Blood Far Forward -Military and civilian implementation of RDCR - A novel model of resilience

Three Primary Research Modules

1. *Donor Performance and reinfusion - Donor safety research*
2. *Blood efficacy and safety- Blood Research*
3. *Training and educational requirements*

Norwegian Naval Special Operation Commando

Norwegian Armed Forces Medical Services

HELSE BERGEN
Haukeland universitetssjukehus

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FORSVARET

DISCLAIMER

The opinions or assertions contained herein are the private views of the author and are not to be regarded as official nor as reflecting the views of UiB or Norwegian Armed Forces Medical Service

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LEGE

NORWAY


North Sea
Danmark
Denmark
Polska
Poland
Berlin
London
Deutschland
Germany
Česká rep
Czech Rep
Slovensko
Slovakia
Österreich
Austria
France
Hrvatska
Croatia
Србија
Serbia
Italia
Italy
Tyrrhenian Sea
Ελλάδα
Hellas
Greece


Ottawa
Toronto
MICHIGAN
Chicago
Boston
New York
OHIO
INDIANA
KENTUCKY
TENNESSEE
ALABAMA
GEORGIA

Blood Far Forward

Three Primary Research Modules

1. *Donor Performance and reinfusion - Donor safety research*
2. *Blood efficacy and safety- Blood Research*
3. *Training and educational requirements*

Norwegian Naval Special Operation Commando

Norwegian Armed Forces Medical Services

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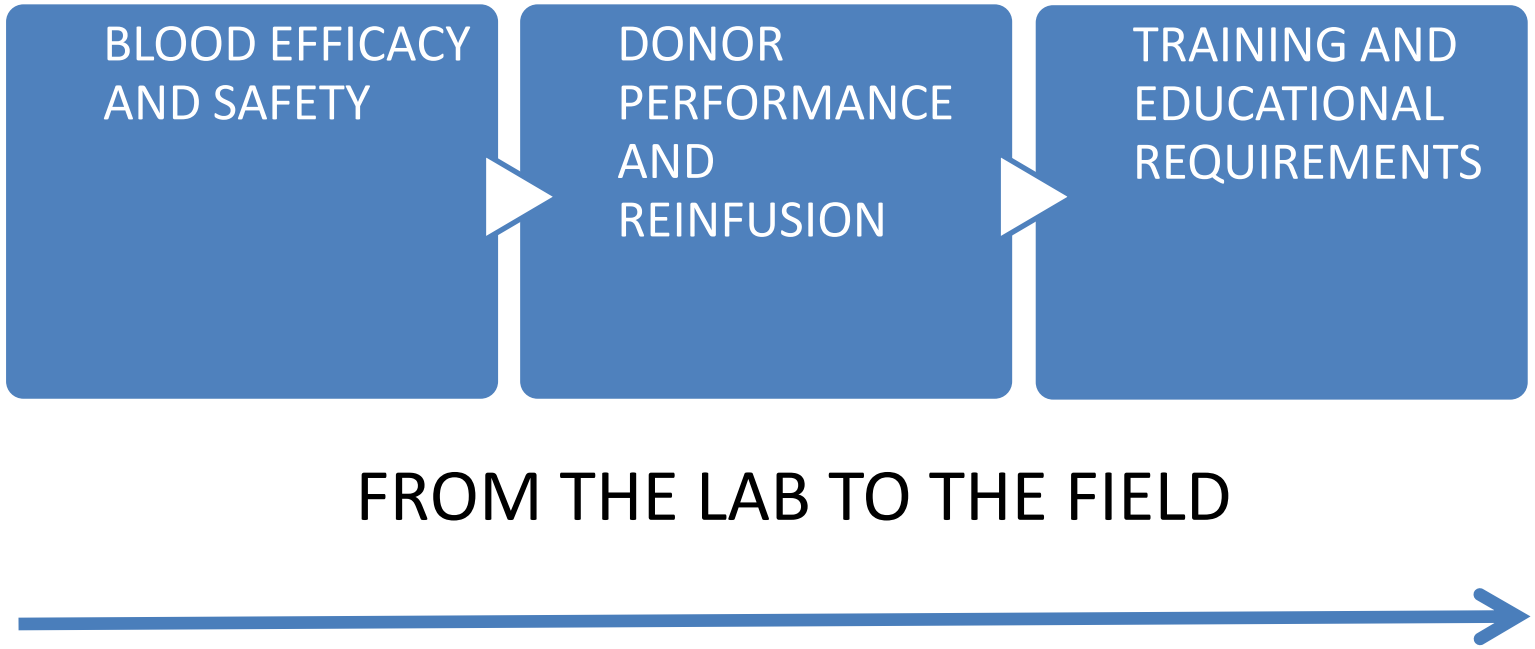
UNITED STATES ARMY
INSTITUTE OF SURGICAL RESEARCH

“There are three stages of scientific discovery: first people deny it is true; then they deny it is important; finally they credit the wrong person.”

Alexander von Humboldt (1769-1859)

PROJECT PLAN – 3 MODULES

STIKKORD: GJENNOMFØRBARHET



Blood Far Forward Research Group, Bergen

Turid Helen

Einar

Geir

Christopher

Joar

Hanne

Håkon

Tor

Theodor

Torunn

BFF INTERNATIONAL COLLABORATORS

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- **Philip C. Spinella, MD, FCCM**
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  Director, Critical Care Translational Research Program
  Washington University in St. Louis
  St. Louis, Missouri USA
- **THOR NETWORK**
- **75TH RANGER REGIMENT**
- **SPECIAL OPERATION WARFARE DEVELOPMENT GROUP**
- **CANSOF**
- **UK Military Blood Program**

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BLOOD FAR FORWARD

- Development of a safe and logistically feasible method to provide optimal blood products for prehospital resuscitation to reduce death from hemorrhage.

Development of Norwegian Naval SOF Prehospital Whole Blood Program

- Education and training program started in 2010
- Whole blood and freeze dried plasma as primary resuscitation fluids for hemorrhagic shock prehospital
- Research program in parallel with implemention

DONOR PERFORMANCE
BLOOD EFFICACY AND SAFETY
TRAINING REQUIREMNTS

DONOR PERFORMANCE

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OVERVIEW DONOR PERFORMANCE

2011 - Donor performance 1.0

25 x SOF

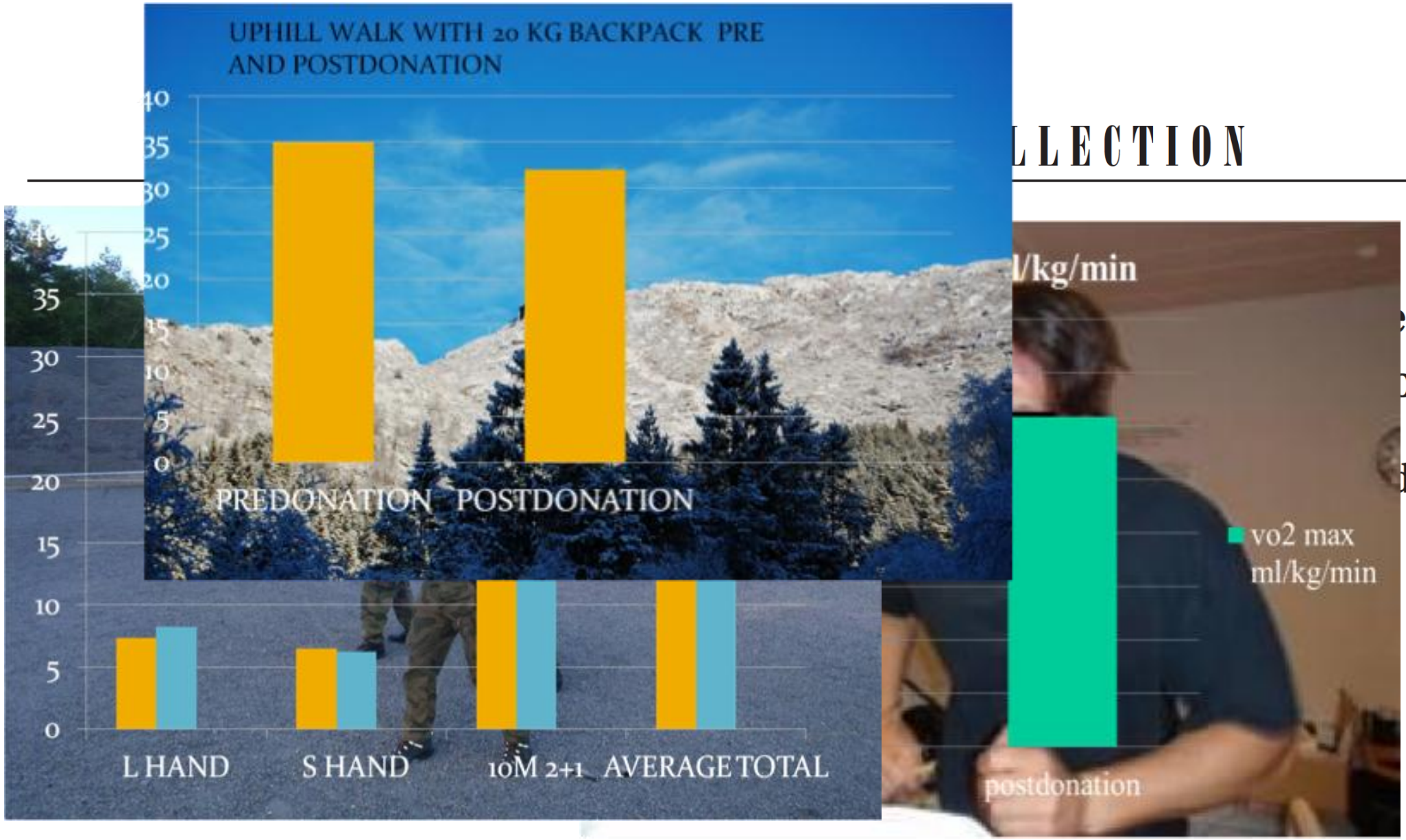
2013 - Donor performance 2.0

13 x SOF

2016 - Donor performance 3.0

60 x Average Joe

LLECTION


UPHILL WALK WITH 20 KG BACKPACK PRE AND POSTDONATION
40
35
30
25
20
15
10
5
0
PREDONATION
POSTDONATION
40
35
30
25
20
15
10
5
0
L HAND
S HAND
10M 2+1
AVERAGE TOTAL
l/kg/min
vo2 max ml/kg/min
postdonation

Variable	Group	Pretest	Retest	Difference value (%)	P-value
ETT (seconds)	D	968 (33)	876 (60)	-92 (-9.5)	0.006
	ND	970 (39)	937 (71)	-33 (-3.4)	0.124
VO_2max ($mL \cdot kg^{-1} \cdot min^{-1}$)	D	56.0 (3.0)	52.0 (3.4)	-4.0 (-7.1)	0.001
	ND	57.8 (3.6)	57.8 (5.3)	0	1.00
VO_2max ($L \cdot min^{-1}$)	D	4.91 (0.30)	4.36 (0.35)	-0.55 (-11.2)	<0.001
	ND	5.03 (0.65)	4.85 (0.54)	-0.18 (-3.6)	0.128
Body weight (Kg)	D	87.7 (3.8)	83.9 (3.6)	-3.8 (-4.3)	0.001
	ND	87.5 (15.3)	84.6 (14.3)	-2.9 (-3.3)	<0.001
HF_{peak} ($beats \cdot min^{-1}$)	D	196 (2)	192 (6)	-4 (-2.0)	0.181
	ND	192 (9)	184 (11)	-8 (-4.2)	0.085

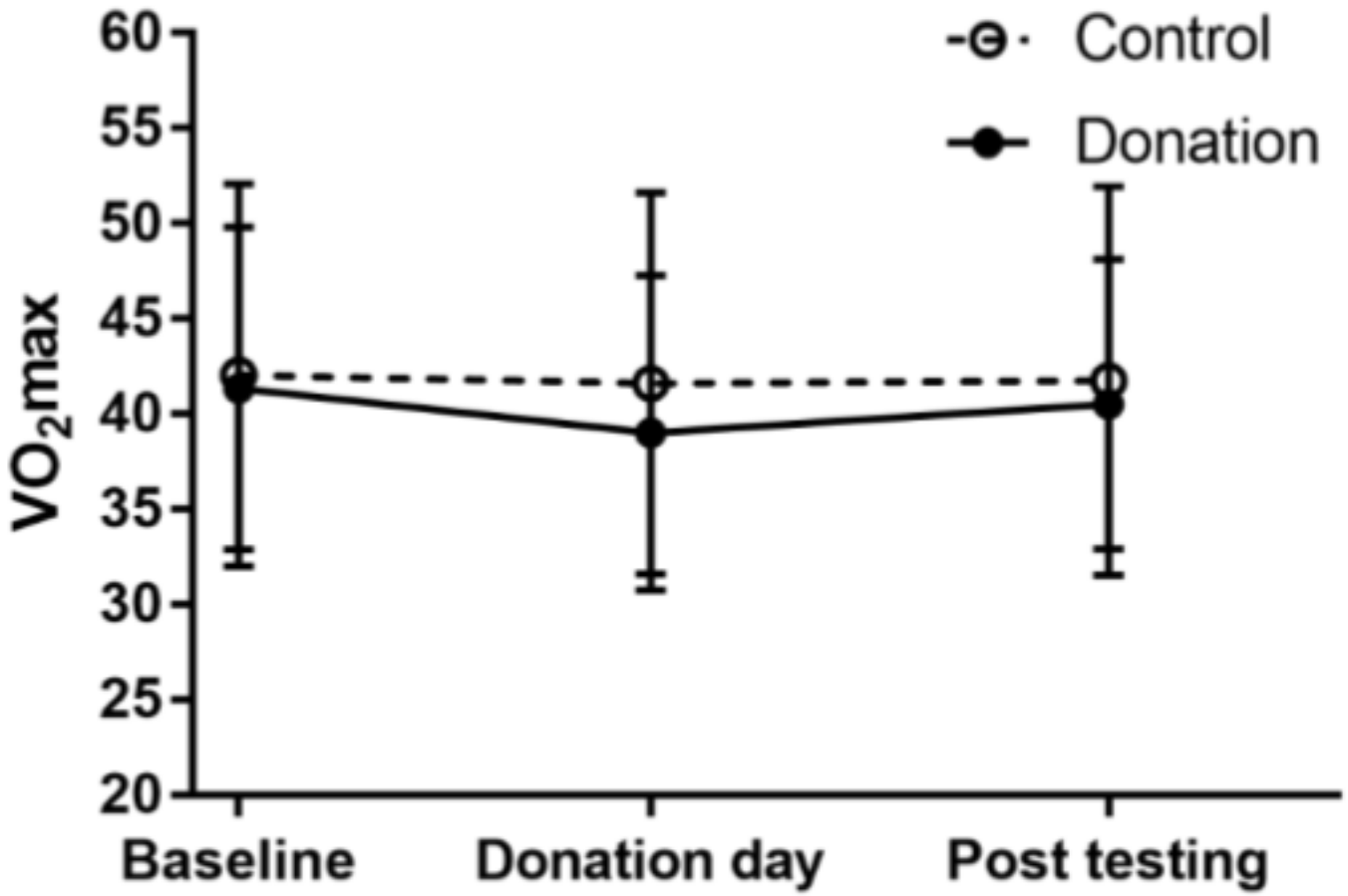
ments:

1,2,5

Do

Journal of Trauma and Acute Care Surgery

Immediate effects of blood donation on physical and cognitive performance - A randomized controlled double blinded trial.



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STAFF OFFICERS AS BLOOD SUPPLIERS: EFFECTS OF REPEATED DONATIONS AND AUTOLOGOUS REINFUSIONS OF UNTRANSFUSED UNITS (JOT)

This is a single-center cohort study approved by the local ethics committee. The cohort consisted of 9 voluntary staff officers who consented to donate whole blood up to 5 times during a 5-week period and to get the unit re-infused after 24 hour storage at 4 °C. This simulates the period where the blood is available for emergency transfusion during a high-risk mission before it is reinfused to the donor.

CURRENT OPINION

What is the evidence of utility for intraosseous blood transfusion in damage-control resuscitation?

Melvyn Harris, MD, Robert Balog, MS, PhD, *and* Gavin Devries, MS

J Trauma Acute Care Surg
Volume 75, Number 5

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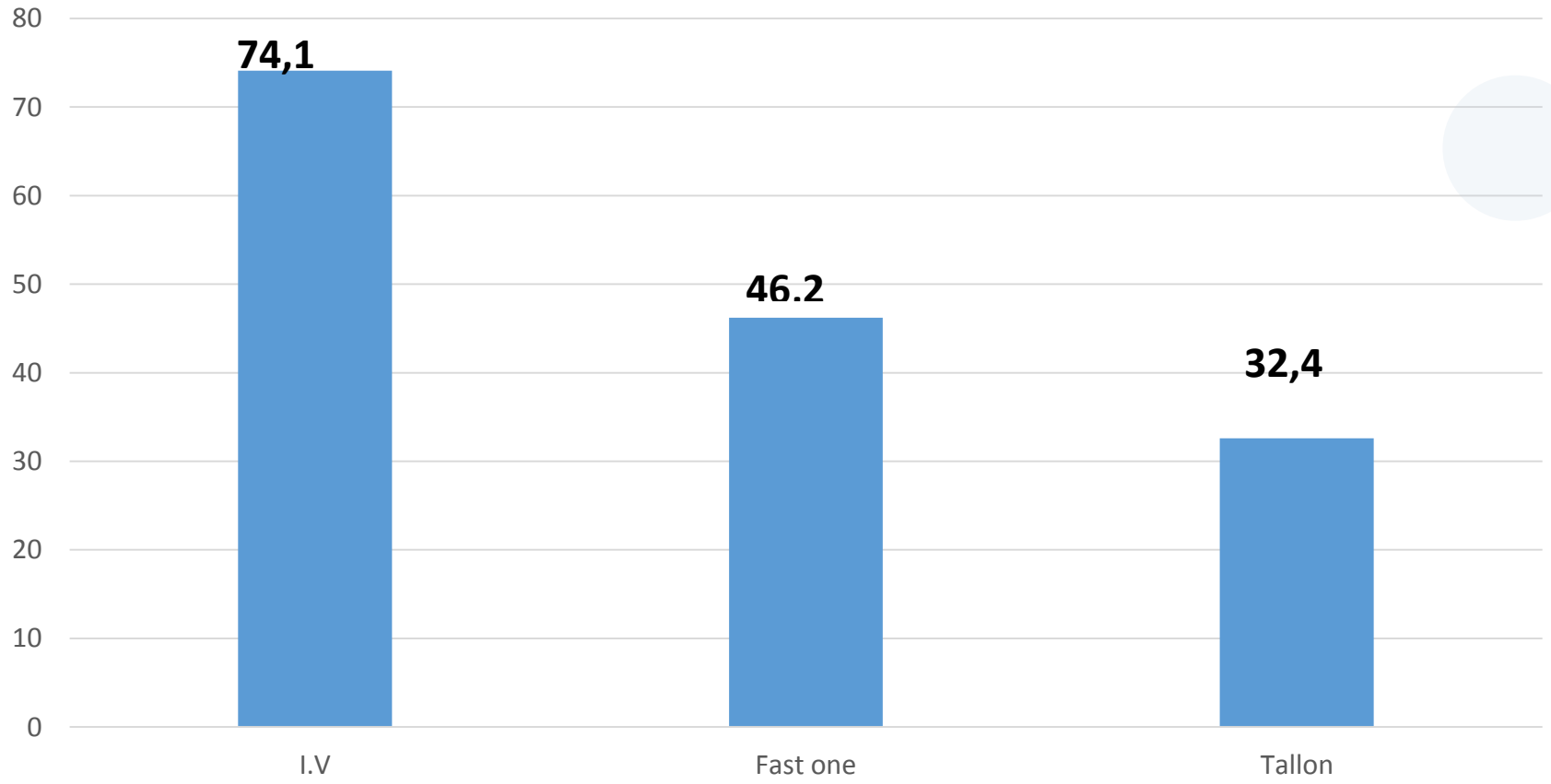
Emergency sternal intraosseous access for warm fresh whole blood transfusion in damage control resuscitation.

Bjerkvig CK, Fosse TK, Apelseth TO, Sivertsen J, Braathen H, Eliassen HS, Guttormsen AB, Cap AP, Strandenes G

REINFUSION RATES IN ML/MIN N=10 IN EACH GROUP



BLOOD EFFICACY AND AFETY BLOOD RESEARCH

VITRO STUDIER

INISKE STUDIER

LIDERINGS STUDIER

Three Primary Research Modules

1. *Donor Performance and reinfusion - Donor safety research*
2. *Blood efficacy and safety- Blood Research*
3. *Training and educational requirements*

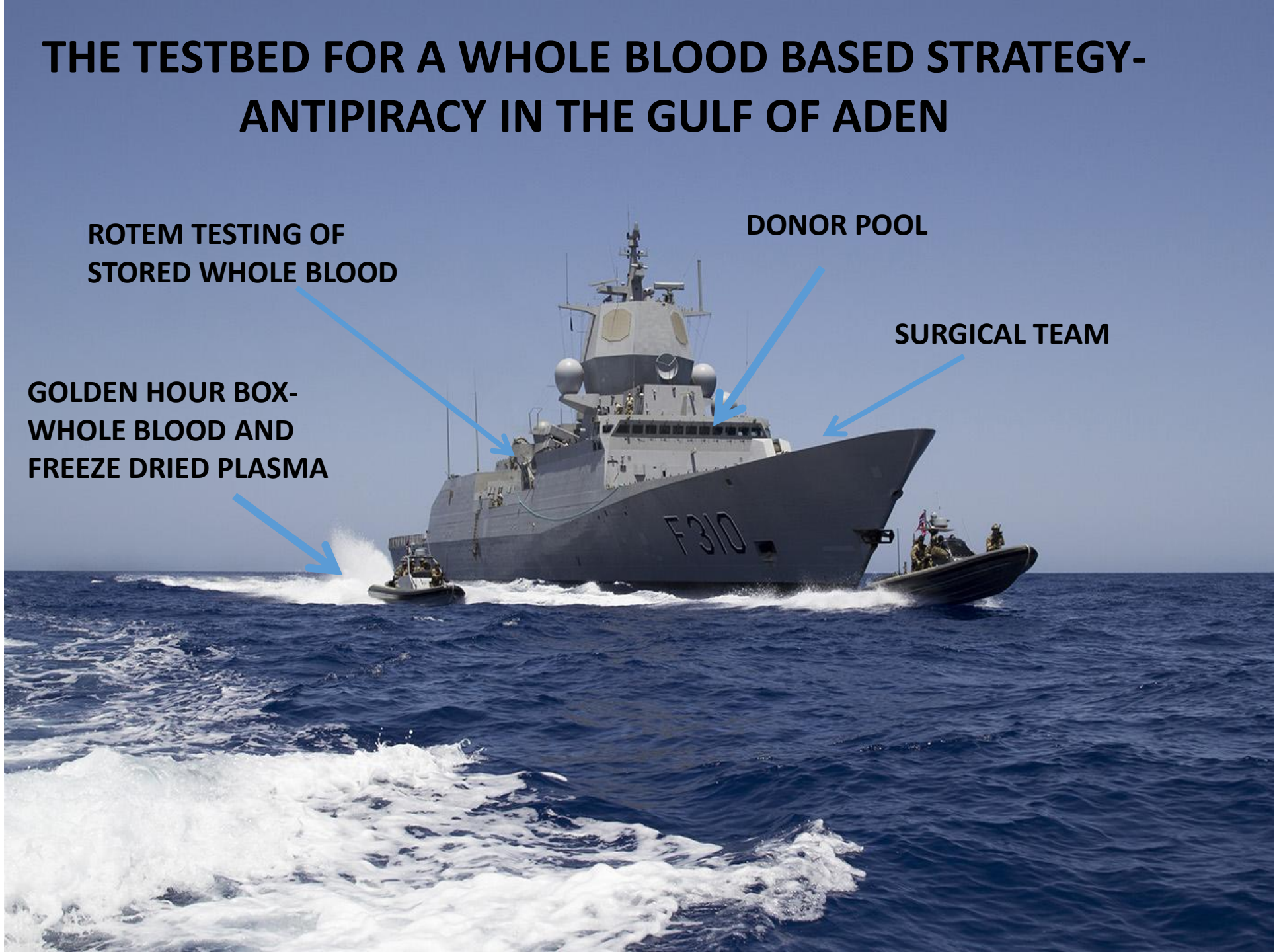

DURAC
FoU AIT
121011AF

FOU LAB

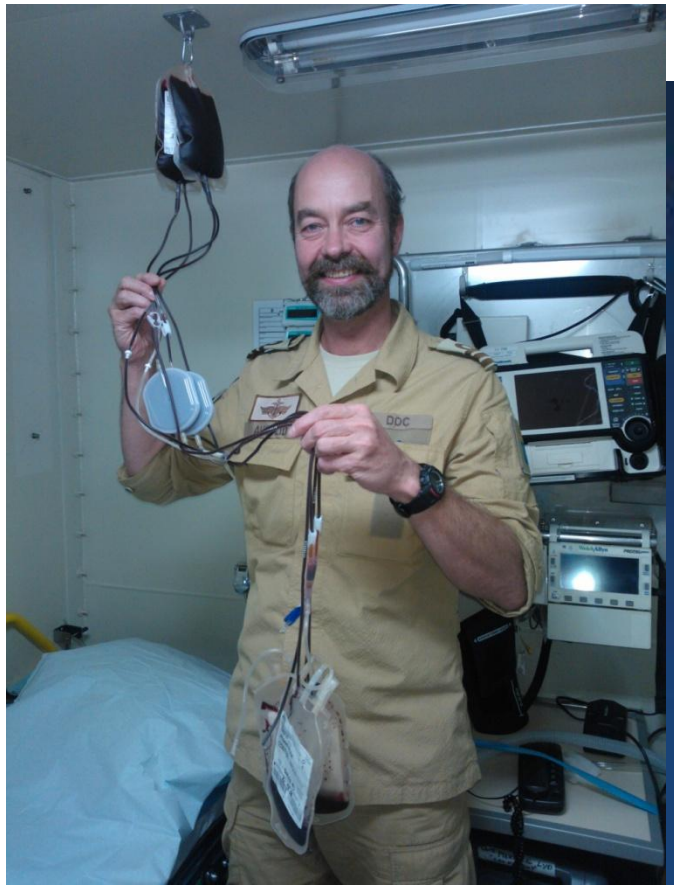

Bluetooth
LOG-IC
www.americanthermal.com
Libero
WWW.ELPRO.COM
START
Transit
STOP
Arrived


witt

THE TESTBED FOR A WHOLE BLOOD BASED STRATEGY- ANTIPIRACY IN THE GULF OF ADEN



In Vitro Studies Of Cold Stored Leukoreduced Whole Blood



- Imuflex® WB-SP
- Polyurethane
- Platelet recovery
- Wbc removal
- Platelet function

Coagulation function of
file:///C:/Users/Ugradert/Documents/artikler/mine%20artikler/Coagulation%20function%20of%20stored%20whole%20blood%20is%20pres
Suggested Sites
Web Slice Gallery
1 of 8

ORIGINAL ARTICLE

Coagulation function of stored whole blood is preserved for 14 days in austere conditions: A ROTEM feasibility study during a Norwegian antipiracy mission and comparison to equal ratio reconstituted blood

Geir Strandenes, MD, Ivar Austlid, MD, Torunn O. Apelseth, MD, PhD, Tor A. Hervig, MD, PhD, Jan Sommerfelt-Pettersen, MD, Maryanne C. Herzig, PhD, Andrew P. Cap, MD, PhD, Heather F. Pidcoke, MD, PhD, *and* **Einar K. Kristoffersen, MD, PhD,** *Bergen, Norway*

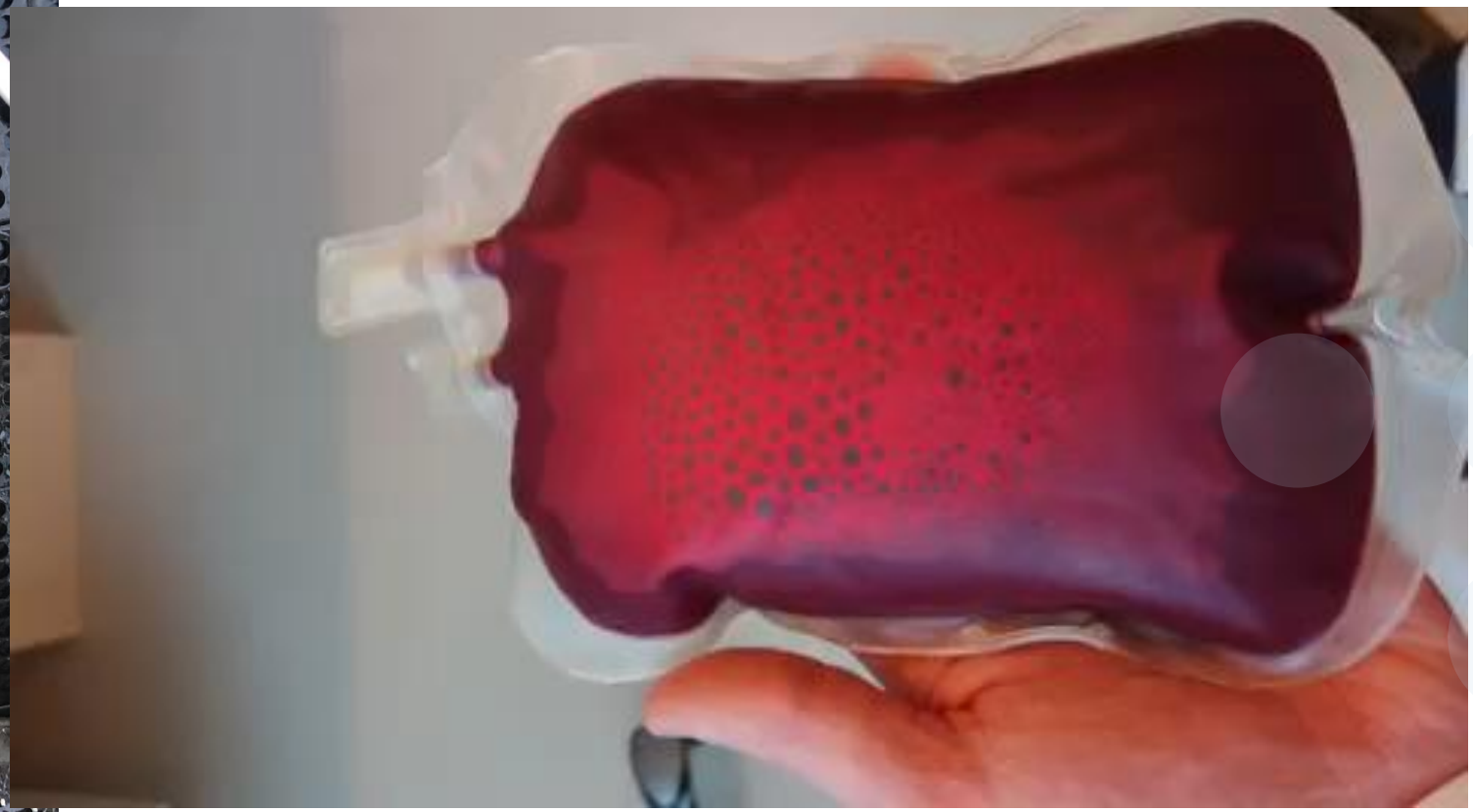
NOB 17:41 07.10.2017

Preparation of leukoreduced whole blood for transfusion in austere environments; effects of forced filtration, storage agitation, and high temperatures on hemostatic function.

Sivertsen J, Braathen H, Lunde THF, Spinella PC, Dorlac W, Strandenes G, Apelseth TO, Hervig TA, Kristoffersen EK.

J Trauma Acute Care Surg. 2018 Jun;84

Is Blood Fragile?



IN PREPARATION

- **The quality of red cell concentrates produced from whole blood stored for 7 days at 4°C**
- **The in vitro quality of cold stored leukococyte-reduced whole blood**

IN PREPARATION

- **FORWARD STORAGE OF WHOLE BLOOD**
- **QUALITY AFTER STORAGE IN CLOSED GOLDEN HOUR BOXES**

PLANNED IN VITRO

- **LEUKOCYTE FILTRATION CPDA WHOLE BLOOD(ONGOING)**
- **«SEAHORSE» Mitochondriell stresstest : HYPOTESEGENERERENDE**

SEAHORSE

KURS 28.1117

Functional mitochondrial measurements are key to understanding cellular activation, proliferation, differentiation and dysfunction. The Seahorse XF Cell Mito Stress Test provides a complete mitochondrial profile in intact cells and reveals critical information not evident in basal metabolism measurements alone.

DEL AV DOKTORGRADS ARBEIDET TIL FOSSE OG BJERKVIG. TETT SAMARBEID M USAISR

CLINICAL STUDIES

Apelseth_et_al-2017-ISI
file:///C:/Users/Ugradert/AppData/Local/Microsoft/Windows/INetCache/Content.Outlook/IVOJX5NT/Apelseth_et_al-2017-ISBT_Science_Seri
Suggested Sites
Web Slice Gallery

ISBT Science Series

ISBT International Society of Blood Transfusion

An affiliated publication to Vox Sanguinis

ISBT Science Series (2017) **0**, 1–8

CONGRESS REVIEW

4A–S19–02

Published 2017. This article is a U.S. Government work and is in the public domain in the USA.

Cold stored platelets in treatment of bleeding

T. O. Apelseth,[1,2] A. P. Cap,[3] P. C. Spinella,[4] T. Hervig[2,5,6] & G. Strandenes[2,6]

[1]*Laboratory of Clinical Biochemistry, Haukeland University Hospital, Bergen, Norway*

[2]*Department of Immunology and Transfusion Medicine, Haukeland University Hospital, Bergen, Norway*

[3]*U.S. Army Institute of Surgical Research, FT Sam Houston, San Antonio, TX, USA*

[4]*Division of Critical Care, Department of Pediatrics, Washington University in St. Louis, St. Louis, MO, USA*

[5]*Institute of Clinical Science, School of Medicine and Dentistry, University of Bergen, Bergen, Norway*

[6]*Norwegian Armed Forces Medical Services, Oslo, Norway*

NOB 20:40 28.11.2017

Is it Time to Reconsider How Platelets Are Stored?

AABB session 2017
Geir Strandenes, MD
Senior Anesthetist
Dept of War Surgery and Emergency Medicine
Norwegian Armed Forces Medical Services
Co-Chair Thor Network
Dept.of Immunology and Transfusion Medicine

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Transfusion With Cold Stored Platelets In Patients Undergoing Complex Cardiothoracic Surgery With Cardiopulmonary Bypass Circulation:

Effect On Bleeding, platelet-aggregation, viscoelastic essays and Risk

FUNDED BY THE NORWEGIAN ARMED FORCES MEDICAL SERVICES

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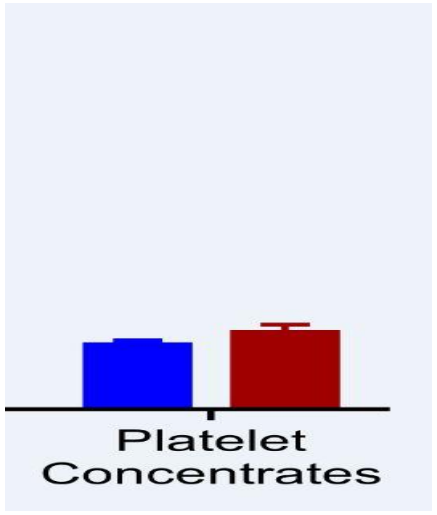
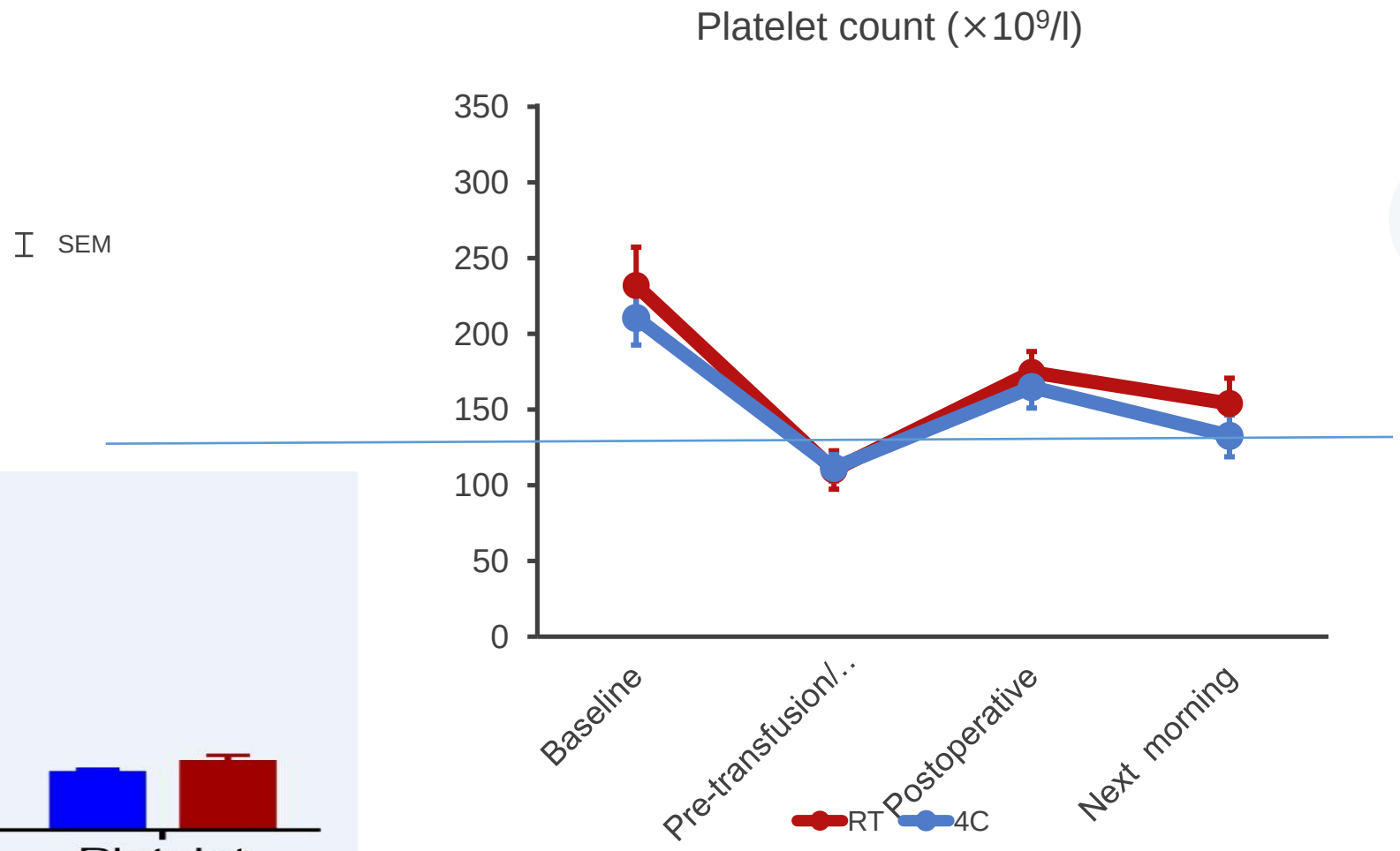
Platelet transfusions and total platelet counts





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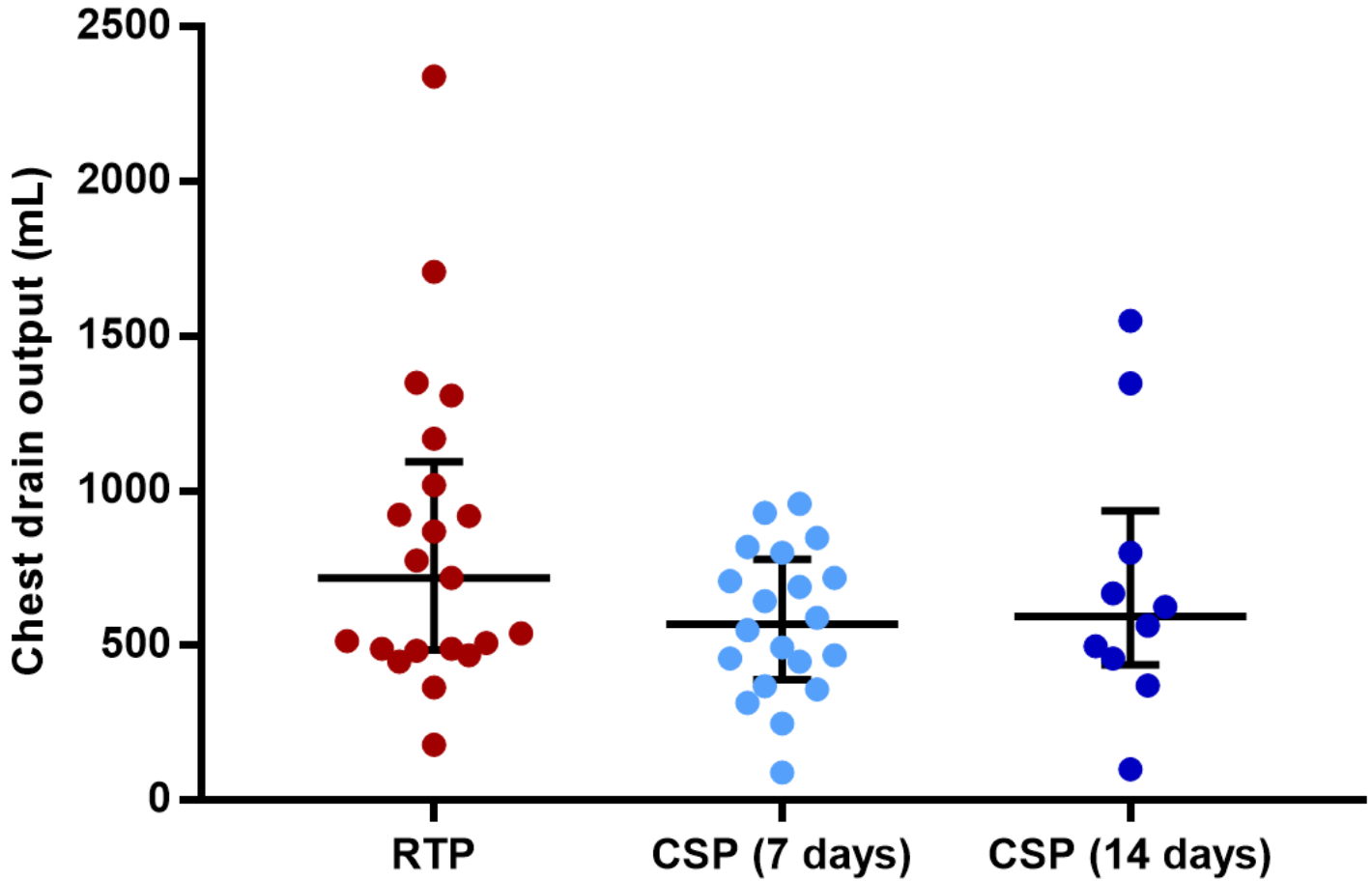
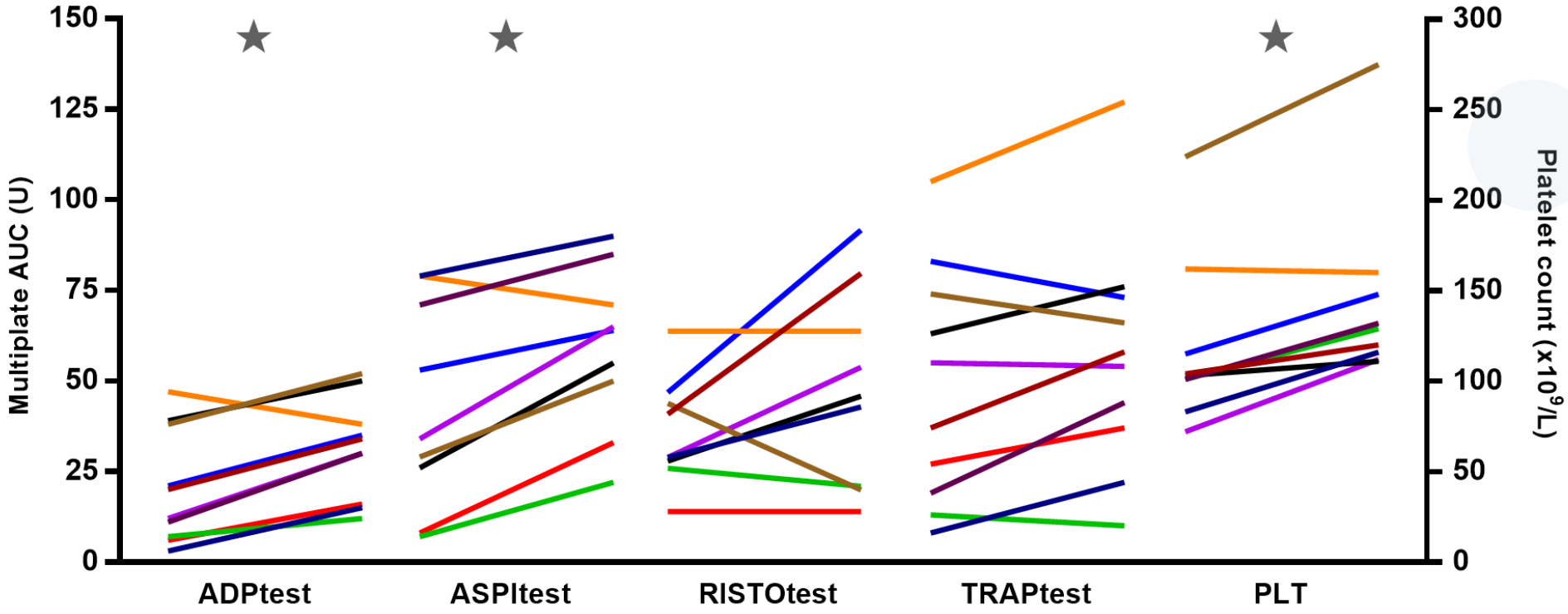

Chest drain output (mL)
2500
2000
1500
1000
500
0
RTP
CSP (7 days)
CSP (14 days)



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FUTURE STUDIES IN THE PIPELINE

- **FOLLOW UP OBSERVATIONAL STUDY OF PREHOSPITAL CWB USE**
- **FOLLOW UP PATIENT RECEIVING CWB IN HOSPITAL AS PART OF MASSIVE TRANSFUSION PROTOCOL**
- **RANDOMISED STUDY IN CARDIOTHORACIC SURGERY WHOLE BLOOD :«CUT OFF» FOR PLATELET FUNCTION – SHELF LIFE IMPACT ON CLINICAL OUTCOME**
- **COLD STORED PLATELETS UNTIL DAY 21 OF STORAGE – CLINICAL PILOT STUDY**

TRAINING AND EDUCATIONAL REQUIREMENTS

Three Primary Research Modules

1. *Donor Performance and reinfusion - Donor safety research*
2. *Blood efficacy and safety- Blood Research*
3. *Training and educational requirements*

[A proposed field emergency donor panel questionnaire and triage tool.]
Doughty H, Thompson P, Cap AP, Spinella PC, Glassberg E, Skogrand Eliassen H, De Pasquale M, **Strandenes G**.
Transfusion. 2016 Apr;56 Suppl 2:S119-27

[Tactical Damage Control Resuscitation.]
Fisher AD, Miles EA, Cap AP, **Strandenes G**, Kane SF.
Mil Med. 2015 Aug;180(8):869-75.

[Emergency whole-blood use in the field: a simplified protocol for collection and transfusion.]
Strandenes G, De Pasquale M, Cap AP, Hervig TA, Kristoffersen EK, Hickey M, Cordova C, Berseus O, Eliassen HS, Fisher L, Williams S, Spinella PC.
Shock. 2014 May;41 Suppl 1:76-83.

[Blood Far Forward--a whole blood research and training program for austere environments.]
Strandenes G, Cap AP, Cacic D, Lunde TH, Eliassen HS, Hervig T, Spinella PC.
Transfusion. 2013 Jan;53 Suppl 1:124S-130S

TRAINING AND EDUCATIONAL REQUIREMENTS

- PROTOCOL FOR PREHOSPITAL FWB/CWB TRANSFUSION 2013
- CLINICAL PRACTICAL GUISELINE CHANGE – WB AS PRIMARY RESUSCITATION FLUID FOR THE ENTIRE FORCE
- NATO ACCREDITED EDUCATIONAL PROGRAM «NORDIC SOCOM AND ISTC PFULLENDORF
- PUBLISHED ALSO HERE : http://rdcr.org/education/educational-materials/

VALIDATION AND QUALITY CONTROLLS

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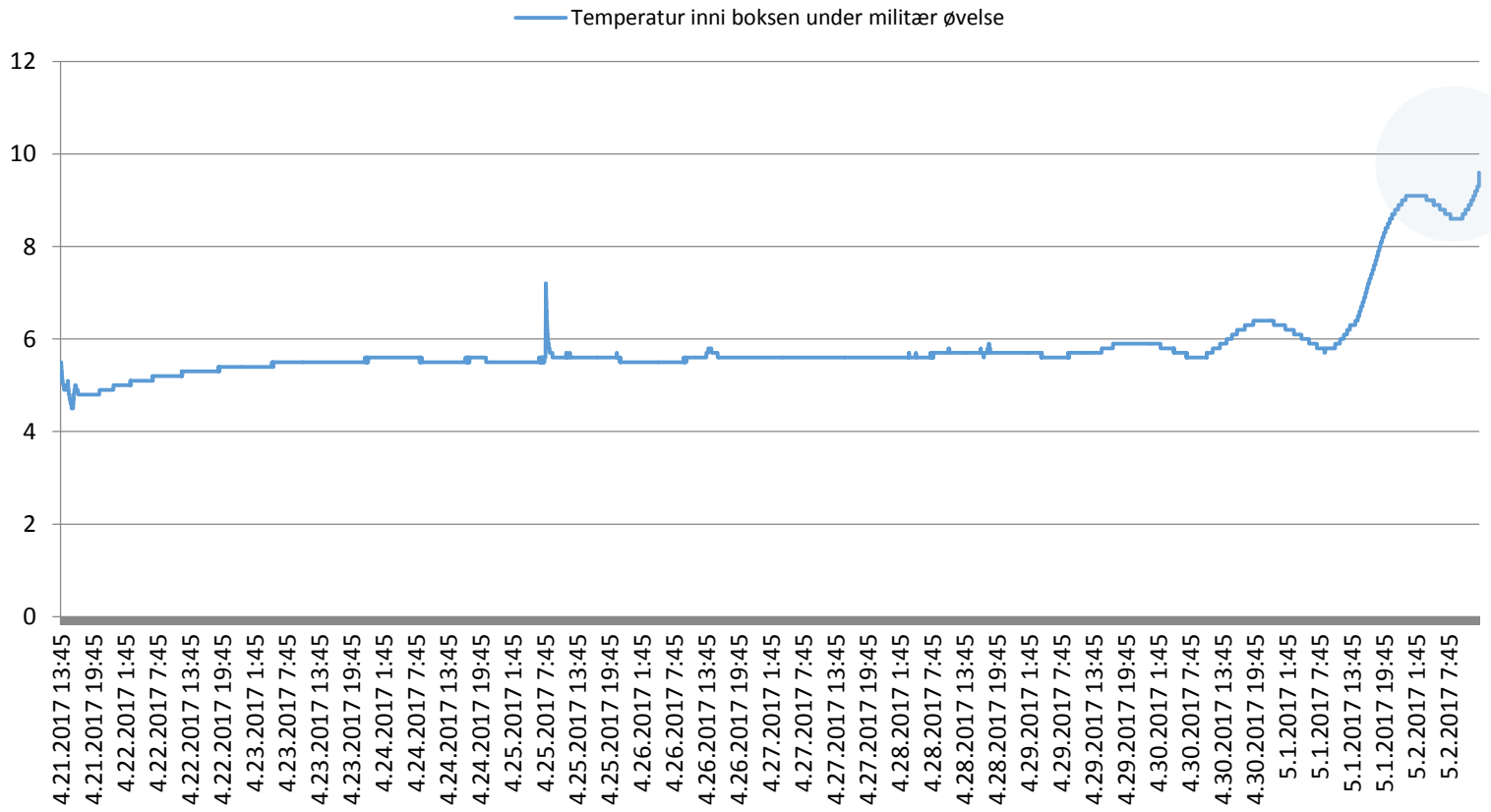
Validations

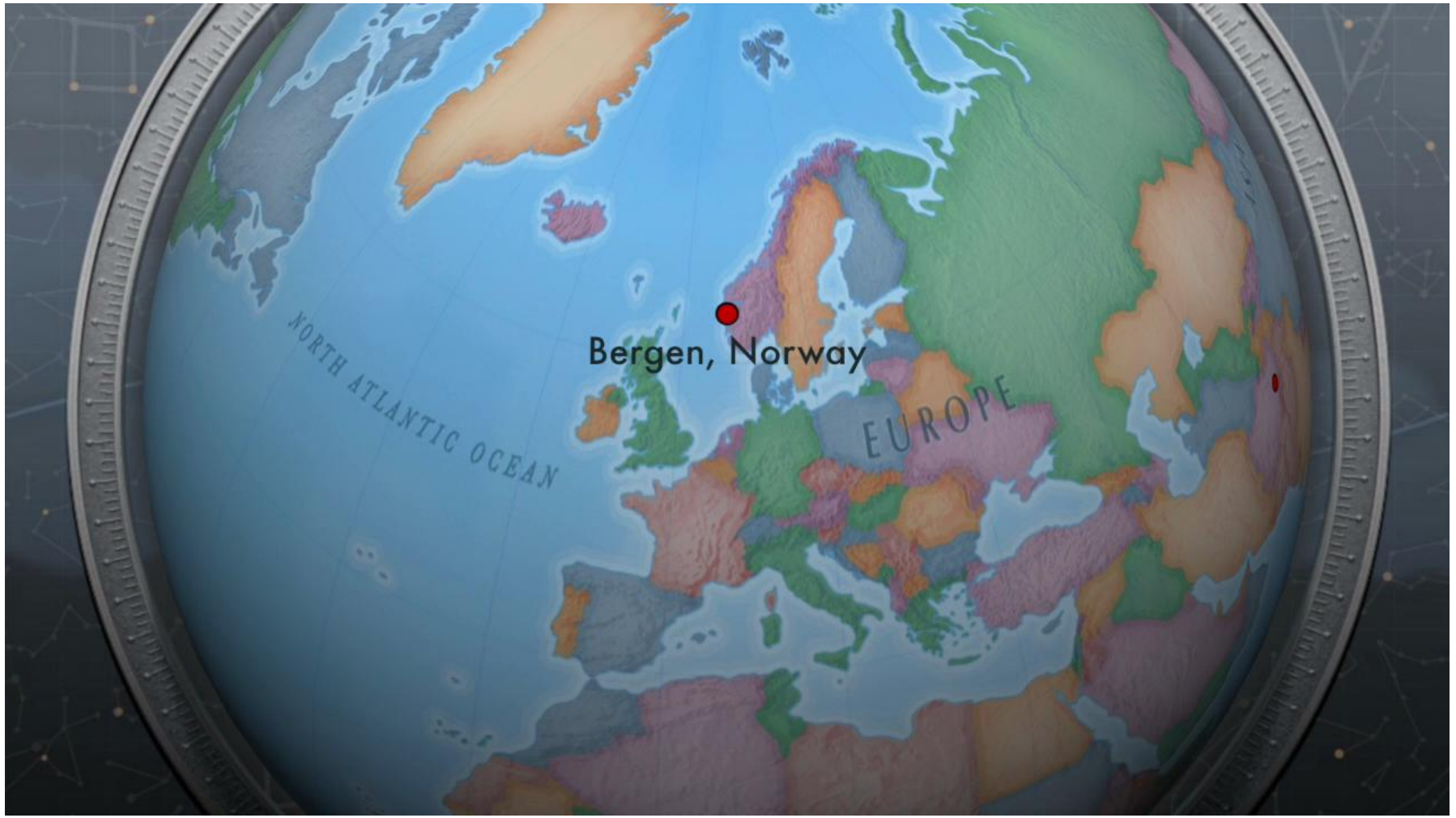
- Golden Hour Boxes (GHB), series 4 (2, 16, 28 &56 liter)
  - Storage ubder extreme conditions (4°C, 0-20, -40, +50)
- Libero Ti1 temploggers
- Validation of 30 collection sets for WB Imuflex®-WB-SP before leukoreduced WB used as standard in the blood bank

Ambient

Control of internal temperature during military exercise. Nine days to the temperature exceeded 6 ° C, ten days until the temperature exceeded 8 ° C.



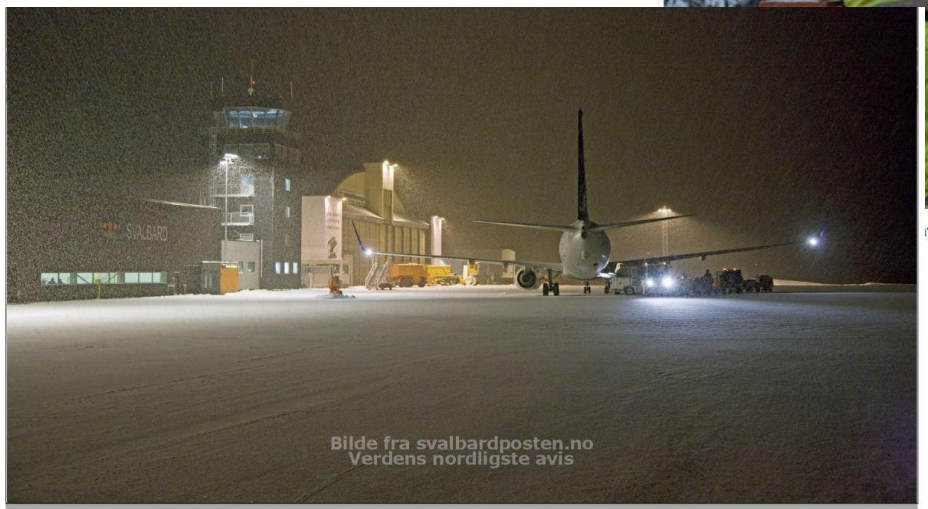
WHOLE BLOOD TO THEATRE IN GOLDEN XES


Bergen, Norway
NORTH ATLANTIC OCEAN
EUROPE

- **In Norway all Blood Banks are hospital-based**

- All blood banks collect blood
- 20 out of 50 acute hospitals without platelets

However, our geography and climate do not always cooperate.

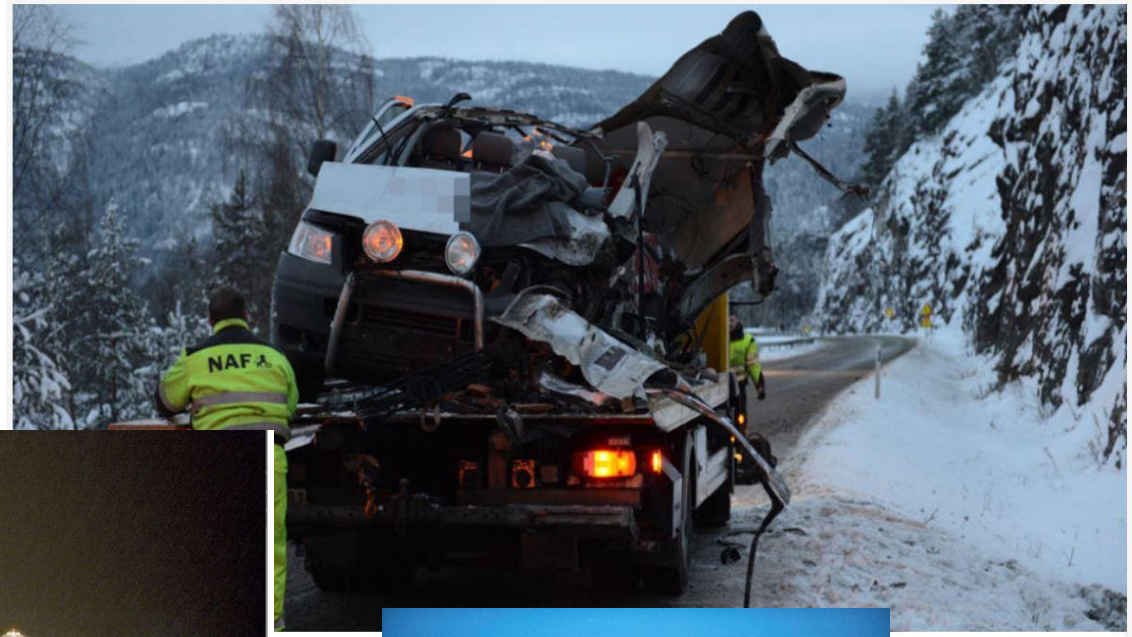


Flyet fra Tromsø er kansellert fredag. FOTO: Birger Amundsen (arkiv)

Flyet er kansellert

Dårlig vær i Longyearbyen gjør at SAS-flyet fra Tromsø er kansellert fredag.

Forsiden > Nyheter > Innenriks



v en bergingsb

- Prehospital blood transfusion and local blood preparedness plans are therefore important!

Since all blood banks can collect blood, they have the resources to provide themselves with whole blood at demand.

Implementation of a Whole Blood program in Bergen

Freeze Dried Plasma
Air Ambulance
2013

RBC
Air Ambulance
July 2014

Whole Blood
Air Ambulance
December 2015

Whole Blood in hospital Massive Transfusion Packages
December 2017

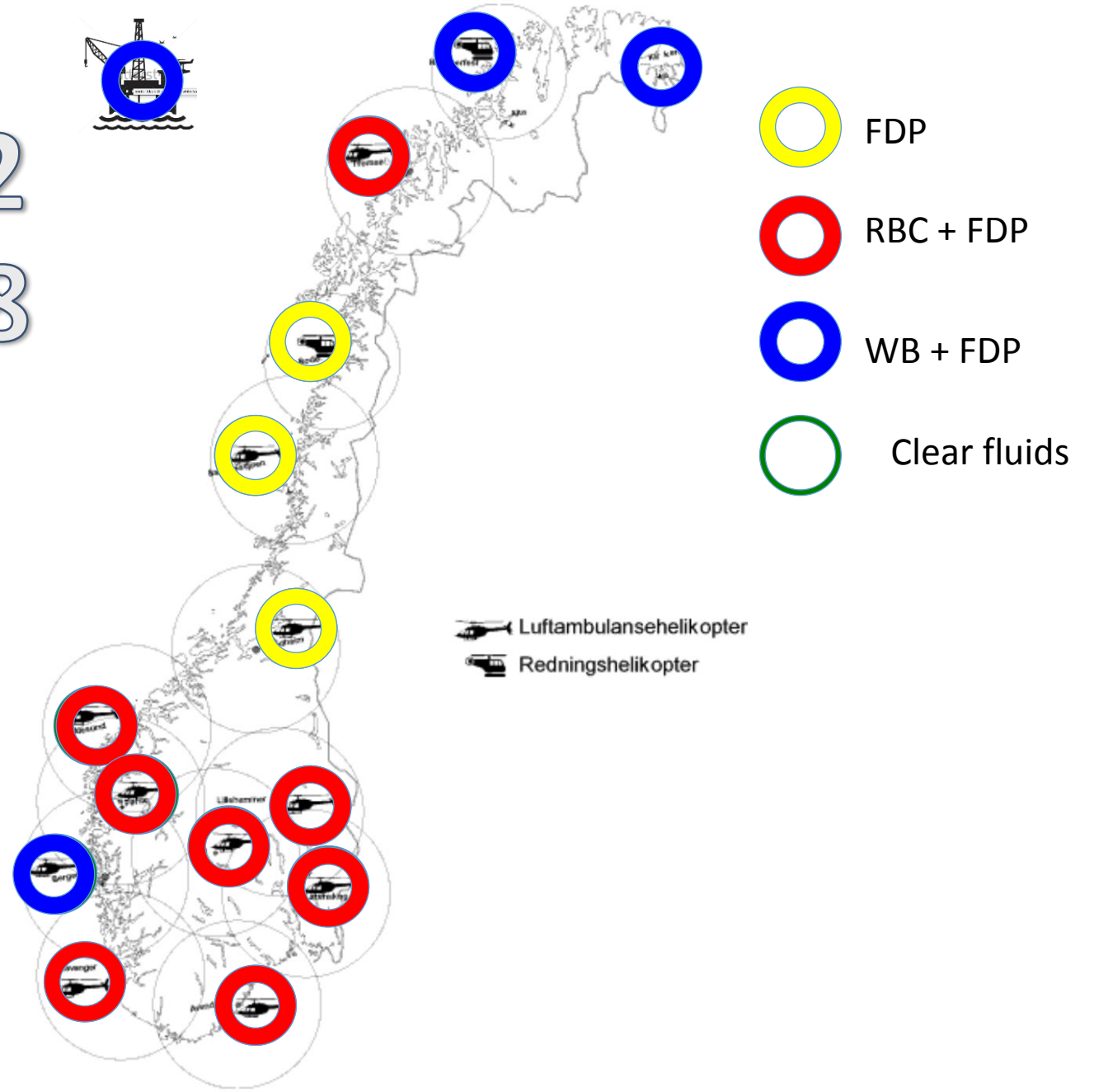
Massive Transfusion Packages in Bergen

- Whole blood based MTP
- -4 units Low Titer Group O
- Oneg, K neg: female < 50 y
- Opos, K neg: male, female > 50 y

- Component based MTP
- 6 RBC
- 6 SD-plasma
- 2 Platelet Concentrate

- Children:
- Both MTPs available
- Reduced number of units

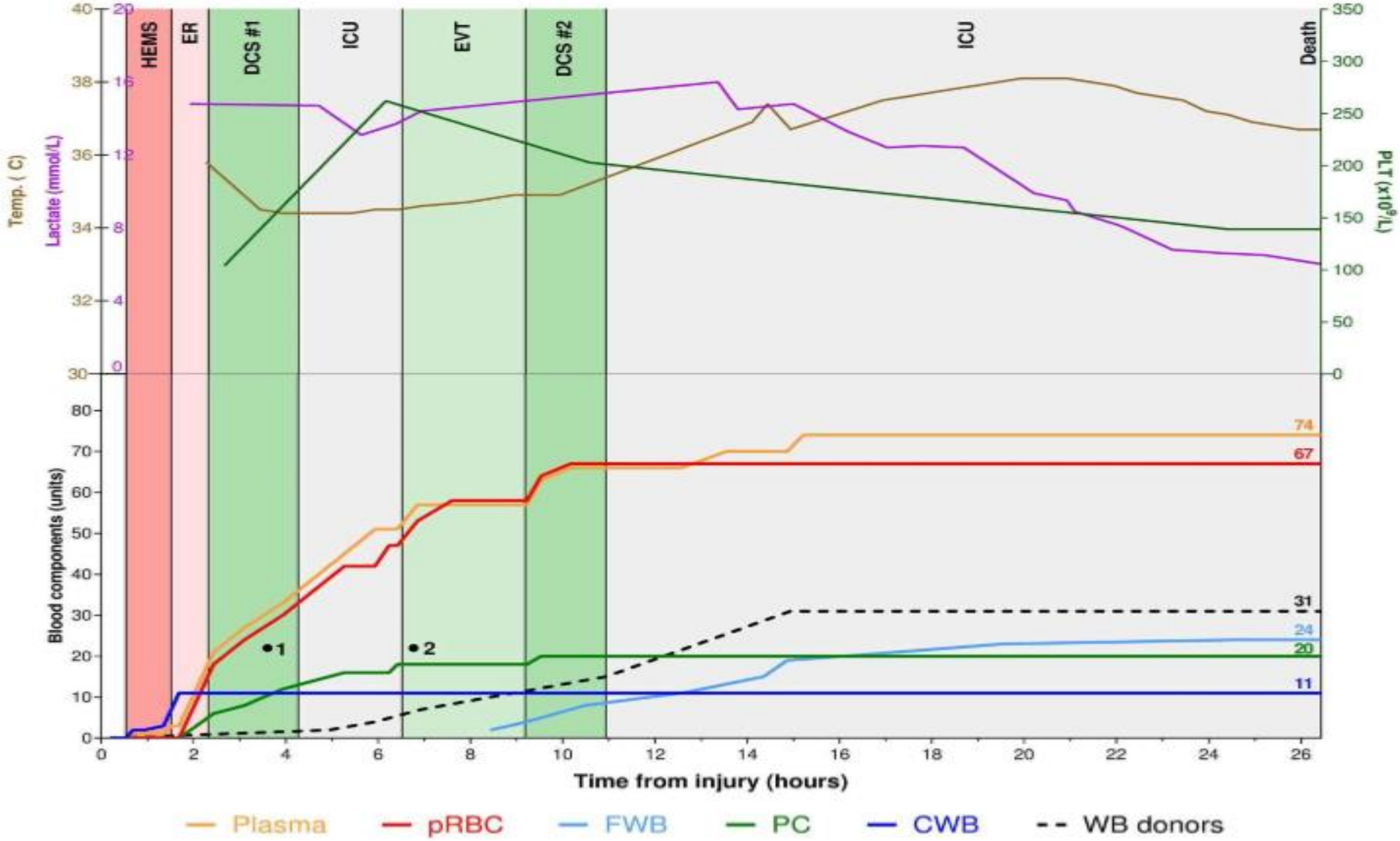
2012
2018


FDP
RBC + FDP
WB + FDP
Clear fluids
Luftambulansehelikopter
Redningshelikopter

Cold is good for you…

CASE PRESENTATION

HOW 1 CASUALTY DEPLETED THE PLATELET INVENTORY IN THE SECOND LARGEST BLOOD BANK IN NORWAY


HEMS
ER
DCS #1
ICU
EVT
DCS #2
ICU
Death
Temp. (C)
Lactate (mmol/L)
PLT (x10⁹/L)
Blood components (units)
Time from injury (hours)
74
67
31
24
20
11
•1
•2
Plasma
pRBC
FWB
PC
CWB
WB donors

FORSVARET

HEALTH DIRECTORATE WORKING GROUP

- WORKING GROUP MANDATE
- CREATE A PLAN FOR NATIONAL PREPAREDNESS AND RESUPPLY OF BLOOD AND BLOOD PODUCTS IN PEACETIME/CRISIS/WAR

THE WAY FORWARD FOR BFF

- NORDIC COLLOBORATION FDP
- SYNCRONISE NORDIC APPROACH
- TRAINING/EDUCATION PROGRAM FOR THE ENTIRE FORCE (THATS WHERE THE MONEY SHOULD BE PUT)
- RECRUITEMENT OF EMERGENCY DONORS
- LOCAL CIVILAIN PREPAREDNESS – EDUCATE THE CIVILIAN HEALTH CARE SYSTEM
- CONTINUE BFF RESERACH

BFF

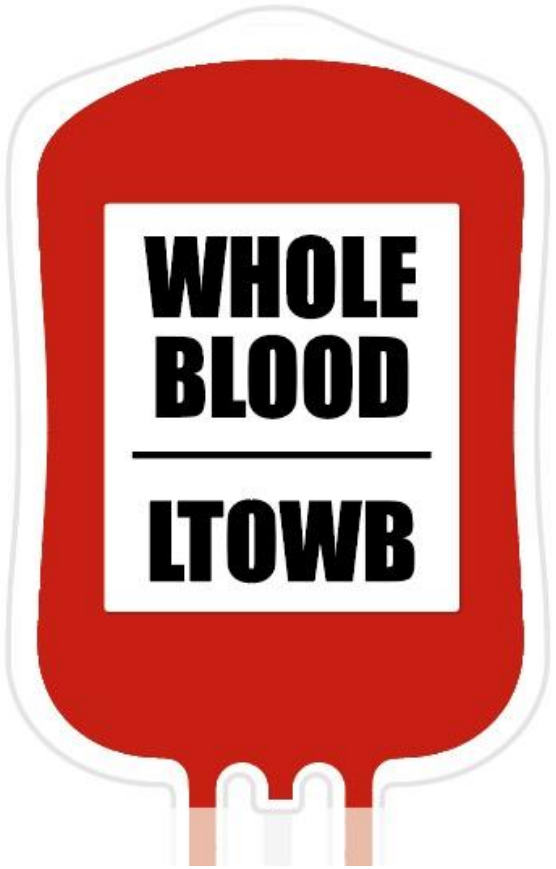
FORSVARET

- NATO ACCREDITED TRAINING PROGRAM
- WHOLE BLOOD IMPLEMENTATION THE ENTIRE FORCE FOR RDCR AND DCR
- FDP IN CIVILIAN HOSPITALS
- FDP/Prbc/WB IN HEMS
- MILITÆR COLD CHAIN SOLUTION IMPLEMENTED IN CIVILIAN SECTOR
- WHOLE BLOOD IN TRAUMA CIVILIAN
- COLD PLATELETS WILL CHANGE TRANSFUSION POLICY MIL/CIV ??
- PREPAREDNESS PLANNING
- WBB IN CIVILIAN HOSPITALS?
- THOR ANNUAL CONFERENCE
- INTERNATIONAL RESEARCH COLLOBORATION

FORSVARET

“THE WHOLE IS GREATER THAN THE SUM OF ITS PARTS”

-ARISTOTLE



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- Torunn O Apelseth, MD, PhD
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- Hanne Braathen, BSc
- Joar Sivertsen, BSc
- Venny Kvalheim, MD, PhD
- Rune Haaverstad, MD, PhD
- Håkon Eliassen, Stud Med

Andrew P Cap, MD, PhD, FACP

James K Aden, PhD

U.S. Army Institute of Surgical Research, FT Sam Houston, TX, USA

Philip C Spinella, MD, FCCM

Division of Critical Care Medicine, Clinical Care Translational Research Program, Washington University, St. Louis, US

<u>Advisors, debaters and critics</u> in the THOR Network

THOR TRAUMA HEMOSTASIS & OXYGENATION RESEARCH NETWORK

<u>*Our institutions:*</u>

Department of immunology and transfusion medicine, Department of Anaesthesia and Intensive Care, Section of Cardiothoracic Surgery, Department of Heath Disease, and Laboratory of Clinical Biochemistry, Haukeland University Hospital, Bergen, Norway

Institute of Clinical Science, School of Medicine and Dentistry, University of Bergen, Norway

Norwegian Naval Special Operations Commando

Norwegian Armed Forces Medical Services