

Casualty Flow Through The Deployed Medical Evacuation Chain

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Introduction

Within the Policy and Capability Studies Department (PCSD) of Dstl, we undertake medical OA to support decision makers in MoD, for both operational planning, which is short term, and long term equipment planning.

Casualties

Casualty Types. There are two types of casualties that are considered when assessing medical support requirement:

- Battle casualties and;
- Disease and non-battle injury (DNBI) casualties.

The battle casualties are estimated from combat modelling whereas the DNBI are determined by the population at risk (PAR) in theatre using historical evidence.

Triage. Casualties are prioritised into three main categories based on the urgency for treatment. The 'P' system of classification is typically used and is as follows:

- Priority One (P1)** – the highest priority assigned to cases that require resuscitation and surgery/treatment urgently.
- Priority Two (P2)** – assigned to cases that require possible resuscitation and/or early surgery/treatment and may be delayed longer than P1.
- Priority Three (P3)** – the lowest priority. Cases may still require surgery/treatment but may be delayed longer than P1 and P2.

Mass Casualty (MASCAL)

In a MASCAL situation, a different classification is used in order to enable the provision of the greatest benefit for the largest number of casualties. The 'P' system for triage is replaced by the 'T' system (T1-T4) where T1 is for those requiring life-saving but not time-consuming treatment whereas T4 is for those that have sustained serious and often multiple injuries whose treatment would be time-consuming and complicated with a low chance of survival.

The Medical Evacuation Chain

The land-based medical evacuation chain consists of a series of medical facilities which are designated a 'Role' number to describe their functional capability to deliver specific level of care (see Figure 1). Casualties passing between Roles of care should receive continuous, relevant and progressive care. The deployed medical chain typically comprises of 3 Roles:

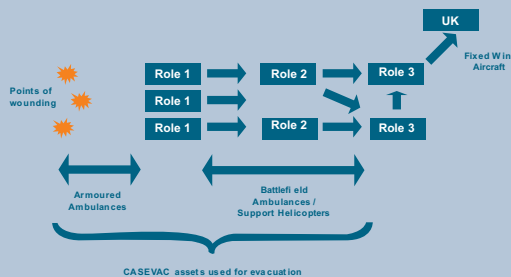


Figure 1: A simple representation of the land transfer chain

Role 1: Regimental / Unit Aid Post (RAP / UAP)



- Functions include
 - Medical evacuation from point of wounding to Role 1
 - Casualty triage
 - Treating minor casualties for immediate return to duty
 - Resuscitation and stabilisation

- Typical personnel include
 - 1 Doctor
 - 8 Medical Officers

Role 2 / 2+ : Dressing Station (DS) / Critical Care Station (CCS)



- Functions include
 - Medical Evacuation from Role 1 to Role 2
 - Casualty triage
 - Carry out medical treatment (Role 2) and damage control surgery (Role 2+)
 - Holding facility up to 25 beds

- Typical personnel include
 - 15 Doctors / Medical Officers
 - 4 Surgeons
 - 76 Nurses
 - 2 Anaes and Resus Teams
 - 67 Dental Officers / Technicians

Role 3: Field Hospital (Fd Hosp)



- Functions include
 - Medical Evacuation from Role 2 to Role 3
 - Casualty triage
 - Equivalent capability to an NHS hospital
 - o Major surgery
 - o Dentistry
 - o Radiology
 - o Intensive care unit
 - Wards with between 50-200 beds

- Typical personnel include
 - 22 Doctors / Medical Officers
 - 8 Surgeons
 - 213 Nurses (General, Burns, ITU)
 - 11 Anaes and Resus Teams
 - 13 Dental Officers / Dental Technicians

Often casualties require repatriation out of theatre back to the UK. In this case, the UK would be known as Role 4.

The afloat medical chain is similar to the land-based medical chain except the medical facilities are designated an 'Echelon' number to describe their functional capability to deliver specific level of care.

Analysis

To support equipment planning, we carry out analysis for particular scenarios of interest and test whether the deployed medical Order of Battle (ORBAT) is sufficient to support the anticipated flow of casualties, both battle and DNBI.

Large-Scale (LS) / Medium-Scale (MS) / Small-Scale (SS) Scenarios

The following represents the stages involved when testing a medical ORBAT for a particular scenario:

- Combat modelling determines the attrition to platforms for all coalition nations;
- Using historical evidence to determine the number of personnel casualties attributed to UK units; Casualties broken down into wounded in action (WIA), killed in action (KIA), captured/missing in action (C/MIA) and Battle Stress (BS)
- Using a post processor to the combat modelling, a casualty stream is generated by location and time;
- The casualties are then prioritised in P1, P2 and P3 by applying assumptions based on historical evidence;
- Using military advice, a medical footprint is laid down to position all medical facilities based on the locations of the casualties;
- **LS / MS scenarios.** These typically occur over a few weeks/ months and the casualty numbers are usually in the hundreds. Therefore a model is required to assist with the analysis.
 - o Populate the input sheet to a medical model;
 - The input data includes relevant distances between medical facilities, number of field hospitals, number of beds, number of surgical teams, number of ambulances for evacuation, casualty streams for both battle and DNBI casualties amongst other generic inputs;
 - o Run the model for the duration of the campaign and carry out a number of repetitions (typically 10). Results in the form of a spreadsheet;
 - o Carry out analysis – determine the number of P1, P2 and P3 casualties that receive treatment/surgery within the policy target times;
 - o Where there are shortfalls in capability determined by bottlenecks in the system, carry out an iterative process by adjusting the numbers of assets available in order to determine the optimum number of surgical teams, CASEVAC assets, and ward beds.
- **MS / SS Scenarios.** These typically occur over a few days with casualties usually less than a hundred. Therefore it's possible to carry out the analysis using spreadsheets.

MEDEVAC Model Overview

When assessing large-scale scenarios, a medical model called MEDEVAC is used. MEDEVAC is a medical assessment model developed within a simulation environment called Extend to model the flow of casualties through the medical evacuation chain from Role 1 to Role 3. The model allows users to test the ability of scenario-specific medical ORBATs to cope with the anticipated flow of casualties. Users are able to input data relating to casualty flow, field hospital resource levels and CASEVAC asset availability. The model then tracks individual casualties as they progress through the three stages of the system – transfer, treatment, and recovery.

Inputs

- The percentage split of battle casualties into the prioritisation categories (P1, P2, P3 and Battle Shock);
- The percentage split of DNBI casualties into the prioritisation categories (P1, P2, P3 and diseased);
- Relative distances between medical facilities;

- No. of Role 3 facilities;
- No. of ward beds at each Role 3 facility;
- No. of surgical teams at each Role 2+ facility;
- No. of recovery beds at a Role 2+ facility;
- No. of ambulances at each Role 2 facility for casualty evacuation;
- Arrival times of each CASEVAC asset;
- CASEVAC capability (speed, capacity)
- Treatment times;
- Recovery durations.

Outputs

The outputs are in the form of a spreadsheet where each row corresponds to data for a specific casualty. As the casualty flows through the medical chain, they are time-stamped at various locations such that the time spent in the system up to particular points can be determined. These time-stamps are the primary outputs in the excel spreadsheet.

The overall output is their total time in the system from the time a casualty enters a Role 1 facility up to the time they receive surgery at a Role 3 facility. This time (assuming they have reached the Role 1 within 1-hour from wounding) is then compared to the UK medical policy target times known as the 1-2-4 hour rule.

1-2-4 hour principle. It is best practice that a casualty will receive rapid access to first aid resuscitation within one hour from time of wounding; access to surgical resuscitation for those who require it within two hours from time of wounding; and primary surgery within four hours from time of wounding.

Results

There are five main measures of effectiveness that are reported:

1. No. of surgical teams;
2. No. of ward beds;
3. No. of CASEVAC assets (armoured ambulances, battlefield ambulances, and support helicopters);
4. No. of aeromed assets (fixed wing aircraft)
5. No. of on-board aeromed teams.

Surgical Teams

For the casualty stream in Figure 2, Figure 3 shows an example of the utilisation of surgical teams at a field hospital. The duration of surgery for the three priority categories are:

- 120 mins for a P1 casualty;
- 60 mins for a P2 casualty and;
- 35 mins for a P3 casualty.

Time (mins)	No of P1 casualties	No of P2 casualties	No of P3 casualties
0	0	0	0
60	2	0	0
120	0	1	1
180	0	2	4
240	0	0	6
300	1	1	4
360	0	0	2

Figure 2: Casualty stream example

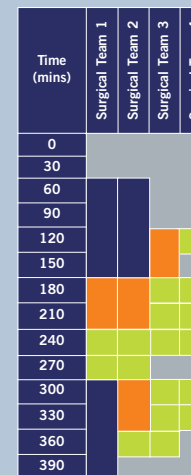


Figure 3: Surgery Teams utilisation for casualty stream shown in figure 2

Figure 4 shows an example of the bed occupancy and evacuation profile of casualties at a 50-bed Role 3 facility.

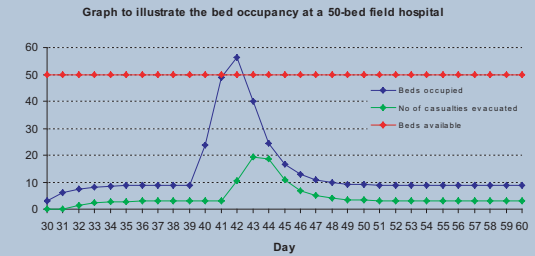


Figure 4: Bed occupancy profile at a 50-bed field hospital

CASEVAC / AEROMED Assets Requirement

AFV-432 armoured ambulances are solely responsible for the evacuation of casualties from point of wounding to Role 1.

However, transferring casualties from Role 1 to Role 2 can be done using battlefield ambulances or support helicopters.

Similarly to Role 1 to Role 2 evacuation, the transfer of casualties between Role 3 facilities can be achieved using either ground or air CASEVAC assets.

Repatriation of casualties from a Role 3 facility back to the UK or a NATO country (Role 4) is achieved using fixed wing aircraft.

An example of presenting the CASEVAC / Aeromedical evacuation requirements is shown below.

CASEVAC requirement

25 Armoured Ambulances (AFV432)
and
20 Battlefield Ambulances or 7 Chinooks or 10 Merlins

AEROMED requirement (in aeromed teams)

1 Future Strategic Tanker Aircraft (FSTA) flight per day
7 Aeromed Teams/ 3 Critical Care Aeromed Support Teams (CCAST)

Additional results can be extrapolated from the spreadsheet analysis such as graphically displaying the build up of casualties at particular points in the system showing shortfalls in capability. These shortfalls could be an insufficient number of evacuation ambulances, surgical teams or ward beds. An example of a chart showing a build up of casualties for surgery is shown in Figure 5.

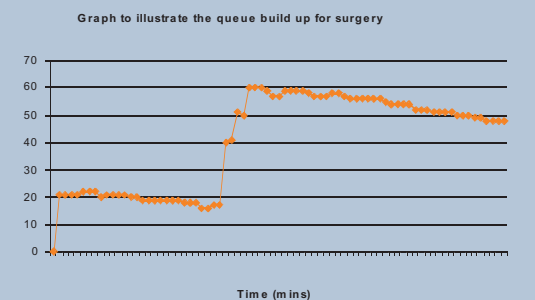


Figure 5: Graph showing the build up of casualties queuing for surgery