

Blood Transfusion for war injuries: Experience from northern Israel, summer 2006

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RAMBAM Health Care Campus Haifa Israel



Rambam Campus (900 Beds tertiary medical center, level 1 trauma center for the north of Israel serving 1.3 million inhabitants)



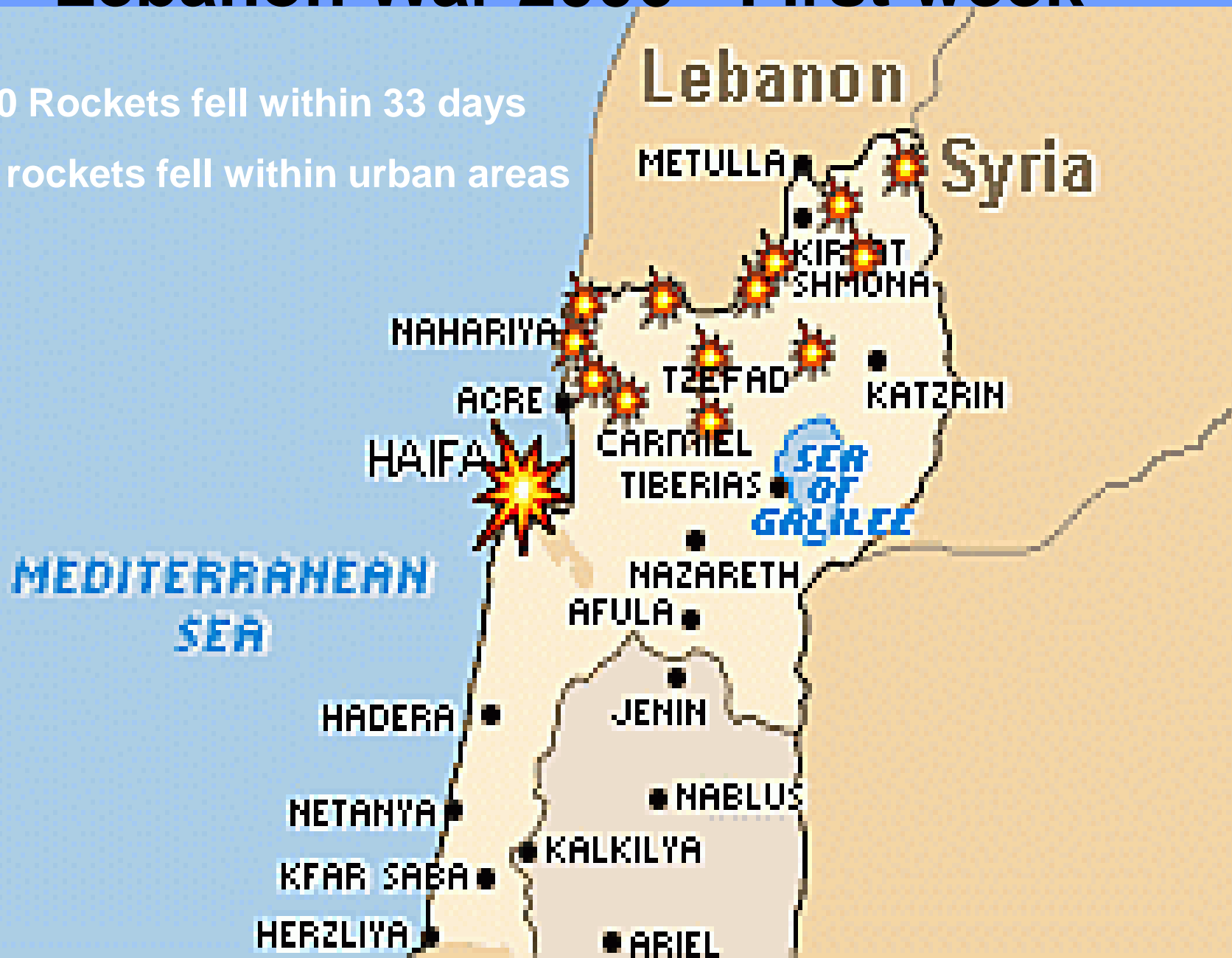
**More than 45 rockets fell within 0.5 KM of Rambam medical center
Overall 93 rockets fell over the city 13 Death**



Lebanon War 2006 - First week

3970 Rockets fell within 33 days

901 rockets fell within urban areas



August 13, 2006

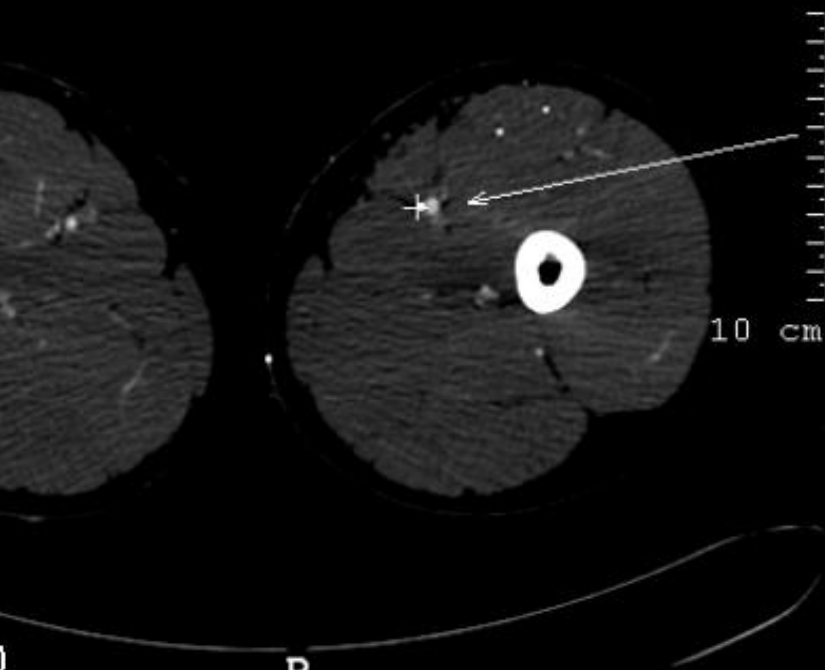


House Hit in Bat Galim- 9 injured

17.07.2006



Which shrapnel should be extracted ???



R

10 cm



20 cm

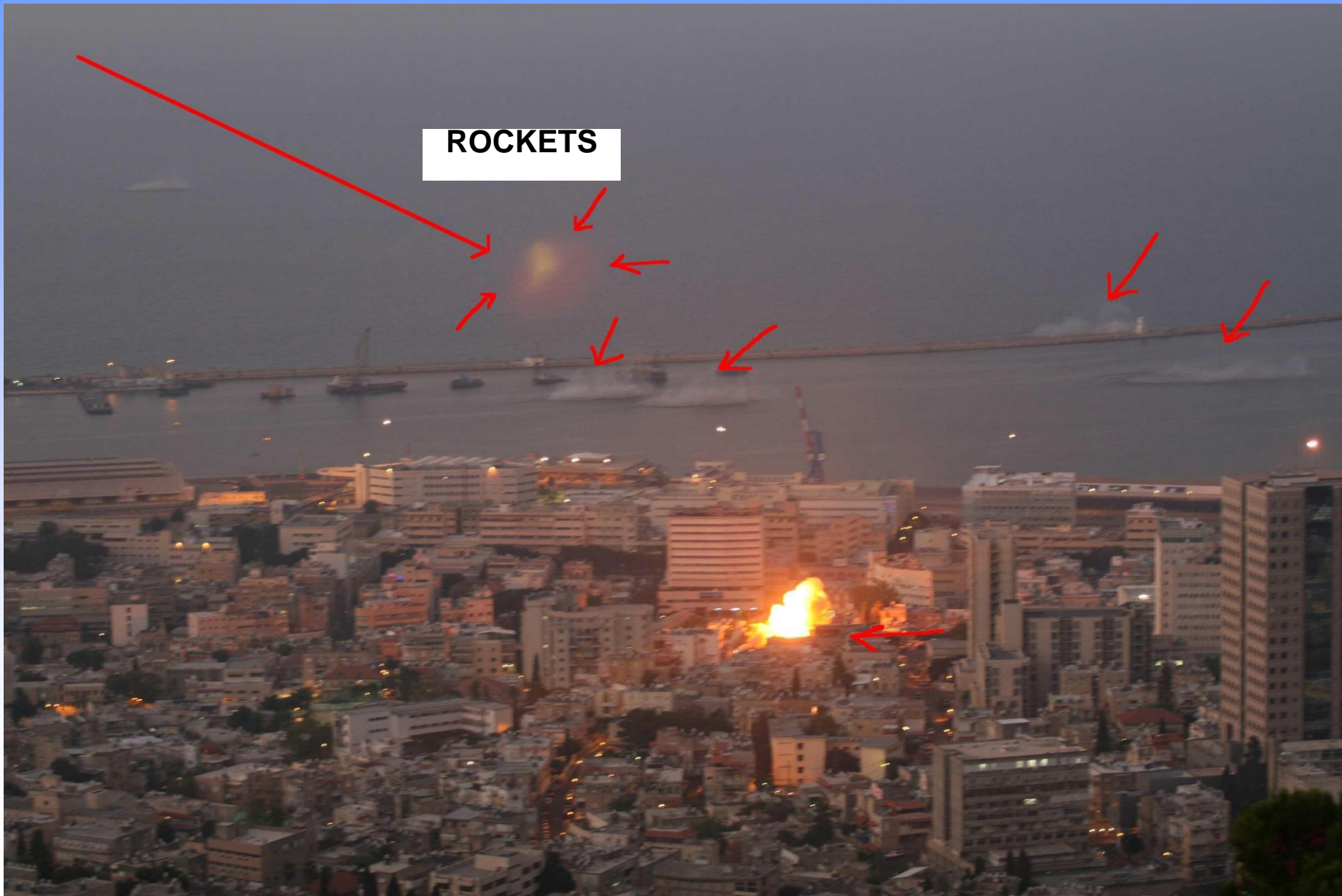
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Lecture objectives

- Organization of emergency department for mass casualty even
- Transfusion medicine in mass casualty events
- Massive transfusion protocol.
- Pharmacologic treatment (anti fibrinolytic, activated factor VII)
- Fresh whole blood ?



Hospital Under Attack- Sunday, August 6th



Trauma Center- Evening Attack on Haifa Rambam- Sunday, August 6th



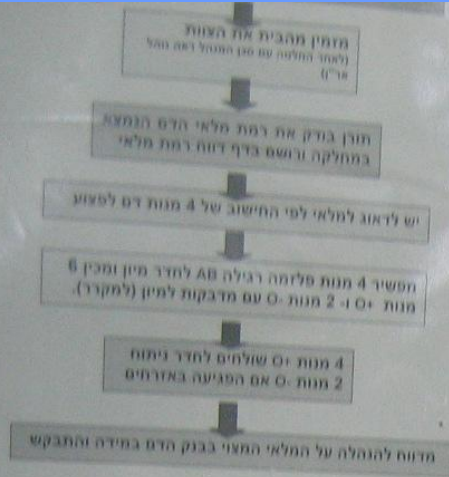
27/02/2007

בטחון

תורן בטחון - מירס
40-2525
44-465
איתורית

שער ראשי - טל. 2747
אינטרקום 5119

משרד - (עד השעה 13:00)
טל. 2639



מספר טלפון בנק הדם - מגן דוד אדום ישיור בחיפה
מספר טלפון מגן דוד אדום, חיפה
מספר טלפון מ"מ, תל-אביב (מוקד) - משלוחים

8533876 / 855
101 מ 851
5300436

רשת קריאה בנק הדם:
בזמן חרום שבדי בנק הדם כמות וכן יודיעו מידית **לאחראית המעבדה** (פילץ) שחלילה
על דימון עזרה. אין להתקשר ישירות לראשי חלילה.

פילץ: 45-2177 טמוראית מעבדה

| חלילה א' | חלילה ב' | חלילה ג' |
|--------------------------|------------------|------------------|
| מחלה טל. 85814 | רעות טל. 85805 | לוחב ג טל. 85807 |
| בית: | בית: 8597690 | בית: 8224915 |
| קללה טל. 45-4902 | גריש טל. 85810 | ליקח טל. 85812 |
| בית: 077-5254006 | בית: 8520045 | בית: 8529406 |
| | | קין טל. 85704 |
| | | 077-5252032 |
| עידית טל. 45-1210, 85822 | לוחב א טל. 85806 | יוליה טל. 85424 |
| בית: 8244278 | בית: 8737599 | בית: 8252348 |

טל. מרכז קריאה מירס מ"מ ישיור דוד וסגן ראש
מירס 052113 00000
מירס 052113 00000
מירס 052113 00000

Back up for communication
system since cellular system
will collapse during such
incidence

Flow of duties for large scale casualties events

- BTS technician is informed on a large scale casualty event.

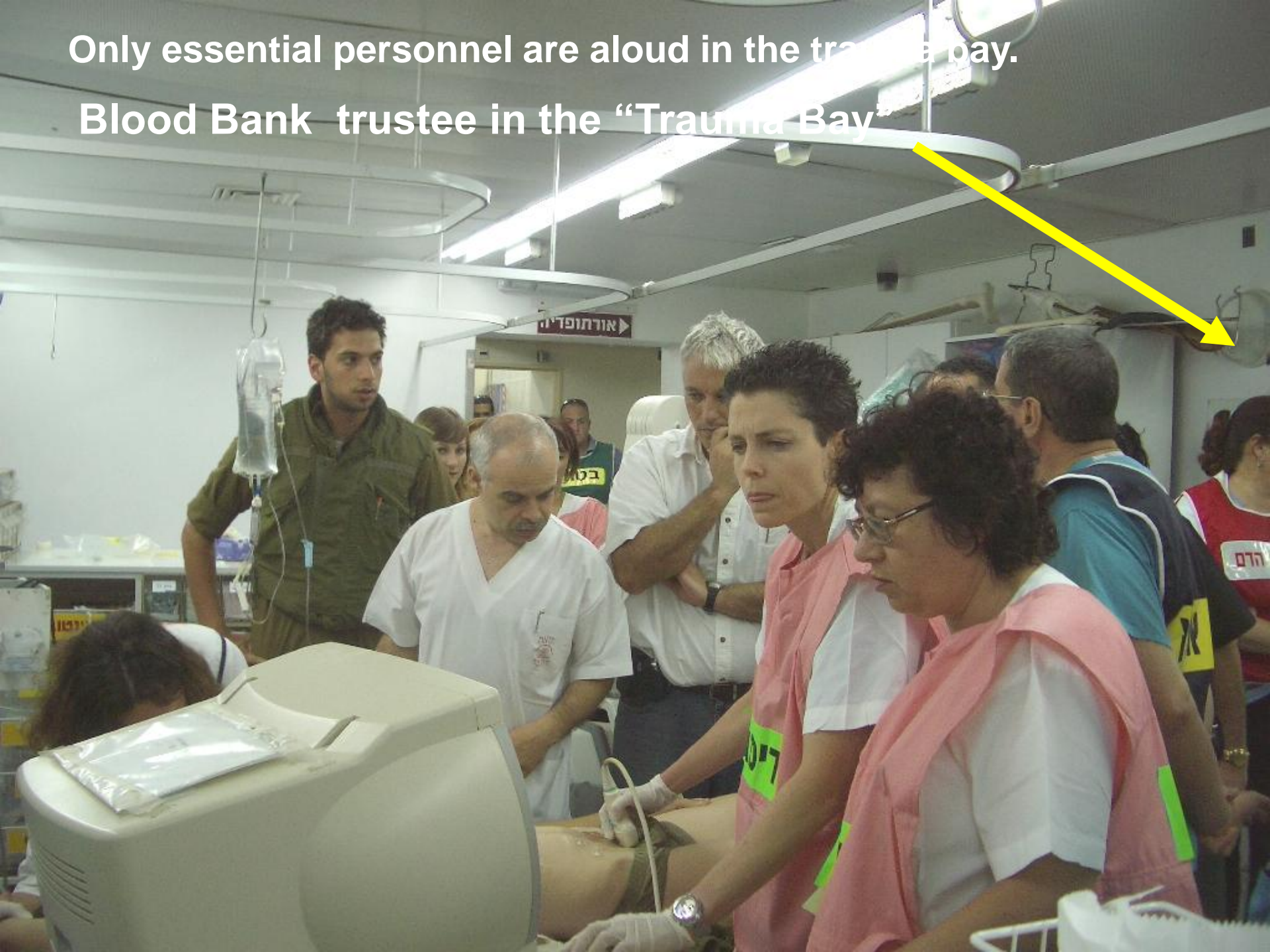
Notify Blood Bank Director.

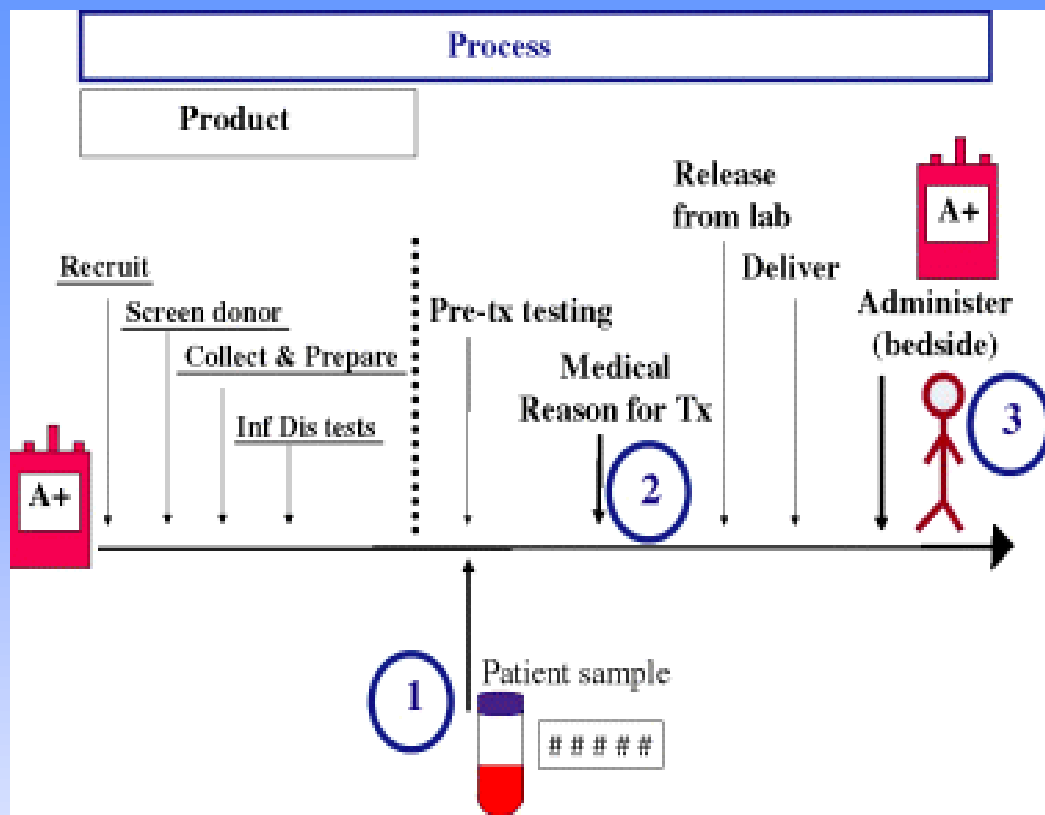
- If unavailable, notify Deputy Director Summon the BTS technician on call to hospital and if needed, summon other BTS members.
- Thaw 4 units of FFP AB, label and prepare 6 O^{pos} PRBC and 2 O^{neg} PRBC to be sent to the ER (will be kept in the refrigerator until demanded)
- Check the blood product stock. Make sure that the stock is full. If more than 50 casualties are expected, order RBC 1,3 x Nu of patients (A x 0.4, O x 0.4, B x 0.2)
- Report to hospital administration if additional blood products are required.



Only essential personnel are aloud in the trauma bay.

Blood Bank trustee in the "Trauma Bay"





Transfusion Safety: process and product. Safe transfusion depends upon a series of linked processes and includes more than just blood safety. Numbers 1–3 refer to the three zones of error in the process of transfusion. See text for details

1. Presence of a blood bank representative, e.g., BTS deputy director or another “blood bank trustee” in the ER with the aim to monitor the samples for type and screen and thus **reduce hazardous miscollection or mislabeling**

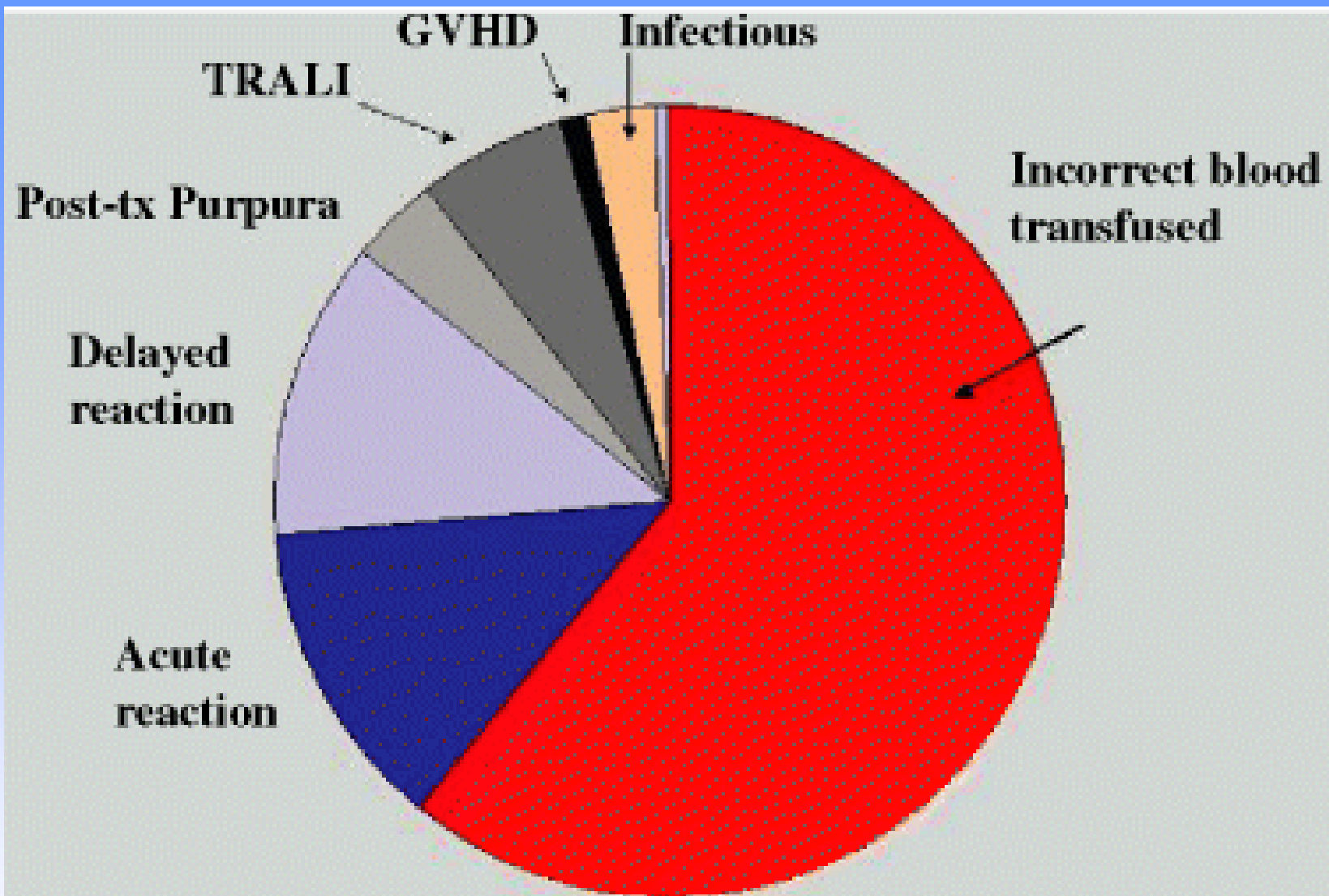


Fig 3 Serious hazards of transfusion (1996–2001). The relative frequency of different transfusion risk is shown. Data available from <http://www.shotuk.org/index.htm> TRALI, transfusion-related lung Injury; GVHD, graft-versus-host disease

3. Since the use of a running temporary 8-digit ID number for unidentified patients is prone to human errors under the stress of a large scale casualty event, an addition of a second, **4-digit number printed in bold and large size font proves to be beneficial.**

Case 1020

Izraeli Adam

Age24

ID 5547552-1

IIIIIIIIIIIIIIIIIIII

Case 1021

Unknown

Age

ID 7012345-6*

IIIIIIIIIIII

1. Presence of a blood bank representative, e.g., BTS deputy director or another “blood bank trustee” in the ER with the aim to monitor the samples for type and screen and thus **reduce hazardous miscollection or mislabeling.**
2. Presence of one more “blood bank trustee”, i.e., either a transfusion medicine physician or an expert in coagulation and disorders in the OR. This person, preferably the **BTS Director, provides real time consultation in issues related to transfusion medicine, acts as a liaison between the OR and the blood bank** and also monitors blood products requests and available products on the anesthesiology cart trying to reduce mistransfusion.

Blood Bank trustee in ER



Packed Red Blood Cells requested and transfused in 3 medical centers following suicide bombing events

| Date | No. of patients admitted to the ER | No. of patients for whom blood was ordered | PRBCs matched (first 2 h) | PRBCs released (first 2 h) | PRBCs transfused (first 2 h + unmatched) | C/T ratio (first 2 h) | % PRBCs transfused |
|------------------|------------------------------------|--|---------------------------|----------------------------|--|-----------------------|--------------------|
| 2 December 2001 | 19 | 9 | 32 | 48 | 22 + 16 | 1.45 | 79 |
| 31 March 2002 | 30 | 5 | 41 | 47 | 22 + 5 | 1.86 | 57 |
| 7 May 2002 | 10 | 6 | 10 | 29 | 5 + 11 | 2 | 55 |
| 22 May 2002 | 44 | 8 | 22 | 38 | 4 + 10 | 5.5 | 37 |
| 4 August 2002 | 11 | 7 | 14 | 16 | 9 | 1.55 | 56 |
| 9 September 2003 | 36 | 11 | 12 | 93 | 8 + 56 | 1.5 | 69 |
| 4 October 2003 | 31 | 15 | 46 | 34 | 11 + 4 | 4.18 | 44 |
| 26 October 2005 | 33 | 6 | 31 | 28 | 11 + 4 | 2.81 | 53 |
| 5 December 2005 | 21 | 3 | 9 | 7 | 5 + 1 | 1.8 | 86 |
| Total | 235 | 70 | 217 | 340 | 204 | | |
| Mean \pm SD | 26 \pm 11 | 7.78 \pm 3.56 | 24 \pm 14 | 38 \pm 25 | 22.6 | 2.52 \pm 1.42 | 60 \pm 16 |
| Median | 30 | 7 | 22 | 34 | | 1.86 | 56 |

An excessive demand is common that may lead to temporary impression of Blood products shortage

What quantity of blood products do we order from the blood bank depot?

Blood requirements us. Wounding Agents Vietnam

| | Gunshot | Artillery (Mortar/Rockets) | Mines and Booby trapst |
|--|-----------|-------------------------------|---------------------------|
| Casualties* | 4565 | 6631 | 1854 |
| Percent requiring blood | 23.7% | 14% | 37.0% |
| Mean blood requirements (all casualties) | 1.6 units | 1.0 units | 1.9units |
| Mean blood requirements (casualties requiring) blood | 7.2 units | 6.3 units | 8.9 units |

***Does not include burns ,multiple agents, and unknown categories were excluded**

Booby traps include grenades, which are otherwise omitted

Mendelson JA The use of whole blood and blood volume expanders in US military medical facilities in Vietnam The J of TRAUMA 15;1:1-13 1975

Was patient given blood products on his way to hospital?



Over 40 Helicopters Landed at Rambam
Median evacuation time of 3 hours versus 1H and 10 min reported by the German trauma registry



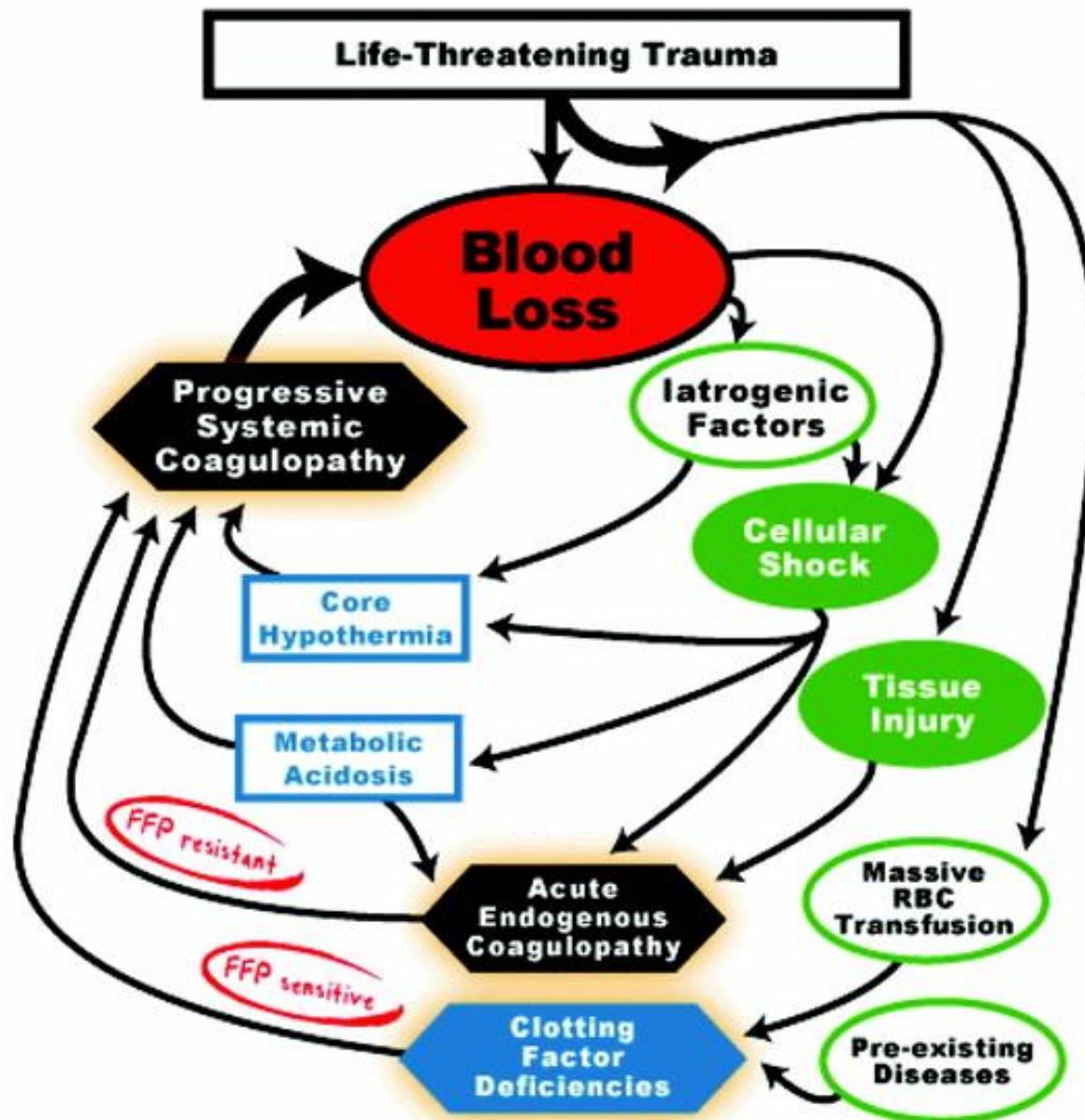
Management of massive blood loss: a template guideline

Therapeutic goals:

- Maintenance of tissue perfusion and oxygenation by restoration of blood volume and restoration of blood volume and haemoglobin. Treating any surgical source of bleeding;
- Correcting coagulopathy by the judicious use of blood component therapy.

"Early consultation with surgical, anaesthetic and haematology colleagues is advisable and the importance of good communication and cooperation in this situation cannot be overemphasized."

Stainby D Br J Anaesth 2000; 85:487, Br J Haem 2006 135



Massive transfusion

Defined as transfusion of 10 or more PRBC within 24 hours

Transfusion of ≥ 5 units of PC within 4 hours

Coagulopathy is common and once present is difficult to correct

Early treatment with plasma and platelets are associated with improved outcome.

Goals: plasma coag factors $>40\%$ **INR** <1.5

Platelets counts **50 – 100** $\times 10^9/L$

Temperature $>34^{\circ}C$

improve tissue oxygenation to reduce acidosis

TRANSFUSION- ISS MEDIAN 17 (6-75)

PT'S who had MASSIVE TRANSFUSIONS 7-8/2006

MASSIVE

| N=21 | HB | PLT X10 ³ /u l | B.E. | PH | H ₂ CO ₃ ⁻ | INR | PTT | FIBRINOGEN |
|---------------------------|--------------------|---------------------------------|--------------------|-------------------|---|-------------------|-------------------|------------------|
| Emergency room (RANGE) | 10.6 (7.3-13.7) | 262 84-464 | -5.8 -22-0.4 | 7.318 6.92-7.5 | 20 7.4-25 | 1.26 1.12-2.2 | 33'' 24-57 | N.D |
| 1H-2H | - | - | -3 -15 - -2 | 7.01-7.34 N=3 | 22 13 -24 | 1.55 1.24-2.31 | 44'' 23-89 | 119 62-183 |
| H4-H8 | 9.9 6.6-15.1 | 120 84-173 | -1.6 -7.8 - +10 | 7.355 7.2-7.4 | 22.6 18 - 35 | 1.35 1.03-2.33 | 41'' 30 - 53 | 181 102 - 245 |
| 24H | 10.52 7.9-14.4 | 98 40-213 | 0.7 -2.2-+6.4 | 7.42 7.29-7.49 | 25.4 20.3-31.2 | 1.27 1.01-1.47 | 38.9 30.7-43.9 | 272 49-358 |

Casualties admitted to 3 hospitals during July 12th to August 15th 2006

| Medical Center | Total number of patients | Pt's with anxiety | Wounded Pt's (hospitalized) | Pt's transfused | Pt's receiving massive transfusion |
|-----------------|--------------------------|-------------------|-----------------------------|-----------------|------------------------------------|
| Rambam | 842 | 338 (10) | 504 (289) | 60(7%) | 21(35%) |
| Ziv | 1558 | 420 | 1138 (415) | 32(2%) | 4(12.5%) |
| Western Galilee | 1805 | 937 | 868 (195) | 15(1%) | 1(6%) |

Blood product transfused to casualties from July 12th to August 15 2006 during PFG II v PFG 1982

| Medical Center | Patients (n) | Packed Cells PRBC | Fresh frozen Plasma FFP | Cryo – precipitate | platelets |
|-------------------------------|--------------|-------------------|-------------------------|--------------------|-----------|
| Rambam | 64 | 463 | 413 | 266 | 258 |
| Ziv | 32 | 134 | 34 | 50 | 30 |
| Western Galilee | 15 | 71 | 68 | 51 | 10 |
| RAMBAM 1982 6/6-15/9/82 | 223 | 1830 | 754 | 44 | 15 |

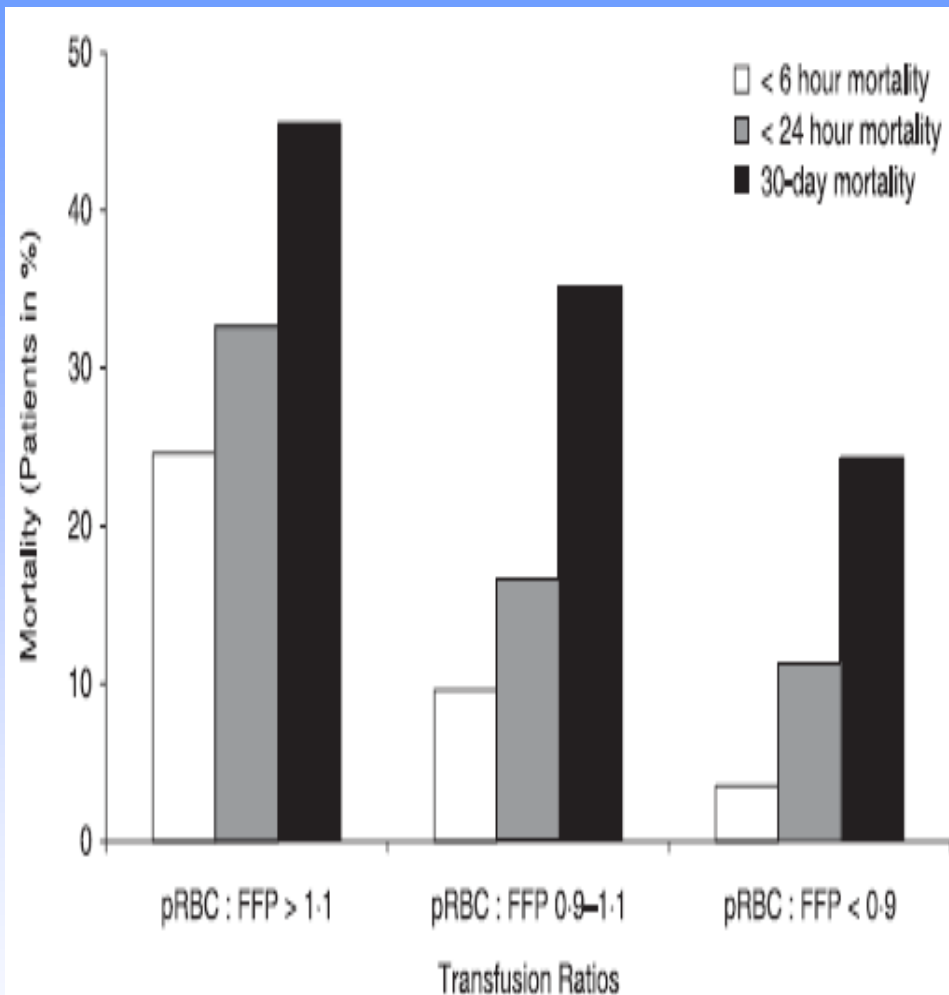
Median products received according to injury severity score. (MEAN)

| | PULSE | CRYSTALLOIDS mll | PC | FFP | PLAT | CRYO |
|------------------|----------------|------------------------------|-------------|--------------|---------------------|-----------|
| ISS< (N=34) | 91 (163) | 1000(1770) (n=97soldiers) | 4 0-17 | 1.5 0-18 | 0 0-12 M(1.9) | - M() |
| ISS≥16 (N=26) | 110.29 (22) | 3000(3140) (n=21soldiers) | 7 (0-45) | 13 (0-54) | 0 0-48 M(7.4) | - M() |
| | | | P=0.026 | P=0.002 | | |

34 PATIENTS WITH ISS HAD BLOOD

26 PATIENTS WITH ISS> 16 HAD BLOOD

Results are presented as median and range



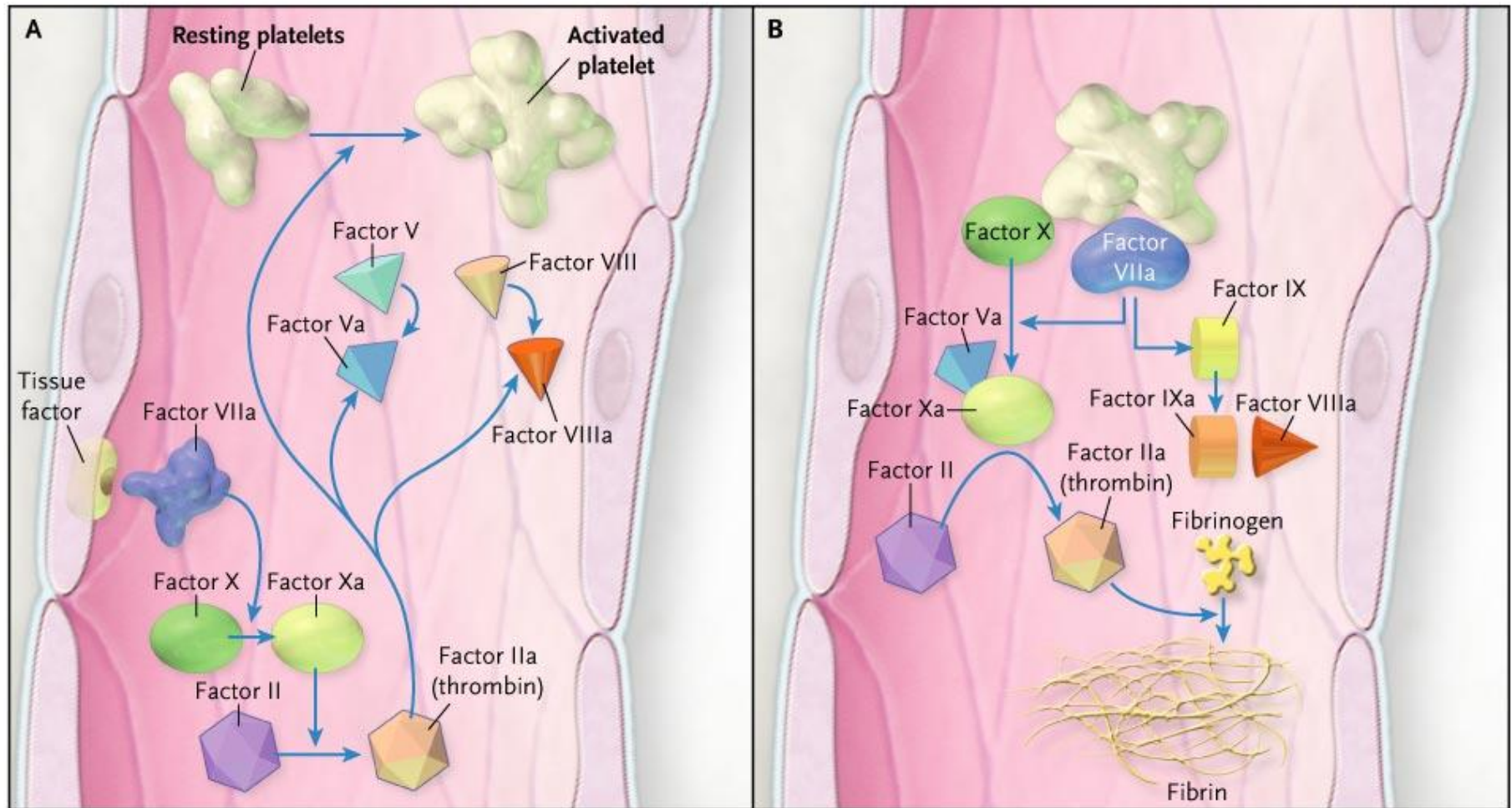
30 day mortality rates were 45.5, 35.1 and 24% for rbc/FFP >1.1 ,0.9-11, <0.9 (p<0.001)

Ventilator days and length of stay for intensive care unit and overall in hospital were highest in the <0.9 ratio p<0.0005

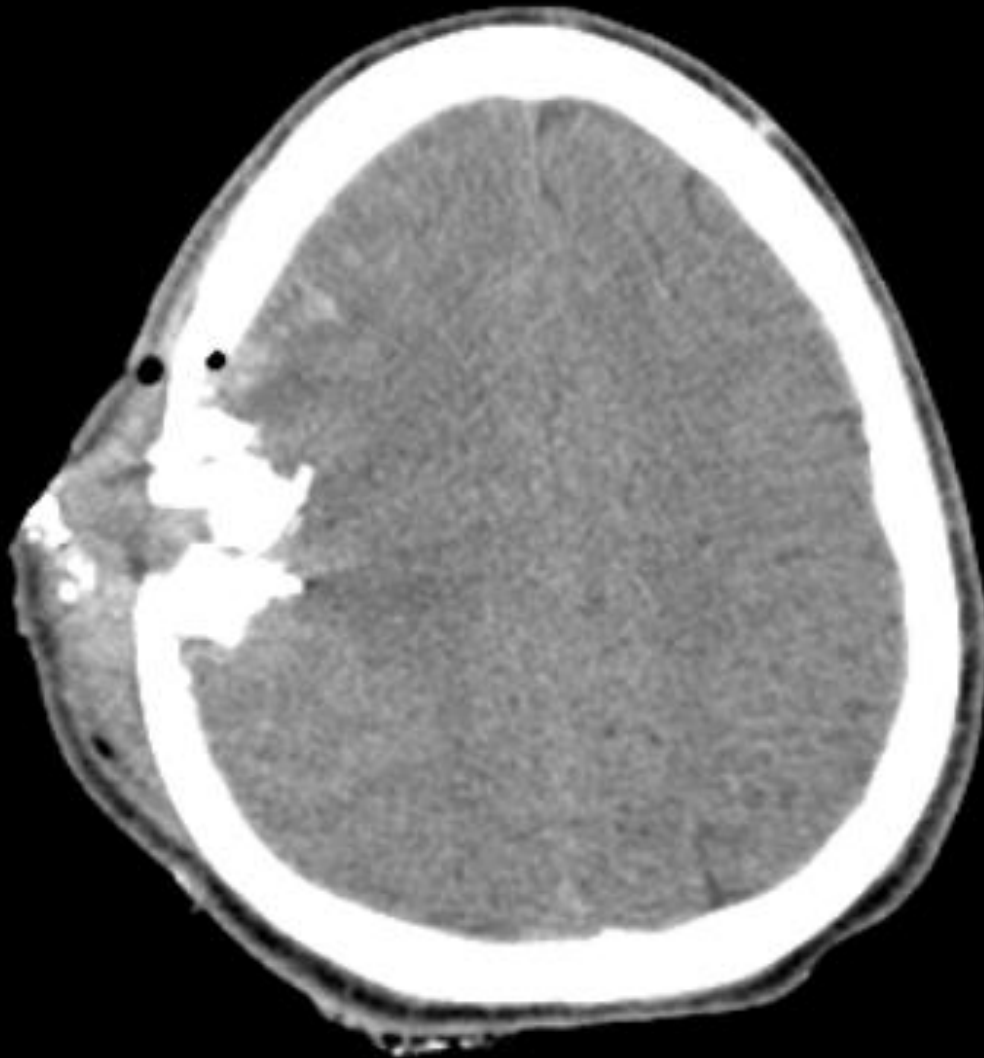
Fig. 2 Early (< 6-h and < 24-h) and 30-day mortality rates in percent (%) for patients transfused with pRBC : FFP > 1 : 1, pRBC : FFP 0.9-1.1 (1 : 1), and pRBC:FFP < 0.9 ratios during immediate care ($P < 0.0001$ for < 6-h and 24-h mortality; $P < 0.001$ for 30-day mortality).

| Pack number | Massive transfusion protocol Blood products released |
|-------------|---|
| Pack n° 1 | 3 PC+3 FFP |
| Pack n° 2 | 3 PC+ 3 FFP |
| Pack n° 3 | 3 PC + 2 FFP+ 10 units cryo precipitate 6 units platelets |
| Pack n° 4 | 4 PC + 4 FFP |
| Pack n° 5 | 4 PC +4 FFP 6 units platelets cryo According to platelets count |

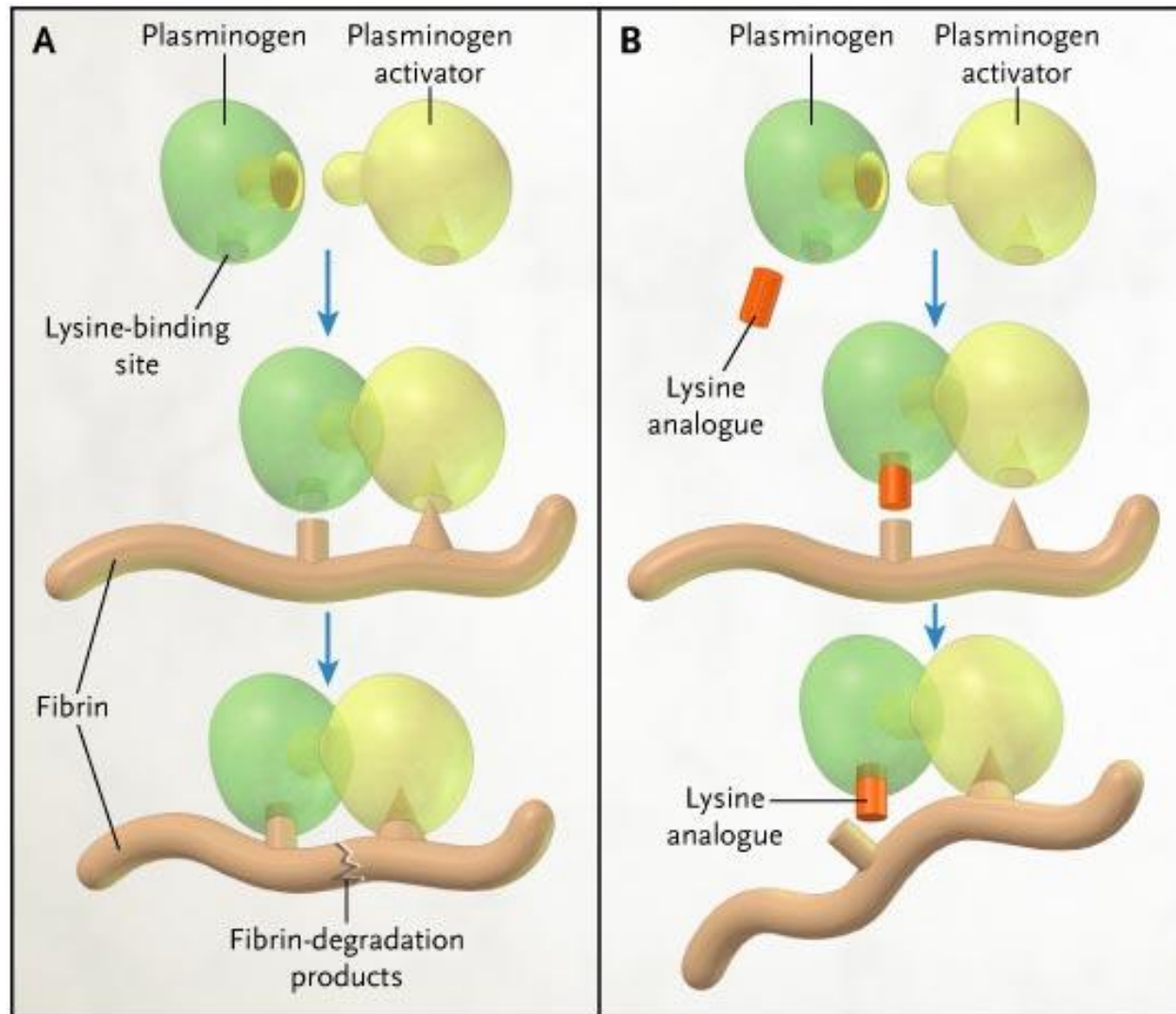
Mechanism of Action of Recombinant Factor VIIa



Penetrating Head Injury treated with surgery and Factor VIIa



Mode of Action of Lysine Analogues (Aminocaproic Acid and Tranexamic Acid)





白求恩同志



HENRY NORMAN BETHUNE
1890-1939

Born in Gravenhurst, Bethune studied medicine in Toronto. He made significant contributions to thoracic surgery in Montreal hospitals, and became a strong advocate of socialized medicine. In 1936-37, during the Spanish Civil War, he led a Canadian medical team which, while serving with the Republican forces, pioneered the use of mobile blood transfusion services. He subsequently worked as a battlefield surgeon and medical adviser with the forces of Mao Tse-tung. After his death at the war front, on November 12, 1939, he became a national hero in China.

**Yanan 1938 marching
blood bank- the issue of
fresh whole blood**

Modern War Surgery: operations in an evacuation hospital during the October 1973 Arab Israeli War

Pfeefferman R, Rozin RR, Durst AL, Marin G

51 severely wounded soldiers, operated upon for abdominal, thoracic, vascular, and brain injury.

39/51 severely hypotensive on arrival to the hospital

Average blood used 15 units of whole blood per patient 7-(1-5)units, 21-(6-15)U 11-(16-25)U 4-(26-40)U, 3-(41-60)U

Mortality; at evacuation hospital 4(8%)

at central hospital 8(16%)

“The first 8-10 units of blood given to each casualty were from the stored blood bank supply which was less than 24 h old

Whenever more blood needed **it was drawn from donors and immediately transmitted.”**

J of trauma vol 16: 694-703 1976

Fresh whole Blood: A Controversial Military Practice-Iraq

During 10 month of (OIF) 3/03 to 12/03

2349 units of blood products were transfused to 281 Pts.

FWB was used during shortage of blood products.

Mainly in forward surgical team (FST) were 20 u of PRBC available and in combat support hospital when no platelets were available or when blood supply was short.

In 2004 87patients received 545 units.

2222 donor samples tested from 5/03 to 8/05

3 HCV serology+ ,1 HTLV1 + 1 unconfirmed HIV

Conclusions

- Patients with high Injury Severity Score($ISS \geq$)are expected to require a higher quantity of blood components.
- Coagulopathy is a major concern during first hours of therapy. Preemptive therapy is recommended. (at least a 1:1 ratio of packed cells to FFP for massively bleeding patient).
- Blood Bank should have a flow chart of duties for mass casualty events.
- A massive transfusion protocol should be recommended. A rapid pack release system should be considered to facilitate blood products administration.
- Transfusion medicine physician should be involved early in the treatment of complicated patients providing a real-time consultation.



Thanks to Blood Bank technicians who work in harmony and are devoted for sake of saving human lives.

Trauma Resuscitation Unit RAMBAM 2006



3

Thanks to Lilach Bonstein, Gila Hymms, Mirit Barzilay and
Dr Moshe Michaelson - Emergency Department
Prof Brenner Dr Hofman hemostasis unit RAMBAM
Health Care Campus