)	82–84.9	50/10	3/4	30/30	1
3 (Yellow)	85–87.9	40/20	3/4	30/30	1
4 (Red)	88–89.9	30/30	3/4	20/40	1
5 (Black)	> 90	20/40	1	10/50	1

NL: not limited (60 minutes work with minimal rest)

WBGT: wet bulb globe temperature

following are common forms of heat injury.

Heat stroke. *Cause:* The body's temperature regulatory system fails and sweating becomes inadequate. *Signs and symptoms:* Body temperature is usually 105°F (40.5°C) or higher. The victim is mentally confused, delirious, perhaps in convulsions, or unconscious. *Medical attention:* First-aid must be administered immediately because death can occur without rapid treatment. Move the victim to a cool shaded area. Process the victim

quickly across the hot line. Remove the victim's IPE, soak the underclothing with water, and fan the patient to increase cooling. Evacuate to nearest MTF for monitored fluid replacement.

Heat exhaustion. *Cause:* Loss of large amounts of fluid by sweating, sometimes with excessive loss of salt. *Signs and symptoms:* Sweating, extreme weakness or fatigue; patient may show giddiness, nausea, or headache; symptoms may resemble those of early heat stroke. The skin is clammy and moist, the complexion is pale and flushed, and body temperature is normal or slightly elevated. The victim may lose consciousness. *Medical attention:* Notify medical personnel immediately. Move the victim to a cool place to rest. Process the victim across the hot line as operation tempo permits. Encourage liquid intake and monitor status.

Heat cramps. *Cause:* Painful spasms of the muscles in those who sweat profusely and drink large quantities of water, but do not adequately replace salt loss. *Medical attention:* Cramps may occur during or after work hours and may be relieved by taking salted liquids by mouth. Move the individual to the warm side rest area and seek medical attention. *Return to work:* patient can be put in a less physically demanding position if the condition improves; or process the patient across the hot line when operations tempo allows.

Fainting. *Cause:* Heat causes blood vessels in the skin and lower part of the body to enlarge to try to cool the body. The blood may pool there rather than return to the heart to be pumped to the brain, causing the person to faint. Typically seen in a worker who is unaccustomed to hot environments. *Medical attention:* The worker should lie down in the warm side rest area. Elevate the legs and seek medical advice. Return the individual to duty when recovered or process across the hot line when operation tempo allows.

Underhydration and overhydration. A worker may produce 2 to 3 gallons of sweat in the course of a day's work. Do not depend on thirst to signal when and how much to drink; 5 to 7 ounces of liquid should be consumed every 15 to 20 minutes. However, water intake should not exceed 1 quart per hour or 12 quarts per

day. Excessive water consumption can dilute the salt content of the blood to the point where it interferes with brain, heart, and muscle function, which can result in heart attack and seizure.