Magen David Adom Blood Services

Use of Blood and Blood Products in Disasters- Background Paper

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Identifying the Needs of Medical First Responder in Disasters (NMFRDisaster)
Theme 10 – Security; Call – FP7-SEC-2007-1

NMFRDisaster - Identifying the Needs of Medical First Responder in Disasters

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Partners:
- Al-Quds Nutrition And Health Research Institute (Palestinian Administered Areas)
- Ambulance Zorg Nederland (Netherlands)
- Centro per La Scienza, La Società e La Cittadinanza- CSSC - (Italy)
- Charles University (Czech Republic)
- Croce Rossa Danese- Danish Red Cross -(Denmark)
- Fundacion Rioja Salud (Spain)
- SAMUR Servicio de Asistencia Municipal de Urgencia y Rescate (SPAIN)
- Shield Group Inc. – Security and Counter Terrorism Management (Netherlands)
- SINERGIE Formazione e Consulenza Professionale (Italy)

- Magen David Adom (Israel)

Duration: 1 year (01.05.2008 – 30.04.2009)

Contents

BACKGROUND

Responsible Blood Services Agencies (RBSA) worldwide must be prepared to meet surges in demand for blood components, needed by casualties of natural domestic disasters and acts of terrorism.

Situations such as Hurricanes and Tsunamis, Wildfire, Floods, Earthquakes, as well as Pandemic influenza may create an increased need for blood and blood components. Man - Made hazards such as industrial accident (fire, building collapse and hazardous material spill), Explosive, Chemical, Biological, Radiological or Nuclear events can be added to this list (1).

In addition civilians and military personnel worldwide have increasingly become targets for bombing and other acts of terrorism (2). Events in Indonesia, India, Britain, Spain, Egypt's Sinai Desert, and the attacks on the World Trade Center and the Pentagon in the United States, have prompted reviews of the capacity of different health care systems to respond to domestic disasters and acts of terrorism (3).

In the framework of the project dedicated to identify the needs of medical first responder in disasters, a working part was included regarding the use of blood and blood products in such events.

Disaster definition:

Different international organizations define disaster in a similar ways:

IFCRC: The International Federation of Red Cross and Red Crescent Societies define a disaster as "a sudden, calamitous event that seriously disrupts the functioning of a community or society and causes human, material, and economic or environmental losses that exceed the community's or society's ability to cope using its own resources. Though often caused by nature, disasters can have human origins (4)."

EM-DAT: The Emergency Events Database similarly defines disasters as situations or events which "overwhelm local capacity, necessitating a request to national or international level for external assistance. (A disaster is) an unforeseen and often sudden event that causes great damage, destruction and human suffering. Though often caused by nature, disasters can have human origins" (5).

As this section of the project deals with the needs of medical first responders regarding the use of blood and blood components, a special attention should be given, in the scope of this background paper, to the definition of a Disaster in the blood services.

AABB: The American Association of Blood Banks states that "unless otherwise stated, the word disaster refers to any domestic disaster or act of terrorism that

• Suddenly requires a much larger amount of blood than usual

OR

• Temporarily restricts or eliminates a blood collector's ability to collect, test, process, and distribute blood

OR

• Temporarily restricts or prevents the local population from donating blood, or restricts or prevents the use of the available inventory of blood products and thus requires immediate replacement or resupply of the region's blood inventory from another region

OR

• Creates a sudden influx of donors, requiring accelerated drawing of blood to meet an emergent need elsewhere (6)."

Past lessons:

Previous international and domestic disasters have led to the following lessons:

1. There is a need to ensure that facilities maintain inventories of blood units and components at all times in all locations.
2. The required combined inventory of both RBSA and hospitals blood banks should be determined, for both regular activities and emergency situations, and closely monitored.
3. There is a need to control collections in excess of actual need in response to a disaster.
4. There should be a clear and consistent message to the blood community, donors, and the public regarding the status of the blood supply (both locally and nationally) during a disaster.
5. Countries should have a general response plan and continuous disaster planning, including participation in disaster drills and close coordination with regional, national, and international response agencies.
6. There is a need for an overall inventory management within the affected country, including a unified approach to communication among blood facilities, medical emergency services and hospitals regarding the needed amount, transportation of and existing alternatives to blood and blood components during a disaster (6-7).

REVIEW OF MAJOR EXISTING DATA

1. Overview of a response plan

Different countries have put together national and /or local response plans, which may be centered either on RBSA and /or on the local facilities in the affected area. The plans include recommendations for a national task force, which will consider the national response and recommend an action strategy including, but not limited to, the shipment of blood to the affected areas, and the coordination and dissemination of a message to the national blood community and donors.

A very good example is that of the AABB, which has created an Inter-organizational task force to be operational in Disasters, and which published a very comprehensive Operations Handbook on Domestic Disasters and Acts of Terrorism Disaster. The information was updated on October 2008, and is available at the organization website (6).

The response plan should include blood collection, processing and testing agencies, as well as Hospital blood banks and contain subjects such as:

Communication strategies- to ensure that there will be effective, communicate with both internal and external key parties during an emergency

Collection options- at designated facilities, adjusted to the type and scenario of the disaster

Transportation Options-regarding transportation to and from the collection sites, as well as blood supply to the hospitals

Managing Donors, Volunteers, and Crowds

Safety Concerns-regarding issues such as blood donors' eligibility, tests performed

Security Concerns – of blood donors, collection teams, blood services laboratories and other facilities and hospital blood banks

Human Resources- in order to ensure the continuity of operations at the Blood Collection facility, blood services components and testing laboratories and hospital blood banks, and balance it with the needs of staff tending to their own families

Information Systems and Records Management - to enable continuity of operation and assure data protection

Regulatory Concerns

Disaster Operations Handbook – Should Be Prepared at the Hospital blood banks levels

2. Blood collection in Disasters

Some disasters, both natural and man-made, can be predictable, and may include early warnings which will allow the RBSA to prepare larger inventories, to evacuate and/or take

shelter before the disaster occurs (i.e. hurricane, tornado, and war acts). Some may happen as a total surprise, without any warning (i.e. terrorist attacks, earthquakes, industrial HAZMAT events, etc.). The sudden onset of the latter event(s), together with the potential disruptions of the general infra-structure may cause a sharp increase in the immediate demands for blood components, thus creating a genuine challenge for the RBSA and hospitals (6 and references therein).

1. In most severe natural disasters significant, even catastrophic damages may occur, posing generally a risk to blood facilities directly and to other medical structures in their path. In addition the event could significantly hamper collection activities if a large area is deemed uninhabitable. Blood collection schedules may be disrupted, depending on the severity of the disaster and the size of the destruction path.

2. Industrial or chemical events may be the result of an accident (e.g. chemical manufacturing plant accident, rupture of a storage tank, train derailment) or as a deliberate action by terrorists. In such events blood collections at the blood center may be lost, and transport of blood collected at local blood drives may be adversely affected. In addition some militarized and industrial chemicals may require specific decontamination of buildings and vehicles and the administration of antidotes to people in the affected areas.
   RBSA should be prepared to minimize the negative impact of a chemical incident, ensure the re-establishment of operations, and protect staff, donors, and volunteers. Depending on the type of agent involved in the event, the blood center may face infectivity issues for staff, volunteers, and donors, need for contamination of facilities and vehicles and deferral of donors.

3. During biological events and/or bioterrorism attack the blood center may be required to conduct an aggressive call-back of donors who develop symptoms after a blood donation, because of the various incubation periods of different agents. Mandated quarantine measures or self-initiated actions by the population could result in loss of blood donations. In addition such measures, as well as travel restrictions may prevent or hinder blood center employees' ability to travel to work and collection sites, and may affect access to the supply chain for critical supplies, equipment, and fuel.

4. A radiological or nuclear event that may occur as accidental or terroristic dispersal of radioactive material. A "private case" may happen in blood banks that operate Cesium-137 blood irradiators.
   Nuclear explosion however, may combine large-scale blast damage with dispersal of radioactive material. Such events may have severe impact of blood donors' availability and deferral. Where radiation is widely dispersed, blood collections would be curtailed if the public (staff and donors) were advised to shelter in place for a period of time during assessment and early radioisotope decay. Blood donors may need extra screening or laboratory testing (blood lymphocyte count) concerning whether they have taken anti radiation medication or have evidence of radiation exposure by symptoms (e.g., vomiting) (8-10).

5. Following explosive events, either resulting from an accident or due to terrorist or criminal bomb, an immediate increased need for blood and blood components' is expected for about 20% of the total number of casualties (7,11-13)

6. There is no real prediction on the impact of a Pandemic influenza on blood collections and supply. Although a reduction in the need for Red Blood Cells (RBC) is expected, significant blood shortages (especially of platelets) may occur because of a shortage in healthy donors. In addition, the situation may have an impact on the availability of the blood banks employees and on the organization and execution of blood drives (14-17).

However, in order to meet the needs in any of the above mentioned disaster, RBSA should activate surge strategies to manage donors and volunteers. Donors should be discouraged from appearing en masse until the medical need has been assessed but a plan should be prepared to control significant crowds. Local authorities may direct the blood center to implement its shelter-in-place plan or evacuate, depending on the biological agent (6).
In addition research should be performed to evaluate the needs for "protected gears" for the blood bags to and from the collection centers to the blood services laboratories and to the hospitals blood banks in different disaster setups.

3. Needed Quantities of blood and blood components

Although the overall quantity of blood and components needed by hospitals during disasters may not constitute a large amount, when compared to the monthly or annually demands, the sudden onset of the event(s) and the potential disruptions of the general infra-structure may caused a sharp increase in immediate demands, thus creating a genuine challenge for the responsible blood services agencies and suppliers.
In disastrous situations the most frequently quoted quantity of blood units is 2-4 units of RBC and 1.5 components / casualty, required for victims of civilian trauma or military actions (7,11-13,18). The data from Israel till 2006 suggested that the “rule of thumb” in planning an adequate response of a national blood supply should be 1.3 RBC and 1.0 component/ patient, if all casualties are included or 6.7 RBC and 4.5 component/ severe or moderately injured patients. These estimates coincide with analyses made after the World Trade Center and Pentagon attacks (18), Oklahoma City bombing (19), war casualties in Sarajevo (20) and others (21). However, in view of recent reports in the literature, regarding better understanding of the mechanism of the coagulopathy in trauma, and the new approaches in its management, the use of blood components should be further investigated and re-considered (22-23).

Potential Impact on the Blood Supply

1. **natural disasters**

Depending on the projected path and force of the hurricane, tornado or flood, blood may be needed to treat casualties, which may number from a few to scores. However, there may be a slight decrease in elective surgeries shortly before and after the storm, followed by a spike in such surgeries once hospitals in the region resume full operations.

The impact on the blood supply following an earthquake could be directly affected by the severity of the event. Blood usage may not be initially significant, as hospitals may temporarily suspend elective surgeries. However, an increased demand may occur once survivors are evacuated to the different hospitals in the coming days, and/or when operations are back to normal.

RBSA should make special preparations to ensure that operations can be quickly resumed following such a natural disaster, and that adequate communication channels exist with the hospitals.

2. **Industrial/chemical/biological events**

If the industrial accident involves the blood center the blood supply should be quarantined until its safety, purity, and potency can be determined. Accidents that do not directly involve the blood center may or may not require increase in the blood support, depending on the nature and number of injuries. The public often will respond by donating blood out of a desire to help.

Most chemical events do not increase the immediate demand for blood products, although some compounds may have complications requiring blood product support later.

3. **Radiation toxicity and nuclear events:**

These events may cause suppression of hematopoiesis, thus victims may need support with RBC, platelet, and granulocyte transfusions, mostly with irradiated and leukoreduced cellular blood components. Highly exposed persons (3–10 Gy) may be considered for hematopoietic stem cell transplantation, requiring HLA typing, donor matching, stem cell collection, and transfusion support after transplant.

National and International coordination of supply and demand for blood components and hematopoietic progenitor cell units would be required as part of the overall emergency response.

4. **Explosive events:**

Immediate mortality may be high, and some survivors would require resuscitation and surgery, with associated transfusion support. As previously mentioned data from Israel as of 2006 indicate that in planning an adequate response of a national blood supply should be

1.3 RBC and 1.0 component/ patient, if all casualties are included or 6.7 RBC and 4.5 component/ severe or moderately injured patients. In theses events 73% of the blood supplied over the first 24 h was administered during the first 2 h. The cross-matched/transfused ratio was 2.52 – 1.42, reflecting the overestimation of blood requirement in these mass casualty episodes.

A comprehensive program for managing blood operations in emergency situations and a coordinated national program can stabilize in-hospital inventories during routine activities, ensure instant access to precisely defined inventories, facilitate sufficient supply in times of disasters, and minimize outdating and wastage

Local inventories of blood components would need assessment for adequacy and augmentation. Surges of blood donors have occurred after such events, and coordinated public announcements about the blood supply are helpful to strike the appropriate balance between supply and demand. (7)

5. Pandemic Influenza

The scenario of Pandemic influenza describes a situation when a new influenza virus will emerge, while people have little or no immunity to it, the agent will be easily spread from person to person, while there will be no vaccine.

The impact of a pandemic flu on the blood supply is a topic of much discussion. No one can predict the next pandemic flu, either in timing or impact. Generally accepted planning estimates a reduction in the need for RBC by as much as 25%, referencing the 2003 Toronto experience with severe acute respiratory syndrome (SARS). It is believed that the requirements for platelets will remain unchanged, as chemotherapy patients will continue to need platelet support. The impact on frozen products is of less concern because of the extended shelf life of these products. Even if the demand for some blood products declines, significant blood shortages (especially for platelets) may occur because of a shortage of healthy donors (15-16).

4. Safety of blood components:

The availability of blood may be the primary concern in a disaster, but the safety of the blood supply is also paramount. Most countries declare that adherence to regulations is crucial, and every effort should be made to follow the current good manufacturing practice regulations and standards employed.

Based on the American experience from September 11th 2001, a 5.2 increase was observed in 1st-time blood donors (24), and donations confirmed positive for human immunodeficiency virus (HIV), hepatitis C virus (HCV), and hepatitis B surface antigen nearly tripled between 1 week before September 11 (0.1%) and 1 week after the attacks (0.3%), largely explained by the increase in first-time and lapsed repeat donors.

Furthermore, during a disaster situations may dictate the need for regulatory exemptions, due to technical inability to prepare and store blood components, to perform (all) the needed tests, etc. For such events different and new approaches should be considered.

4.1 Manual testing

1. Transfusion transmitted Diseases:

Few makers had development various serological assays for Transfusion transmitted Diseases such as HIV, HCV and HBV on rapid diagnostic platforms aimed at low-equipped or non-laboratory settings and point-of-care testing (25)

A search should be made for test kits that accommodate as many samples as possible, but which does not require infra-structure and additional instrumentation, and can therefore be deployable in multiple settings, from centralized laboratories and blood banks to remote point-of-care test locations.

2. Blood grouping:

Blood grouping, especially AB0 and RhD determination, is critical for the blood transfusion compatibility.

Correct AB0 type of the donor and recipient blood prevents acute intravascular post-transfusion hemolytic reaction which could have potential of fatal outcome in case of incompatible transfusion.

Transfusion service centers and hospital blood banks are now performing the blood grouping on semi- or fully automated instruments, based on different principles /agglutination with centrifugation is the most common, others are agglutination by sedimentation, agglutination with magnetization of red cells, column (gel) test and solid phase test (26). These tests are highly accurate but dependent on complicated instrumentation, precise organization of sampling and identifying samples and computer and electricity supply. Most of above mentioned tests are also

available in manual versions, but these are also dependent on availability of electricity power at least.

On the other hand a simple alternative is available- slide test using mixing drops of blood and reagents on glass, ceramic or plastic surface. But this test has many disadvantages /infectious risks, possible cross-contamination, dots drying, missing of weak reactions, difficult reaction identification and result documentation.

A search should be therefore initiated in order to find a testing procedure which does not require infra-structure and additional instrumentation, and can therefore be deployable in multiple settings, from centralized laboratories and blood banks to remote point-of-care test locations.

4.2 Recommended Training and Assignment Sheet

RBSA should developed a handbook of strategies and approaches to domestic disasters and acts of terrorism to ensure that blood collection and distribution efforts run smoothly and are managed properly, and that the public receives clear and consistent messages regarding the status of the blood supply.

"The exercises should be followed by a written knowledge assessment to ensure competency and to evaluate the course. The organization should schedule annual refresher training for all staff, along with quarterly or semiannual disaster drills that include resource-sharing groups."

4.3 Un-tested blood for infectious markers

The last alternative could be the decision not to test blood units collected under extreme fierce conditions (e.g. facility evacuation and shutdown, surge of blood collected over testing facilities, with increased need for the blood and components). This very responsible decision should be taken by the leading RBSA, together with the national health authority, and if possible be based on pre-collected data of blood donor epidemiology in that country/region.

5. Alternatives to conventional blood units and components:

Today, most RBC units are preserved in liquid state for a maximum duration of 42 days, depending on the additive solution used. Less than 1% of the collected blood is frozen for long term storage. Frozen inventories of plasma and cryoprecipitate are easy to build and maintain. However, the issue of having inventories of frozen cellular blood components for disasters is a subject of continuous discussion and debates, also taking into consideration the

long, vulnerable supply lines and unpredictable points in time where these products are needed

1. **Red blood cells (RBC)** can be frozen in glycerol solutions and stored for many years. Thawed RBC must have the glycerol removed, but the recovered cells have normal survival in humans. Freezing has been used to store RBC of rare phenotypes for more than 40 years. In the 1960s and 1970s, when medical technology and blood use were expanding rapidly and liquid whole blood and RBC storage were limited to 3 weeks, many attempts were made to expand the use of frozen RBC for meeting the needs for a stable blood supply and to have RBC reserves for emergencies. These attempts have largely been abandoned because of the cost of freezing, storing and processing, better management of the larger and longer lived RBC inventory, concerns about the safety of stored RBC that have not received the most up-to-date testing and the losses associated with the short shelf life of thawed RBC. Despite the introduction of new automated frozen RBC processing systems, which will potentially allow extending the outdating of thawed RBC to 2 weeks, there still will not materially effect the costs or losses associated with the use of frozen RBC. As a result of the long cumbersome and expensive washing process frozen thawed RBC units cannot be used in acute scenarios such as a battle field or disaster areas. In addition, transportation of frozen units is expensive and introduces logistic challenges, while not having a significant effect on the logistics of blood supply (27)

2. **Frozen cellular blood components:** Some institutions have created systems of frozen blood components of universal donor red cells, plasma and platelets (28).
   This -80°C frozen inventory of the most essential blood components readily available after thawing (and washing if required), enables them to safely reduce shipments and abandon the backup "walking blood bank", without compromising the availability of blood products in theater. Moreover, the authors declare that all thawed (washed) blood products were in compliance with international regulations and guidelines.
   Other publications claim that the frozen blood reserve can likely support normal hospital red blood cell (RBC) demands during typical (3-4 days) seasonal shortages, provide a reduced supply for up to 10 days, or meet an unexpected transient increased RBC demand without requiring intensive support from the regional blood

center. However, they also emphasize that the frozen blood supply is not designed to meet the massive transfusion demand associated with extreme or sustained disasters. Rather, it serves as a short-term bridge-over supply until blood center support can be reestablished (29-30)

3. **A-cellular oxygen carriers red cell substitutes,** such as hemoglobin solutions and perfluorocarbon emulsions have been evaluated throughout the years (31-32). Although it was shown that products can maintain normal levels of oxygen consumption, CO2 production, and circulatory dynamics in primates in the virtual absence of the red blood cell, clinical trials with most of them have been discontinued due to the lack of efficacy and severe side effects in clinical trials. Alternative uses for oxygen carriers continue to be explored.

4. **Alternatives:**

In view of these draw backs a search should be therefore initiated in order to find a freezing and thawing procedures which do not require time, highly qualified man-power, infra-structure and additional instrumentation, and can therefore be deployable in multiple settings, from centralized laboratories and blood banks to remote point-of-care test locations.

ISSUES FOR THE INTERNATIONAL AND EUROPEAN AGENDA

Response to disasters tends to have an international influence, requiring close collaboration of many groups and their involvement in the response efforts.

It has been shown to be the case in both natural and man-made disasters. Disasters which happened lately both in developed as well as in developing countries, brought members of the non-affected areas to offer help and support those affected toward a fast recovery. Although a wide range of differing cultural and ethical values may exist, in the professional blood banking community such diversities have no influence on the will to help and support the needed countries/societies. However, it is true that the lack of international agreements relevant to disaster response may hamper the support efforts, and there is a place for an international guidelines that can be accepted among fellows countries /professional societies regarding the mutual recognition of professional standards, so blood units and components can be supplied and

accepted, from one area to another. We feel that there could be better preparedness and therefore response to disasters among the different members in the European and International blood banking community, if such standards will be put in place.

Today many blood banks work according to either CE or FDA guidelines, using similar (and sometimes compatible) Data Management Systems that may facilitate mutual support. However, a preliminary planning should take place regarding this mutual recognition, and generally accepted guidelines for different stages and severity in Disasters should be decided upon, as part of a universal contingency plan. A comprehensive review and the creation of an official document clearly stating the professional guidelines for collection, testing, inventory management and supply could greatly improve the Transfusion Medical treatment that countries hit by disaster can provide to the population involved. Such guidelines will have to take into consideration the existing disparities between countries and regions. The existing Guidelines and preparedness plans of the AABB inter-organizational task force or those of the International Federation of Red Cross and Red Crescent Societies are actually used in the different countries, while they could become universal and international legally binding documents. This could improve the Disaster response plans and provide better approach to disasters, especially in the view that their occurrence may only increase over the coming years.

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ANNEX 1: MDA WORKSHOP PROGRAM

Identifying the Needs of Medical First Responder in Disasters NMFRDisaster
Theme 10 – Security; Call – FP7-SEC-2007-1

WP-5: Use of blood and blood products in disasters
Coordinator: Prof. Eilat Shinar
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The workshop took place in 24-25/11/08 in Israel

A. Workshop plan:

1. Following the project kickoff meeting, which took place in Jerusalem on May 2008 it was decided that the workshop of WP-5 will be conducted in Israel.
2. It was decided that the workshop will include 2 days of presentations and discussions, followed by summary and recommendations for future actions, to be submitted to the Commission.
3. The program will hold 3 sessions every day. In each session 4 presentations of 20-30 minutes each will given by international experts, followed by a 30 minutes Q & A panel discussion.
4. The suggested daily planned itinerary will be:
   Session 1-09:00-11:00
   Session 2-11:30-13:30
   Lunch- 13:30-14:30
   Session 3-14:3017:00-
5. The following subjects are suggested:

   1. Use of Whole blood and blood Component in Transfusion Therapy at the battle field and in field and conventional transfusion centers
   2. Rapid testing techniques
   3. Alternatives/additions to conventional blood components therapy
   4. Preparedness for Natural and Man-made disasters
   5. Visit to MDA blood services center

B. Participants:

We suggest that participants in the WP-5 workshop will be:

a. Members of the consortium:
   a. Fundacion Rioja Salud, Spain
   b. SAMUR, Spain
   c. AmbulanceZorg, the Nederland
   d. MDA blood services, Israel

    e. El Quds University, PA
b. Additional recommended Professionals from the participating members' countries (1member/country)
c. Additional professionals from the Palestinian Authority and/or the Palestinian Red Crescent
d. Local professionals in Israel, such as:
    a. Representatives form the IDF (Medical Corps and Home Front Command)
    b. Members of the Israeli Consulting committee for the Organization of Blood Services during Emergency situations