NORSOCOM
Marinejegerkommandoen

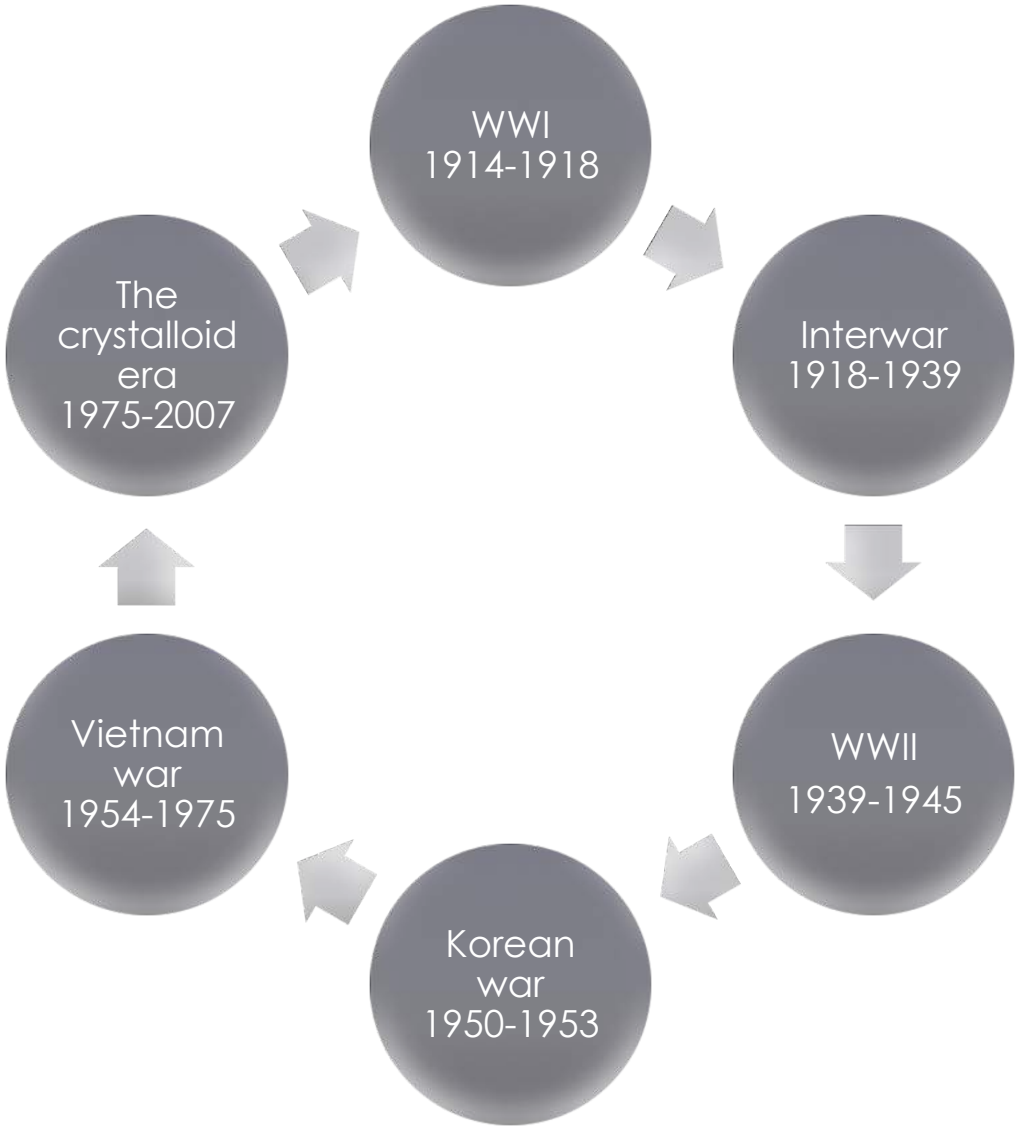
RDCR - HISTORY

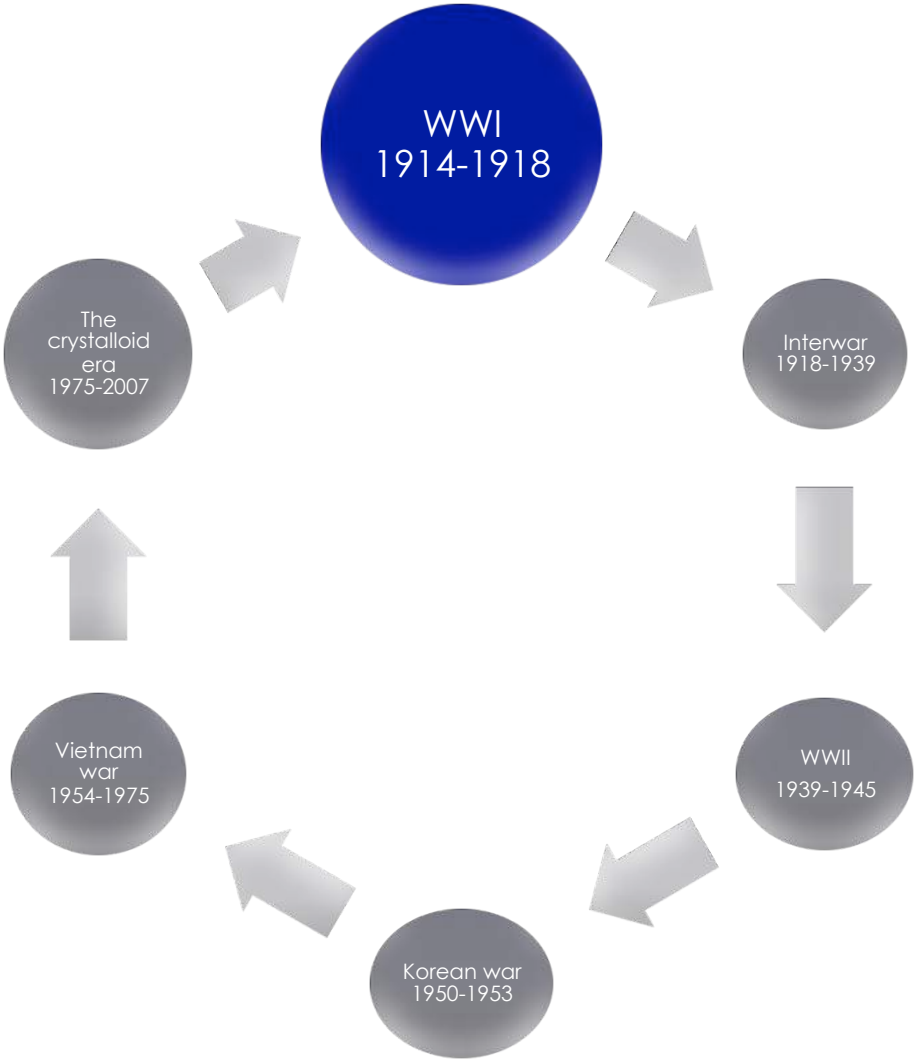
GOAL OF PREHOSPITAL CARE

REDUCE MORTALITY REDUCE MORBIDITY

From the time the enemy's missile strikes until the surgeon begins to repair the damage it has caused, every effort is directed toward a single aim, that of presenting to the surgeon a patient who will be as favorable an operative risk as possible.

BEECHER HK. Anesthesiology. 1946


WWI
1914-1918
Interwar
1918-1939
WWII
1939-1945
Korean
war
1950-1953
Vietnam
war
1954-1975
The
crystalloid
era
1975-2007


WWI
1914-1918
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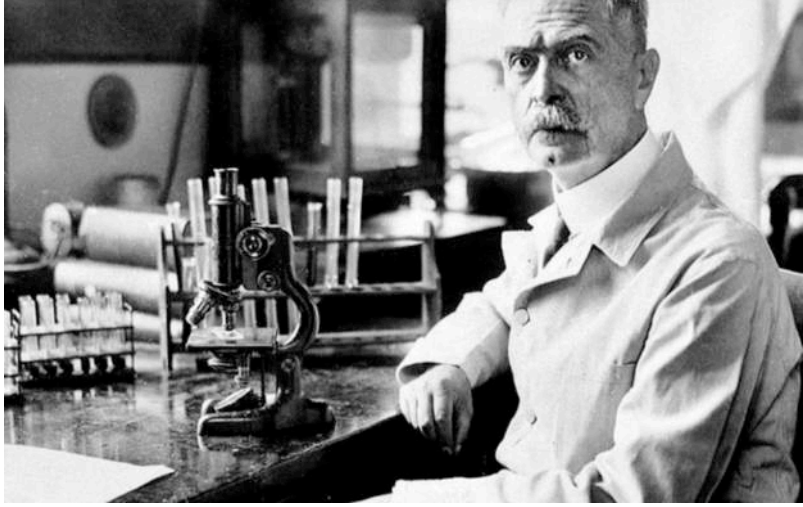
1900

- Karl Landsteiner
  - Identified the three human blood groups A, B and O (which he labeled C)
  - Blood transfusion between persons with the same blood group did not lead to the destruction of blood cells, whereas this occurred between persons of different blood groups.
  - First successful cross matched blood transfusion was performed by Reuben Ottenberg in New York in 1907



"A single kind of red cell is supposed to have an enormous number of different substances on it, and in the same way there are substances in the serum to react with many different animal cells. (…) The number of hypothetical different substances postulated makes this conception so uneconomical that the question must be asked whether it is the only one possible. ... We ourselves hold that another, simpler, explanation is possible."

WW1

- Bruce L Robertson
  - Showed that direct transfusion of uncrossmatched blood from the veins of a donor to a patient could save the lives of many moribund casualties, even if a few died of acute hemolytic reactions.
  - 34 case reports – 62% Survival

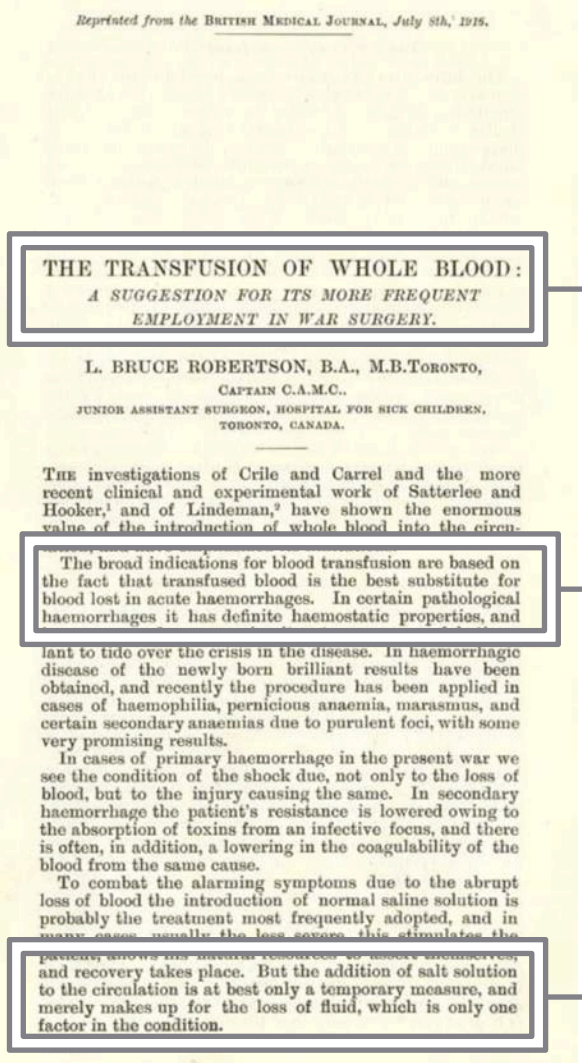
"On the 13th June you took my leg off above the knee, and until I received blood from someone else you considered the betting about 3 to 1 on my pegging out […] Can you find time to let me know the name and address of the man who gave me blood? I should much like to write to him."
- A. C. Tayler – August 14, 1917

"I should like to know Sir if the patient (I acted as blood donor for) is recovering alright."
Gunner F. Birditt – July 22, 1917

WW1 – Bruce L Robertson

- Gordon Watson(1918), in a note attached to one of Robertson's papers, stated that there was no comparison between the results of transfusion, which were instantaneous and permanent**, and those secured by infusions of saline, which were "a flash in the pan" followed by more serious collapse.**

"CASE 22: […] Pte. F. McL. Admitted July 4th, 1917. Had been buried by a shell seven hours previously. Was in a condition of shock and collapse from intra-abdominal injury and fracture of femur. Anti-shock measures for some hours produced slight improvement. […] Blood transfusion (1,C00 c.cm.). Before transfusion: pulse 180; blood pressure: systolic 80, diastolic 40. After transfusion: pulse 140; blood pressure: systolic 185, diastolic 80. […] Evacuated to base in two weeks. Four weeks after operation a note was received from the base stating that the patient was in excellent condition and recovery seemed assured."



Reprinted from the BRITISH MEDICAL JOURNAL, *July 8th,* 1916.

THE TRANSFUSION OF WHOLE BLOOD:
A SUGGESTION FOR ITS MORE FREQUENT EMPLOYMENT IN WAR SURGERY.

L. BRUCE ROBERTSON, B.A., M.B.TORONTO,
CAPTAIN C.A.M.C.,
JUNIOR ASSISTANT SURGEON, HOSPITAL FOR SICK CHILDREN, TORONTO, CANADA.

THE investigations of Crile and Carrel and the more recent clinical and experimental work of Satterlee and Hooker,[1] and of Lindeman,[2] have shown the enormous value of the introduction of whole blood into the circu-

The broad indications for blood transfusion are based on the fact that transfused blood is the best substitute for blood lost in acute haemorrhages. In certain pathological haemorrhages it has definite haemostatic properties, and

lant to tide over the crisis in the disease. In haemorrhagic disease of the newly born brilliant results have been obtained, and recently the procedure has been applied in cases of haemophilia, pernicious anaemia, marasmus, and certain secondary anaemias due to purulent foci, with some very promising results.

In cases of primary haemorrhage in the present war we see the condition of the shock due, not only to the loss of blood, but to the injury causing the same. In secondary haemorrhage the patient's resistance is lowered owing to the absorption of toxins from an infective focus, and there is often, in addition, a lowering in the coagulability of the blood from the same cause.

To combat the alarming symptoms due to the abrupt loss of blood the introduction of normal saline solution is probably the treatment most frequently adopted, and in

and recovery takes place. But the addition of salt solution to the circulation is at best only a temporary measure, and merely makes up for the loss of fluid, which is only one factor in the condition.

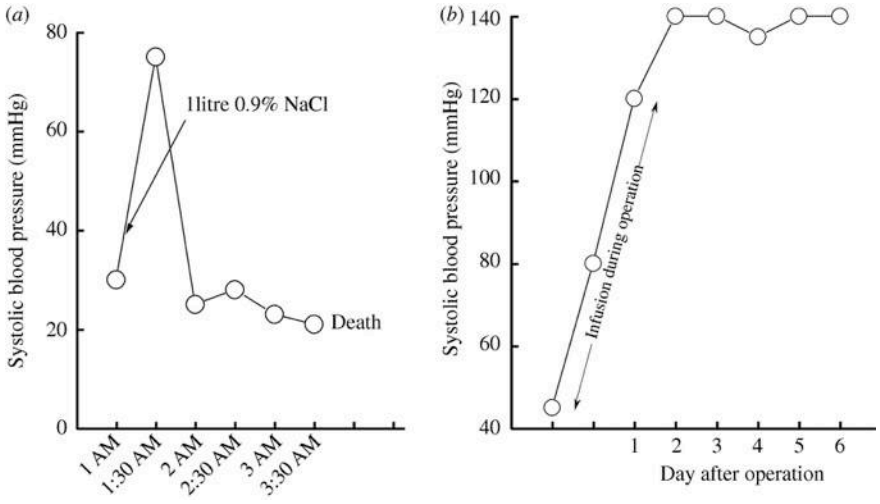
«The transfusion of whole blood – A suggestion for its more frequent employment in war surgery»

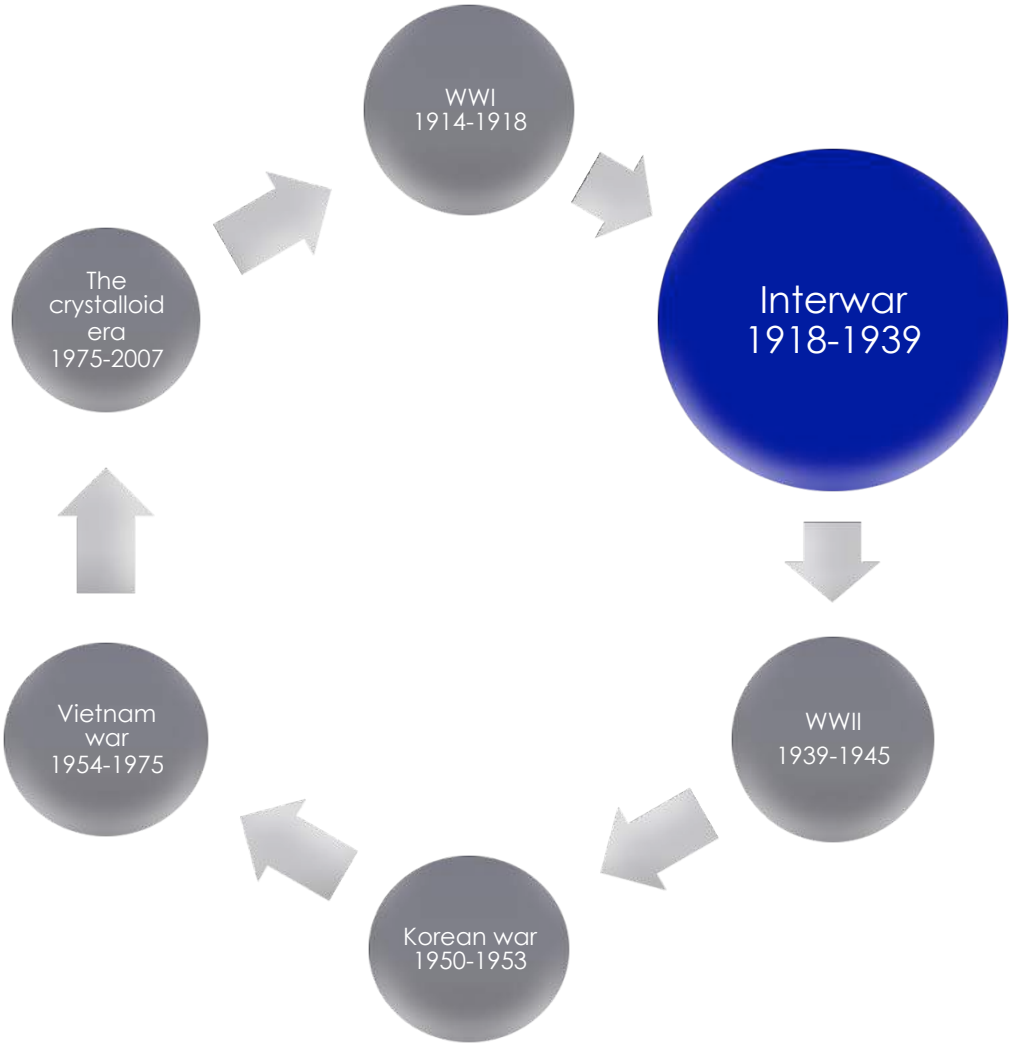
«The broad indications for blood transfusion are based on the fact that transfused blood is the best substitute for blood lost (…) In certain haemorrhages it has definitive haemostatic properties (…)

«But the addition of salt solution to the circulation is at best only a temporary measure, and merely makes up for the loss of fluid, which is only one factor in the condition»

WW1

- Oswald Hope Robertson
  - Stored, syphilis-tested, universal donor whole blood could be given quickly and safely in forward medical units.
  - Citrate as anticoagulant
  - Paved the way for blood banking




WWI
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Interwar period

- The principles of World War I blood banking were continued during the Spanish Civil War by the Blood Transfusion Services of the Spanish Republican and Nationalist Armies.
- Experiments
  - Colloids
  - Gelatins
  - The development of freeze dried plasma
- US Forces entered WWII with FDP as primary resuscitation fluid

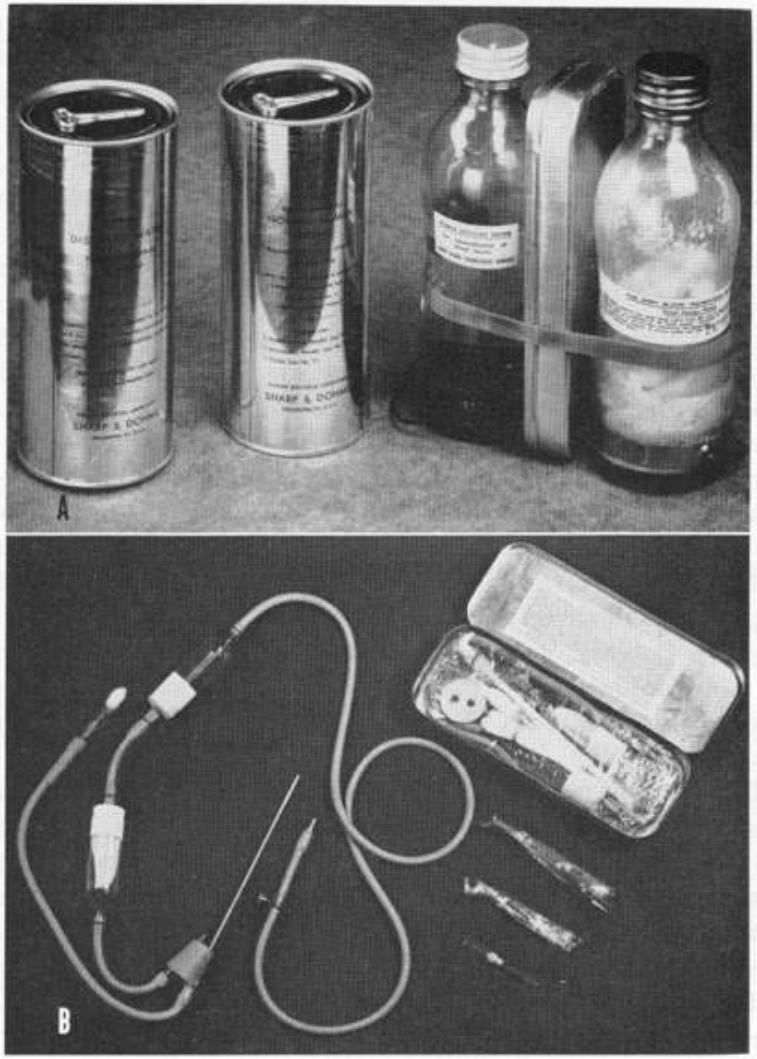
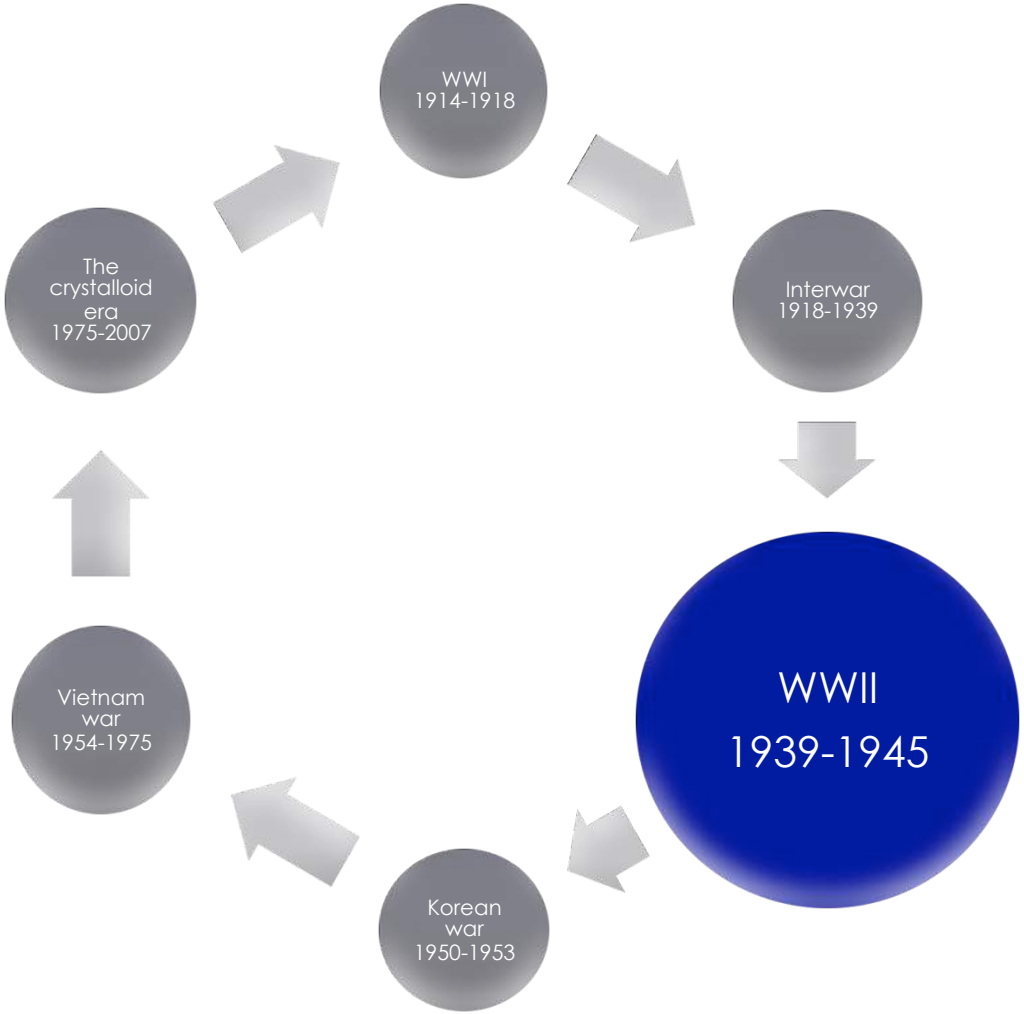


FIGURE 4.—British and Canadian materials and equipment for replacement therapy. A. British (right) and U.S. Army dried plasma units. B. British dispensing set for plasma.


WWI
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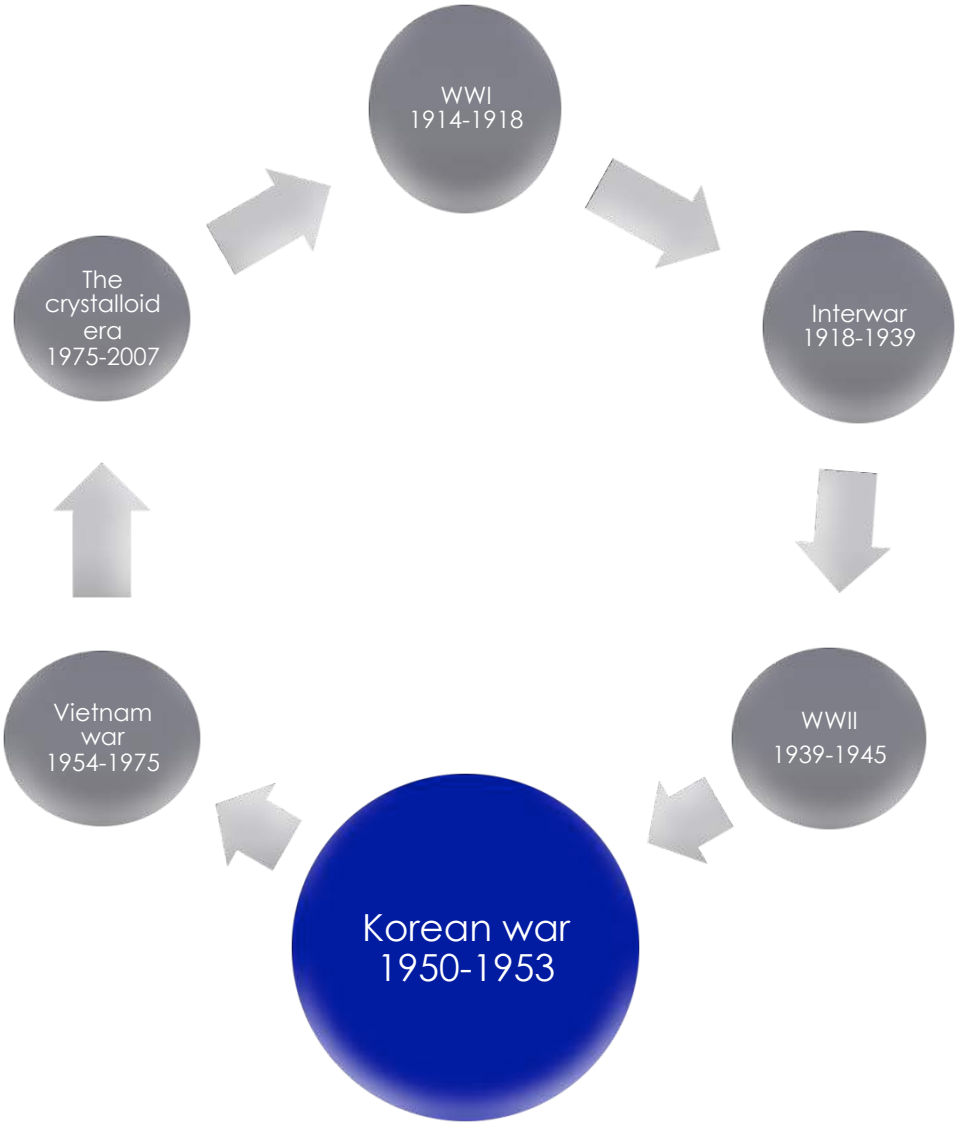
WWII

- American Surgeon General refused implementing whole blood program
- Random call outs from surgeons and surgical teams – need for whole blood program
- North African campaign (June 1940 – May 1943)
  - "British whole blood in US soldiers veins"
- 30,000 pints of group O whole blood would be needed for D-Day and the following month
  - Eventually in sept1944 – US started to export whole blood to theatre
  - In the course of WW2 - 200.000 units were successfully transported to allied forces. Universal group O
  - Due to reports on minor transfusion reactions - Americans started to titer group O.

HK.BEECHER QUOTES 1946

- Pioneering American anesthesiologist
- Crystalloid solutions :
  - "These agents are primarily useful for the correction of dehydration. As "blood substitutes" they are not very effective, and are dangerous."
- Plasma only while waiting for whole blood
  - Lack of oxygen carrying capacity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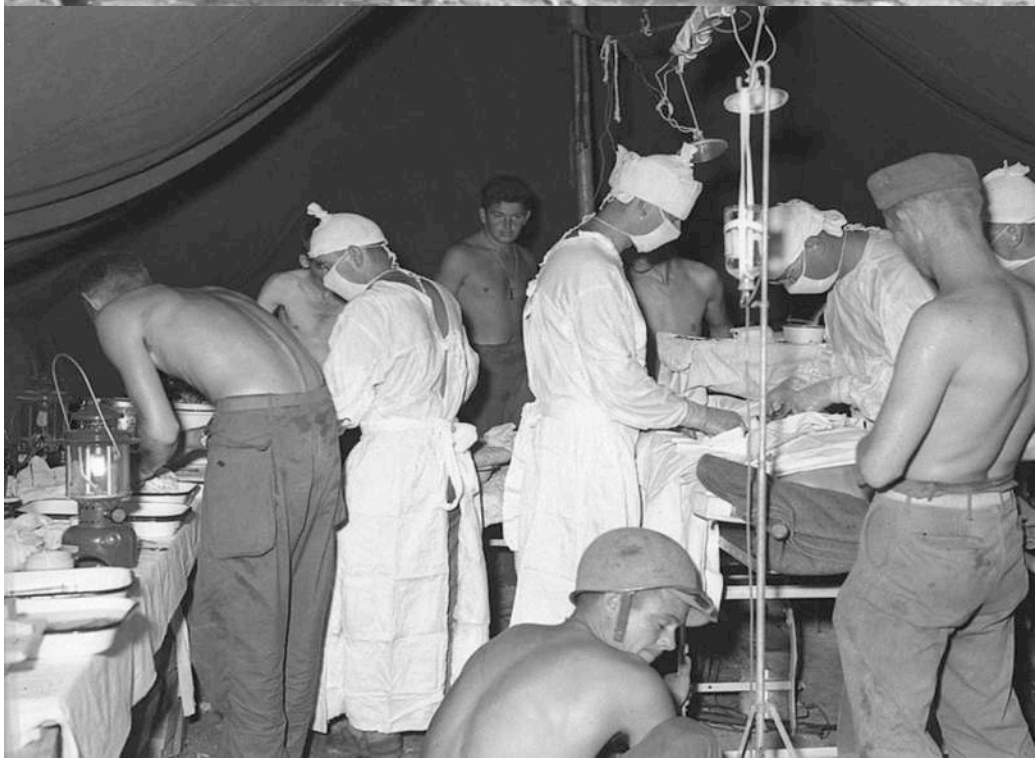
Korean war

- 1950-1953
- When American troops entered the Korean war, they had learned their lesson.
- 400.000 units of universal whole blood group O.
- Far forward resuscitation – low titer group O.
- Massive transfusion introduced for the first time
  - >10 units /24h



ANNALS OF SURGERY

Vol. 141 MARCH, 1955 No. 3

CLINICAL EXPERIENCES IN THE EARLY MANAGEMENT OF THE MOST SEVERELY INJURED BATTLE CASUALTIES*

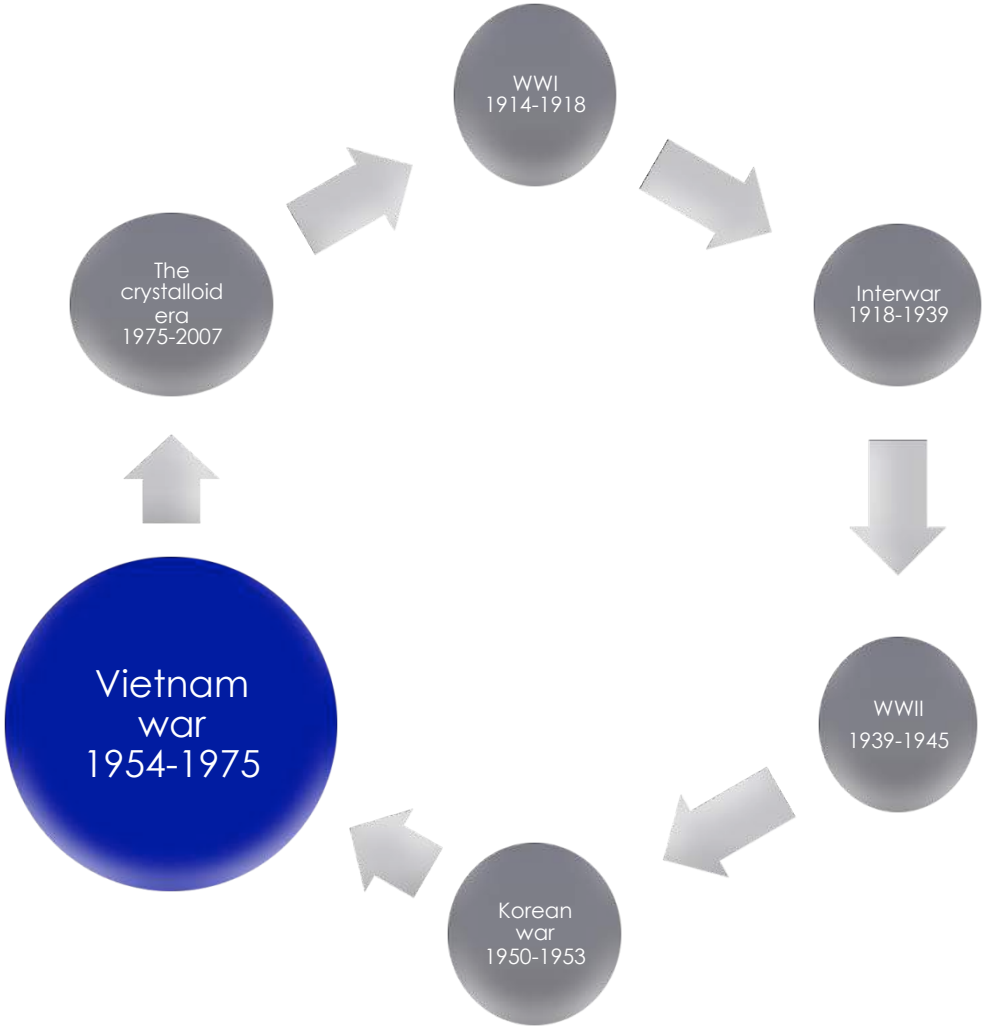
CURTIS P. ARTZ, LIEUTENANT COLONEL, M. C., JOHN M. HOWARD, CAPTAIN, M. C., YOSHIO SAKO, CAPTAIN, M. C., ALVIN W. BRONWELL, CAPTAIN, M. C. AND THEODORE PRENTICE, CAPTAIN, M. C.

FT. SAM HOUSTON, TEXAS

FROM THE SURGICAL RESEARCH TEAM IN KOREA, ARMY MEDICAL SERVICE GRADUATE SCHOOL, WALTER REED ARMY MEDICAL CENTER WASHINGTON, D. C.

TABLE VII. *Most Severely Wounded—Admitted in Severe Shock; 33 Patients, 7 Deaths.*
(Case Fatality Rate, 21 Per Cent)

No.	Type of Wound	Evac. Time (min.)	Admin. Blood Pressure	Preop. Blood (ml)	Blood Total 1st 24 hrs. (ml)	Remarks
1	Extrem.	110	70/30	2,000	2,500	Recovered
2	Extrem.	105	80/40	2,000	3,000	Recovered
3	Abdomen	180	70/40	2,500	3,000	Recovered
4	Extrem.	120	40/0	—	3,500	Recovered
5	Abdomen	60	66/0	2,000	3,500	Recovered
6	Extrem.	270	80/40	2,000	4,000	Recovered
7	Abdomen	185	60/30	2,500	4,000	Recovered
8	Extrem.	270	70/40	3,750	4,750	Recovered
9	Chest	—	60/0	2,500	3,500	Recovered
10	Abdomen	—	40/0	3,000	5,000	Recovered
11	Thor-abd.	150	80/40	3,000	5,000	Recovered
12	Abdomen	—	70/40	4,000	5,500	Recovered
13	Extrem.	120	70/40	3,500	6,000	Recovered
14	Extrem.	195	80/0	5,500	6,500	Recovered
15	Extrem.	45	70/30	3,000	7,000	Recovered
16	Extrem.	170	70/40	2,500	7,000	Recovered
17	Abdomen	130	70/0	4,000	9,000	Recovered
18	Abdomen	90	70/40	5,000	10,000	Recovered
19	Abdomen	90	74/52	3,500	11,500	Recovered
20	Extrem.	103	0/0	5,500	5,500	Recovered
21	Abdomen	180	0/0	4,000	6,000	Recovered
22	Extrem.	120	0/0	6,000	6,000	Recovered
23	Chest	190	0/0	4,000	7,000	Recovered
24	Abdomen	180	0/0	6,500	8,500	Recovered
25	Abdomen	—	0/0	2,500	11,000	Recovered
26	Chest	70	0/0	5,500	13,000	Recovered
27	Thor-abd.	205	0/0	4,000	8,000	Expired, unknown
28	Abdomen	105	0/0	5,500	9,000	Expired, uncontrolled hemorrhage
29	Extrem.	125	0/0	12,000	16,000	Expired, uncontrolled hemorrhage
30	Extrem.	330	80/60	2,500	6,000	Expired cardiac arrest
31	Extrem.	90	80/60	5,500	9,500	Expired, postoperative shock
32	Extrem.	85	40/0	5,500	11,500	Expired, undetermined
33	Abdomen	180	50/30	12,000	28,000	Expired, uncontrolled oozing
	Averages	150	——	4,400	7,600	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Interwar
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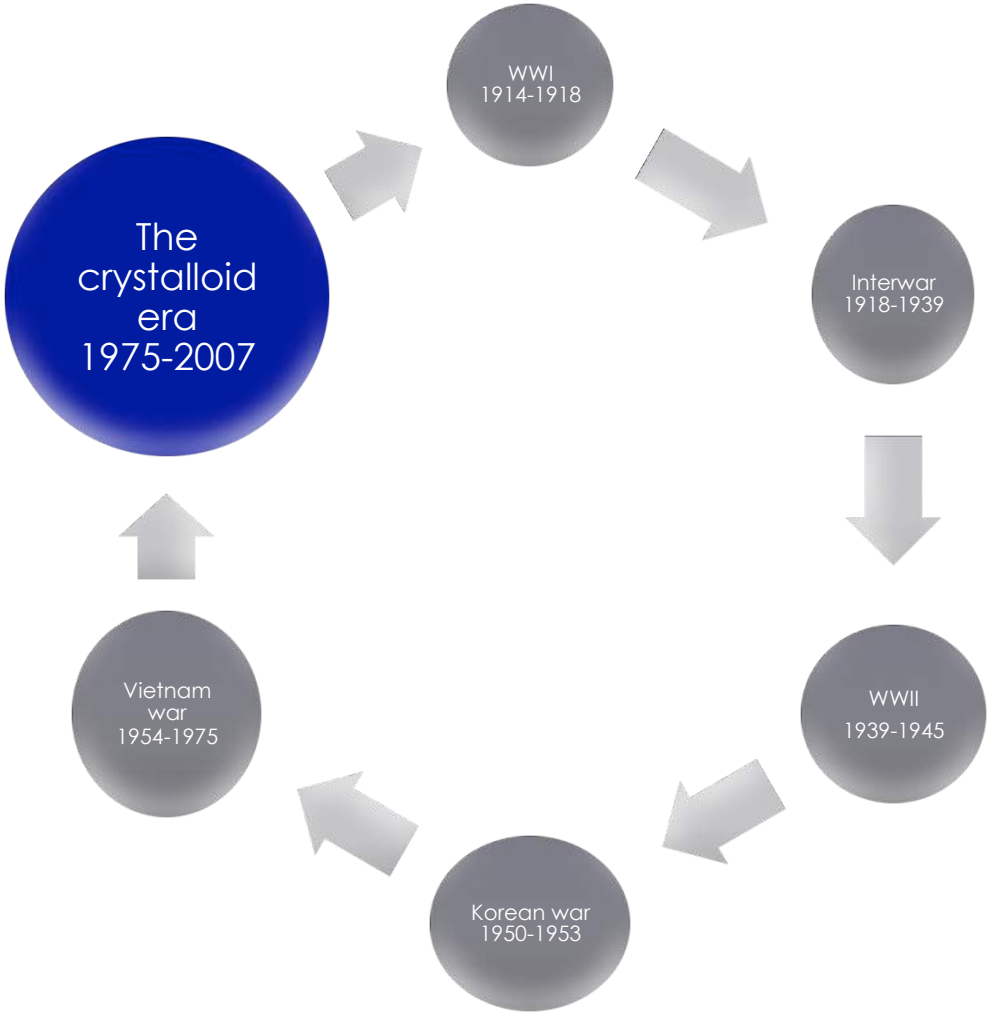
Vietnam War

- In early 1965, during the Vietnam War, a decision was made to only ship universal donor, low-titer, group O whole blood to the war zone.
- As blood requirements increased, the policy was changed to allow for the shipment of nongroup O whole blood.
- Exclusive use of low-titer, group O whole blood utilized by forward medical personnel where pretransfusion testing and compatibility testing could not be performed.
- At the peak of US involvement between September 1967 and February 1969, 230,323 whole blood units (all ABO groups included) were transfused
- During this time period, 24 hemolytic transfusion reactions were documented
  - Caused by accidental high titer group O transfusion.
- The experience in Vietnam served to reinforce the concept that the transfusion of universal donor low-titer group O whole blood was a safe practice.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1975-1993

- "Quiet period" no major military conflicts.
- Civilian period implementation of crystalloid based resuscitation strategies in hemorrhagic shock
  - Based largely on paper by Carrico and Shires
  - However – the actual paper recommended minimal crystalloid (by today's standards) while readying the whole blood transfusions for the seriously injured patient in shock
- Misinterpretation of Carrico data from 1976?

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1993

- The largest ground combat battle since Vietnam occurred in Mogadishu Somalia.
  - 18 Americans were killed
  - 73 wounded.
- Tactical combat casualty care
  - Treat the Casualty
  - Prevent Additional Casualties
  - Complete the Mission
- TCCC : treating the leading causes of preventable combat death:
  - Extremity Hemorrhage
  - Tension Pneumothorax
  - Airway Obstruction

2007-16

- Lessons from OEF OIR.
- Damage control resuscitation principles 2007
  - Hemostatic resuscitation
  - Permissive hypotension
  - Damage control surgery

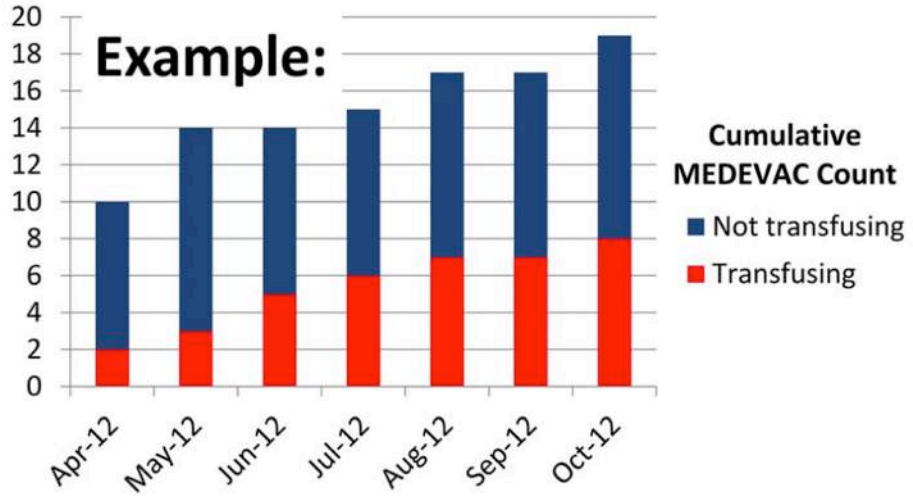
2012-2016

- Military and civilian implementation of hemostatic resuscitation principles
  - Early forward resuscitation with blood products

Study Population: US military casualties in Afghanistan from April 1, 2012 to August 7, 2015

Study Design: Retrospective Cohort (not Pre-Post)

Gradual expansion of transfusion capability to different MEDEVACs



Unadjusted Post-treatment Between-Group Differences	Transfused Pre-hospital	Not Transfused Pre-hospital	*p* value*
*KIA (%)	2 (3.8%)	58 (20.3%)	0.003*
*Died (KIA + DOW) within 24 hours of MEDEVAC take-off from POI (%)	2 (3.8%)	64 (22.4%)	0.001*
*Died (KIA + DOW) within 30 days (%)	5 (9.4%)	77 (26.9%)	0.005*
*Tranexamic Acid [TXA] (%)	48 (90.6%)	144 (50.3%)	<0.001*
Documented shock [SBP<90, HR>120 or shock index >0.9] upon ED arrival (%)	N=52 39 (75%)	N=233 137 (63%)	0.110
*Massive Transfusion [>10 units/24hrs] (%)	40 (75%)	119 (42%)	<0.001*
ISS: Median (IQR)	29 (17, 36)	24 (17, 36)	0.179
AIS Score indicating torso hemorrhage (%)	22 (41.5%)	108 (37.8%)	0.646

6-fold benefit

3-fold benefit, NNT ≤ 6

*Statistically significant at <0.05 level by Fisher's exact test.

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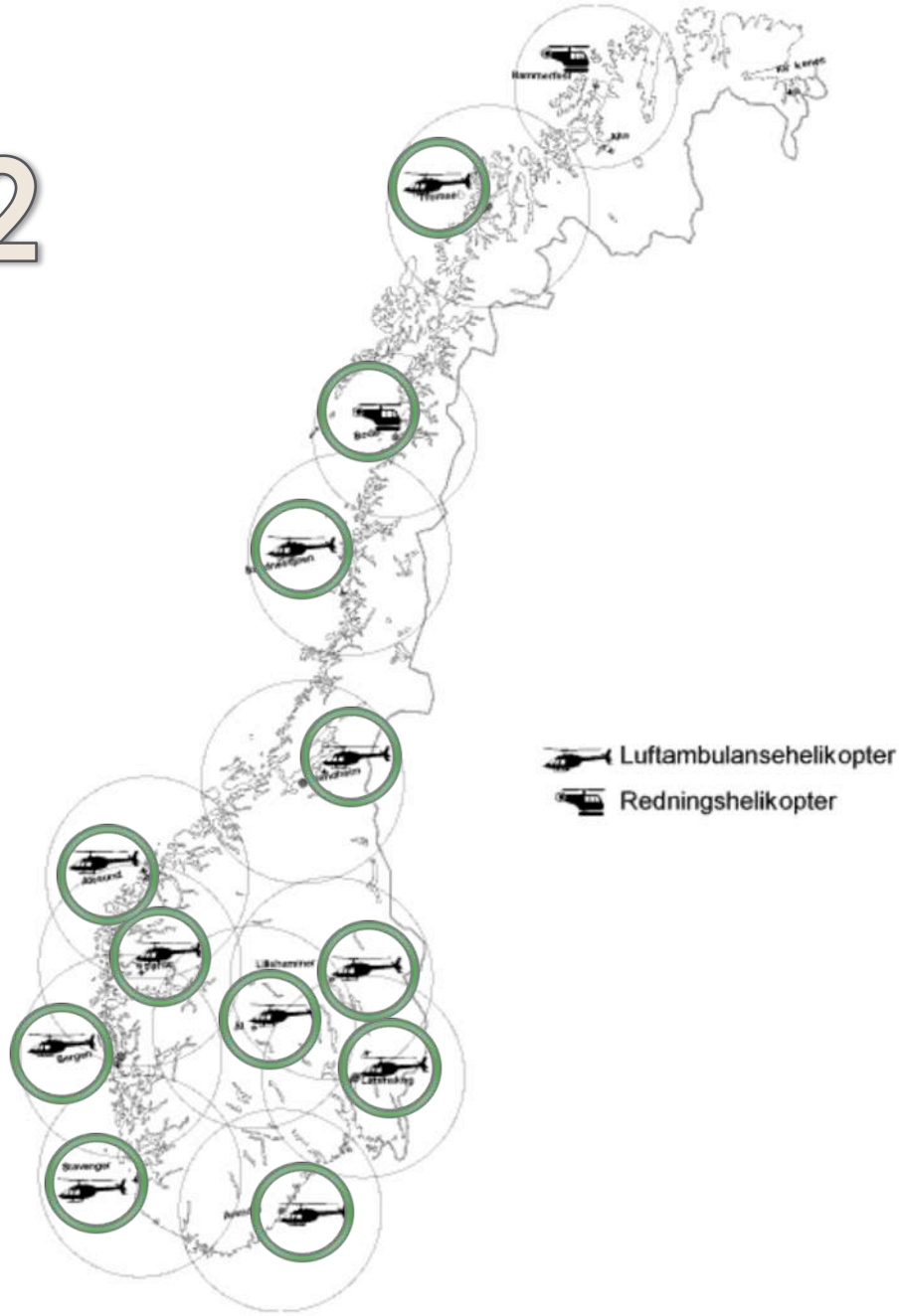
2012



Clear fluids

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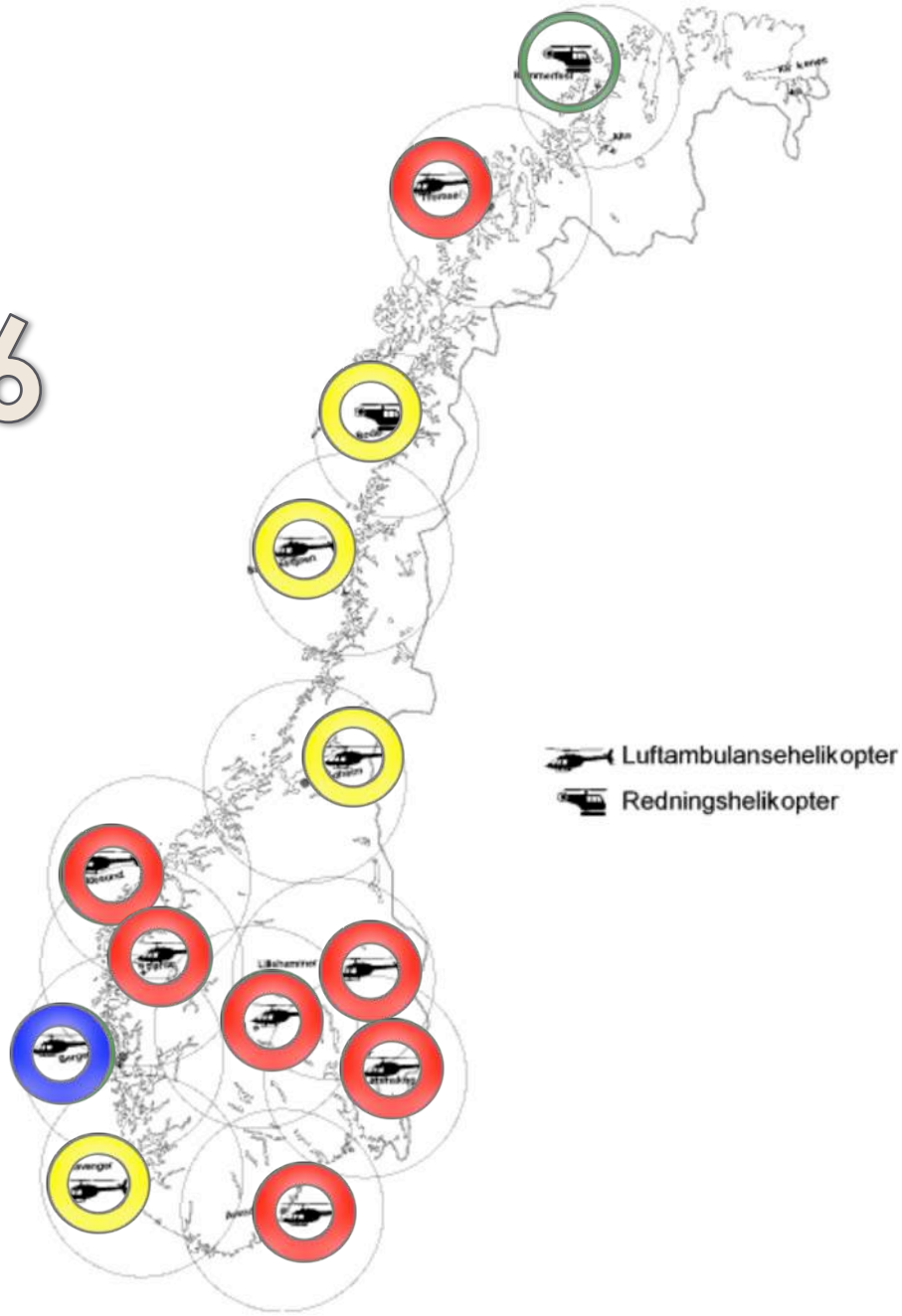
2016



FDP

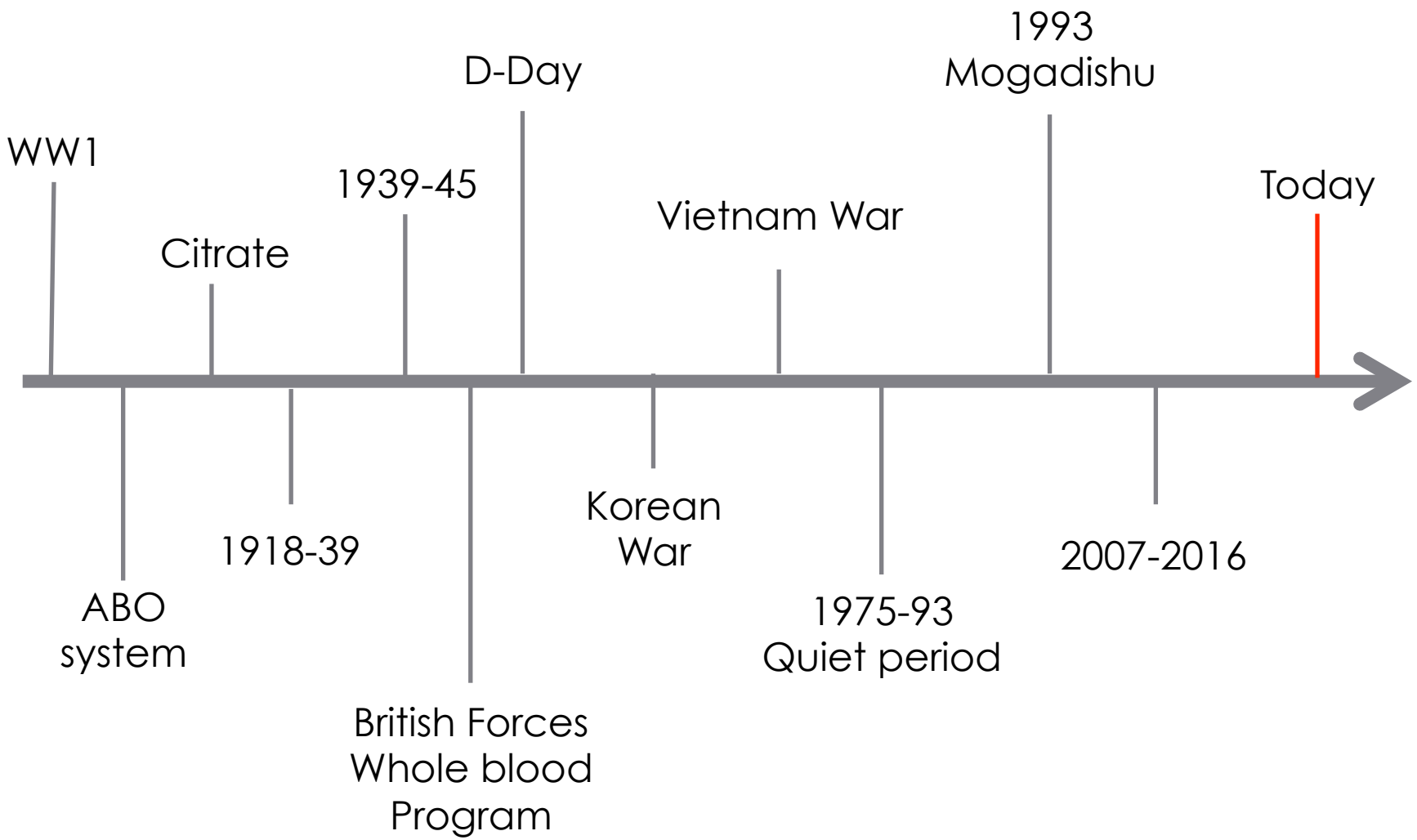
RBC + FDP

WB + FDP

Clear fluids

Today

- Military
  - 75th ranger
  - 160th
  - NORNAVSOC
- Civillian
  - Royal Caribbean cruise lines
  - Norwegian HEMS 2015


WW1
ABO system
Citrate
1918-39
1939-45
British Forces Whole blood Program
D-Day
Korean War
Vietnam War
1975-93 Quiet period
1993 Mogadishu
2007-2016
Today

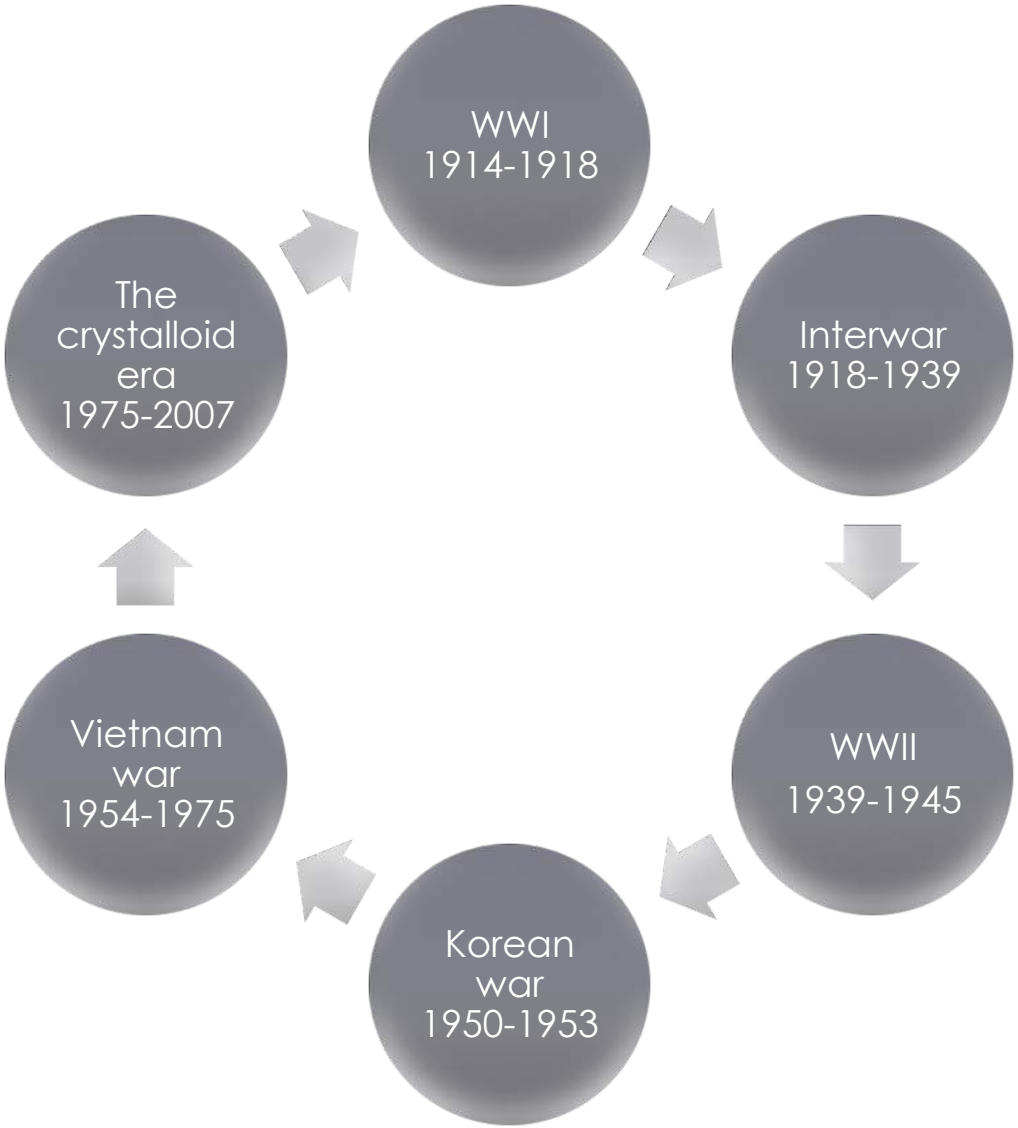
What history tells us about crystalloids

- Ongoing discussion for a 100 years
- In the INTERIN BETWEEN WARS always controversies what replacement fluid to choose.
- In the post war conclusions, made up by the physicians who actually took the heat and did not sit in the warm reseach laboratories: SAME CONCLUSION EVERY POSTWAR UPDATE!!
- **BLOOD IS GOOD – CRYSTALLOIDS ARE BAD**

HISTORY OF PREHOSPITAL SHOCK RESUSCITATION

WW I WW II Korea Vietnam OIF/OEF ?

50 years of Blood | **40 years of Clear Fluids** | **Back to the future???**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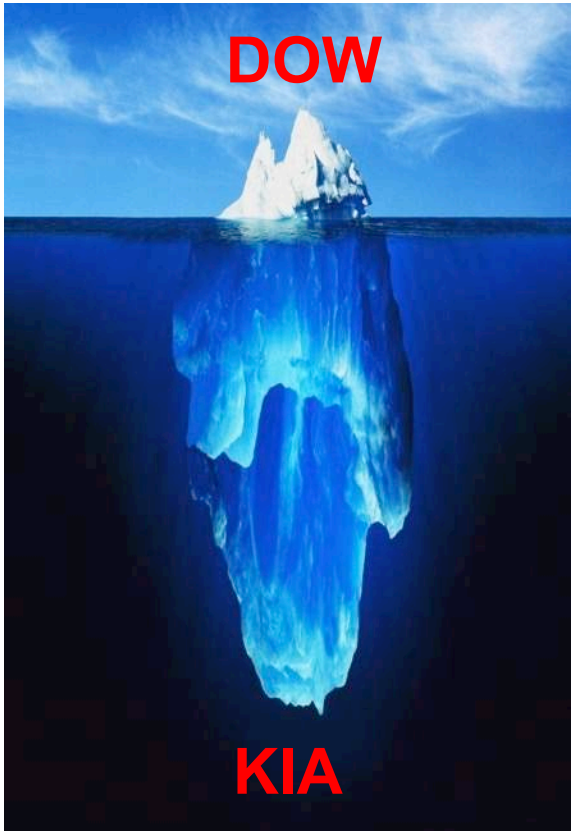
So what is the challenge ahead?

US Military Death Distribution

4,596 Combat Deaths (2001-11)



Died of Wounds (Level II and above)
506 deaths

Killed in Action (Level I) 4,090 deaths	
Total Pre-MTF Combat Deaths	**4,090**
Potentially Survivable Deaths	**1,075 (26%)**
Hemorrhage	984 (91.5)
Airway	69 (6.4)
Other	22 (2.0)
Potentially Survivable Hemorrhage	**984 (24%)**
Truncal	675 (17%)
Junctional	170 (4%)
Extremity	139 (3%)

Eastridge et al. *J Trauma* 2013.

Treat Hemorrhage/Shock/ATC

- 90% of combat deaths occur before reaching Role 2
- 75% of combat deaths are not preventable by medical intervention
- 25% of deaths are possibly preventable, and 90% of these are due to ***hemorrhage***, mostly truncal
- The implications for treatment are:
  - Stop what bleeding you can
  - Resuscitate active non-compressible bleeding to the best of your ability
  - ***Well-trained troops can do this*** **-- YOU!!!**
    - US Army Rangers: 10.7% KIA & 1.7% DOW vs. 16.4% & 5.8% for DoD
    - Ranger interventions mostly for ***hemorrhage control*** (dressing/TK); rare airway interventions

Eastridge et al. *J Trauma* 2013.
Kotwal et al. *Arch Surg* 2011.

US Military at Risk of Exsanguination Iraq / Afghanistan 2001-2014

- 58,831= Killed in Action + all wounded
  - 53,724 = survivors + died of wounds
  - **8,836 transfused**, ≈ 50% Massive transfusion
- Frequency of life-threatening bleeding
  - **4000** requiring massive transfusion
- **1,300 KIA** died of hemorrhage with survivable injuries
- These **5,300 casualties** would have been the most likely to **benefit from Blood Far Forward.**

http://www.defense.gov/news/casualty.pdf