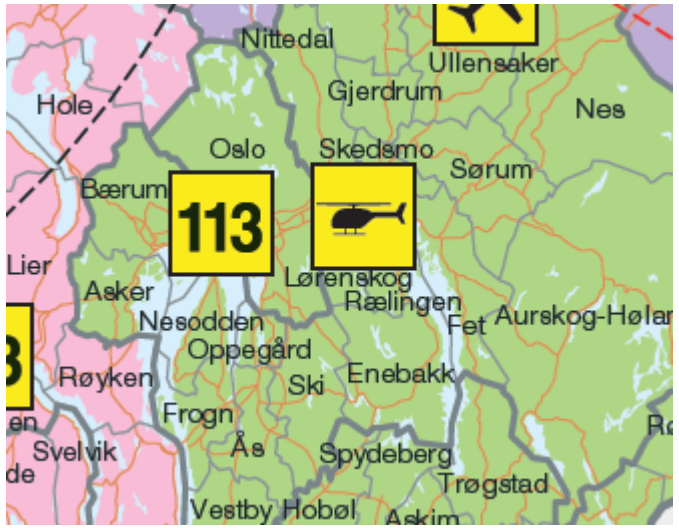
Whole blood for transfusion: Insights from Oslo

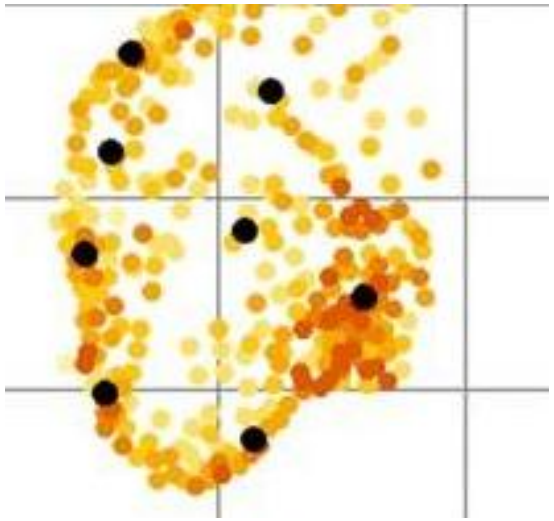
Elena Danilova

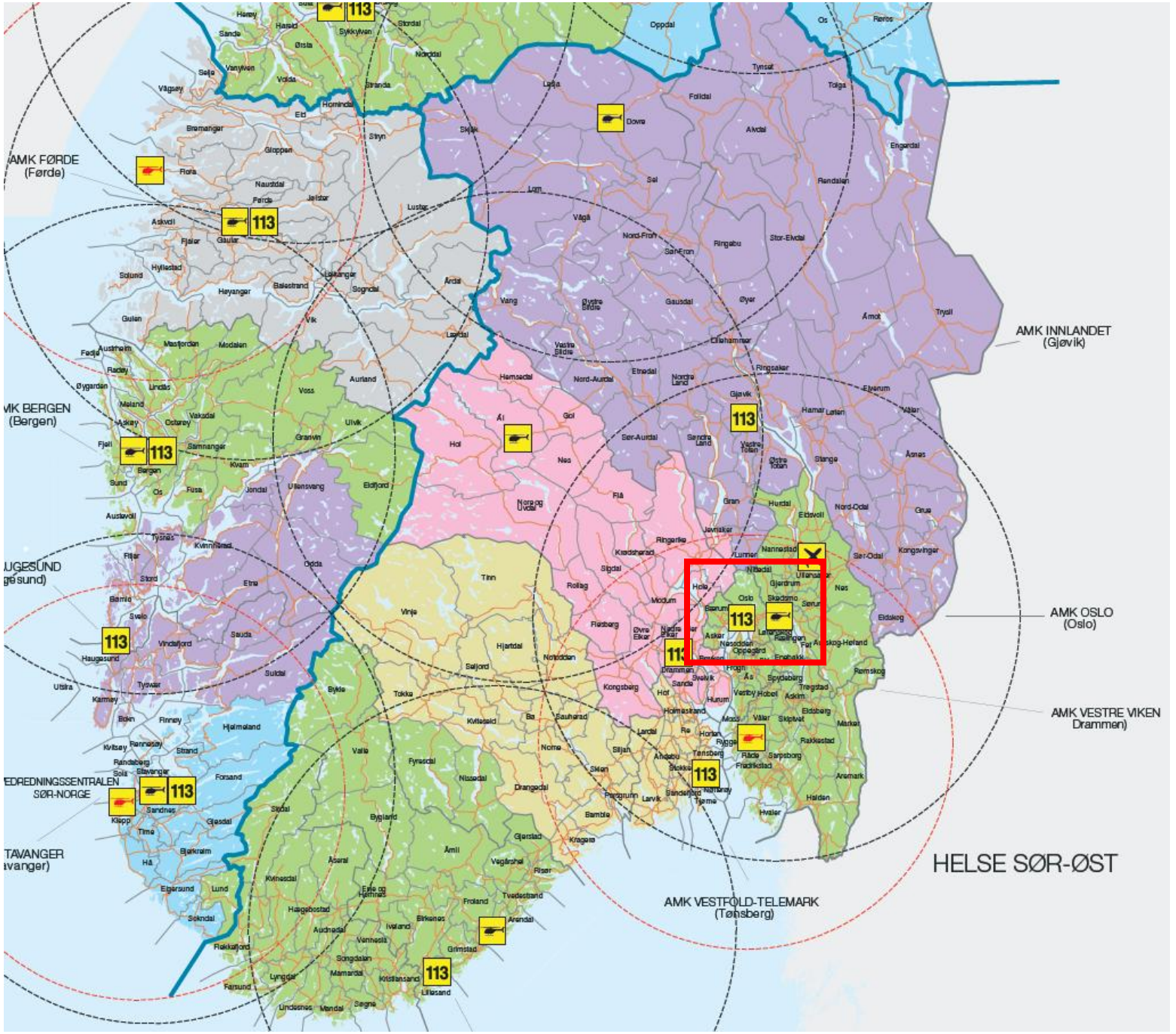
Transfusion Medicine Consultant

OSLO UNIVERSITY HOSPITAL

Basene våre - Luftambulansetjenesten HF







Røislien J. 2018

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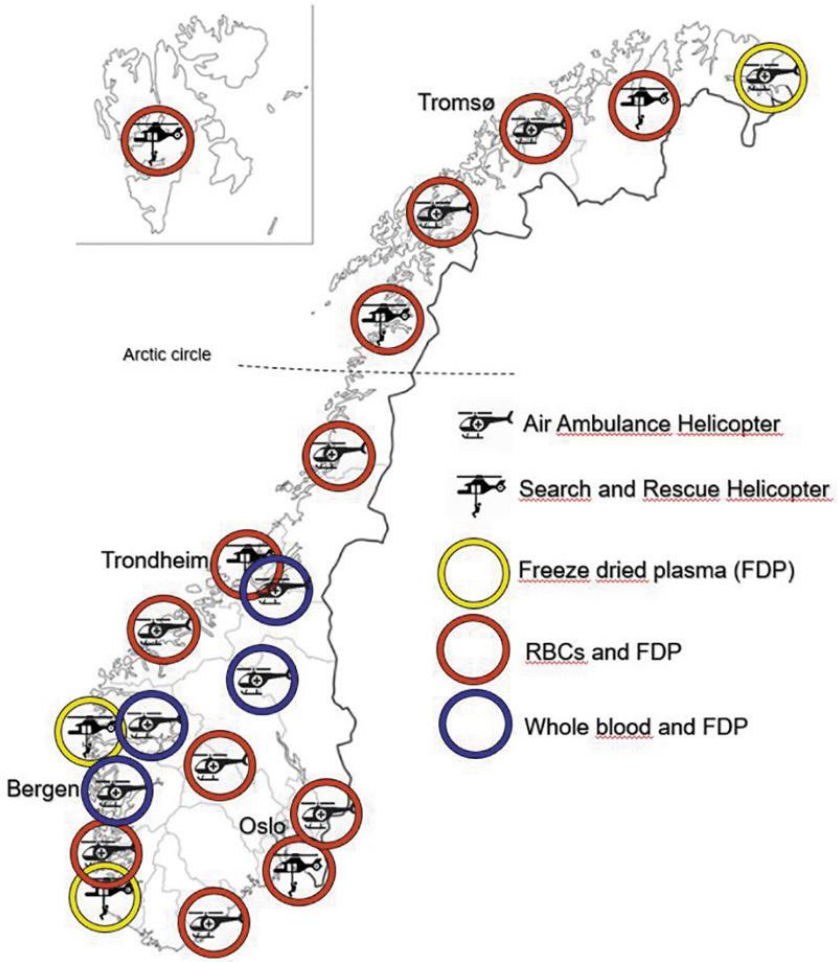
Norway as a Pioneer in Prehospital Whole Blood Transfusion in Europe



- 2022 – “Implementation of a low-titre whole blood transfusion program in a civilian helicopter emergency medical service”. G. Sunde
- The HEMS Bergen covers a population of approximately 550,000
- December 2015 - December 2020: 72 patients were transfused; 52 were followed up and 28 survived 30 days. Of the 24 deceased, 16 died within 24 hour after the trauma.

Prehospital Emergency Medical Services in Helse Sør-Øst: Lørenskog-base

- The Lørenskog base is one of the highest-activity bases, with ~2000 missions/year (🚁 Gjennom luftambulansetjenesten betjener OUS hele Norge 👉 … | Oslo universitetssykehus)
- Physician-staffed unit (rapid response cars and on-scene physicians)
- Air ambulance services (2 helicopters, 14 pilots, 17 medical doctors)
- Response to medical and trauma cases, it also handles pediatric and neonatal retrievals, interhospital transfer, search and rescue missions
- The HEMS are staffed with a prehospital anesthesiologist at the consultant level, a HEMS rescue paramedic, and a pilot.
- Ambulance response time <25 min (remote areas) 83% .

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Bjerkvig CK. 2021. Transfus Med Hemother

Why Component Therapy Replaced Whole Blood?

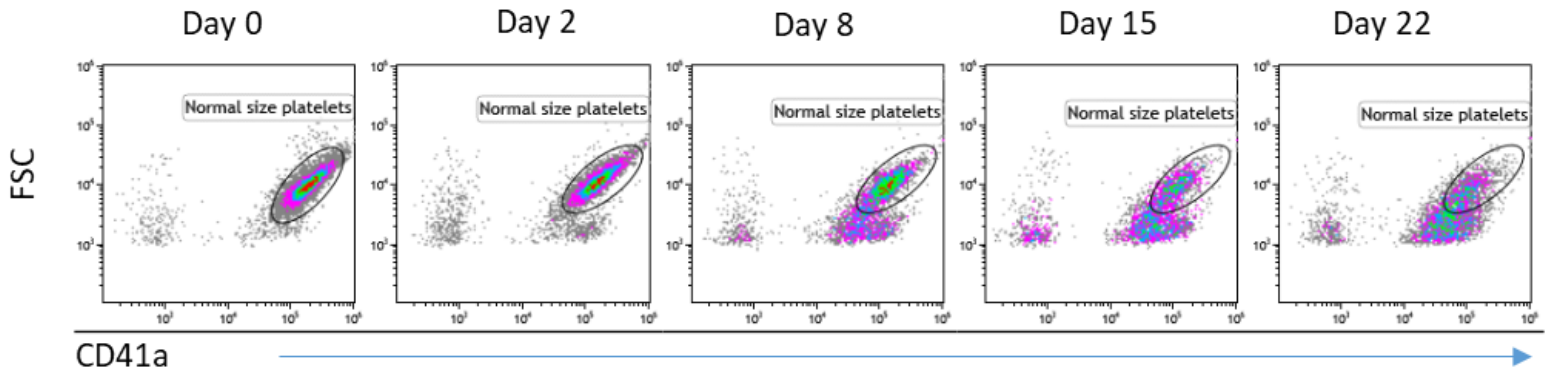
- 1970s–1980s whole blood transfusion was largely replaced by component therapy in civilian practice
- Safety
  - “Universal” RBC (blood group O) and “universal” plasma (blood group AB)
    - simplified ABO matching
  - Octaplasma (Solvent/Detergent–treated pooled human plasma)
    - pathogen inactivation
    - standardized coagulation factor content
    - reduced risk of TRALI and severe allergic reactions
    - immunological uniformity
- PBM: goal-directed transfusion—giving the patient exactly what is needed
- Better storage and availability

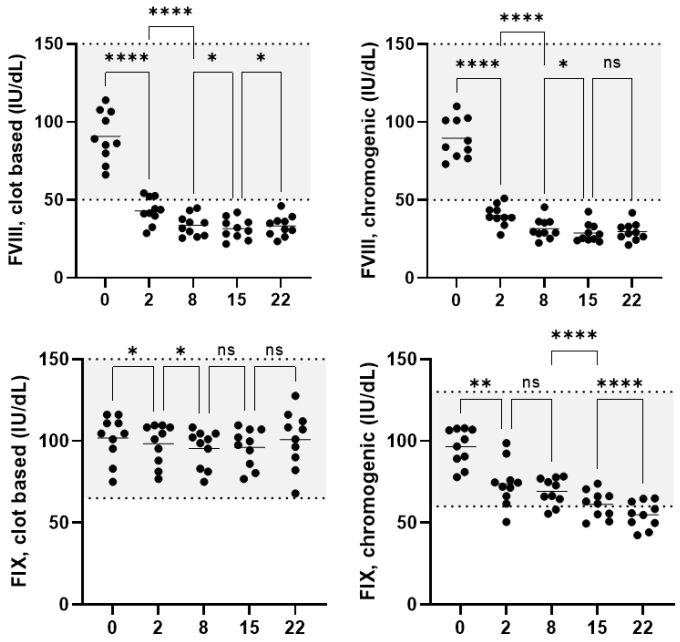
Godbey EA. Clin Lab Med. 2021

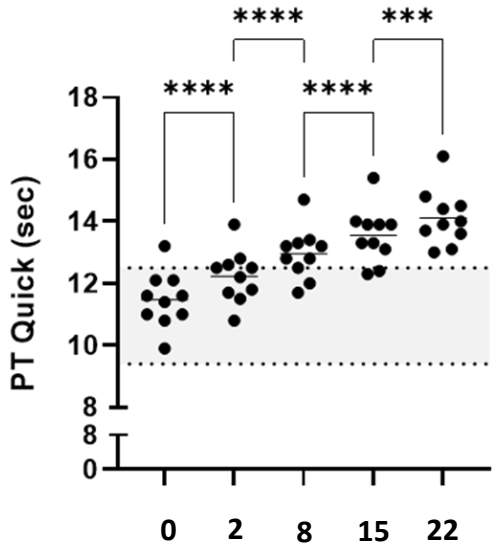
Why the whole blood for transfusion is again an issue for discussion

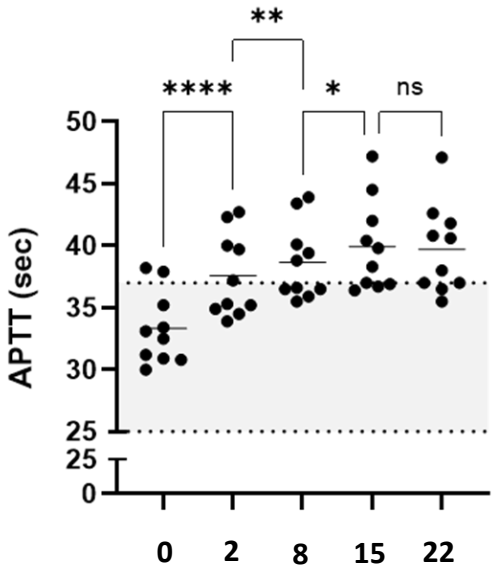
- One unit replaces the need for multiple components (RBC + plasma + platelets)
  - This is only true for units stored for less than one week (best fresh whole blood 72H)
- Patient bleed the whole blood
  - FRESH whole blood is a very different component compared to cold-stored
- Larger volume in one bag
  - Easier logistics prehospital - True
- Significantly less citrate in whole blood
  - additional citrate only in platelet additive solution
  - platelets are only available in fresh whole blood and platelet concentrate
- Additional volume crystalloids - True
- Whole blood transfusion improves survival and reduce use of blood products
  - SWiFT

Platelets and coagulation factors in cold-stored whole blood









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  - platelets are only available in fresh whole blood and platelet concentrate
  - RBC concentrate + plasma = whole blood
- Additional volume crystalloids - True
- Whole blood transfusion improves survival and reduce use of blood products
  - SWiFT

Citrate and volume

Summary of Blood components

Table S26 Summary of Blood components

	Red blood cells in additive solution (RBC)	Fresh-Frozen plasma (immediately once thawed) (TP)	Cryoprecipitate (pool of 5 donations) (Cryo)	Platelet concentrate (buffy coat derived) stored in 65% PAS (PLT PAS)	Platelet concentrate (apheresis) stored in plasma (PLT plasma)	Whole blood, LD (WB) – platelet replete**
Total volume (mL)	289 ± 31.4*	263 ± 16.8*	230 ± 10.2*	294 ± 12.1*	219 ± 13.5*	470 ± 3.4
Volume of anticoagulant (mL)	4.3	56.9	49.6	22.2	30.4	59.8
Citrate (mmol/unit)	0.385	5.088	4.435	1.985	2.275	5.348
Volume of additive solution (mL)	105	n/a	n/a	200	n/a	n/a
Volume (mL) of 'pure' red cells	164	n/a	n/a	n/a	n/a	179

*Values obtained from NHSBT Quality Monitoring data January-March 2020. Where applicable, values shown are mean ± SD. All other values calculated from mean of constituent values.

Smith JE. NEJM.2026

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- Whole blood transfusion improves survival and reduce use of blood products compared to balanced blood component therapy
  - SWiFT (The Study of Whole Blood in Frontline Trauma)

The Study of Whole Blood in Frontline Trauma (SWiFT)

- A pragmatic, phase 3, multicenter, unblinded, randomized, **superiority trial** across 10 air ambulance services in England
- Patients with major traumatic hemorrhage were randomly assigned to receive either **whole-blood transfusion** (up to 2 units) or standard care with blood components (up to 2 units each of **red cells and plasma**) before arrival at the hospital
- The primary outcome was a composite of death from any cause or massive transfusion (≥10 units of blood components or products) within 24 hours after randomization

Smith JE. NEJM.2026

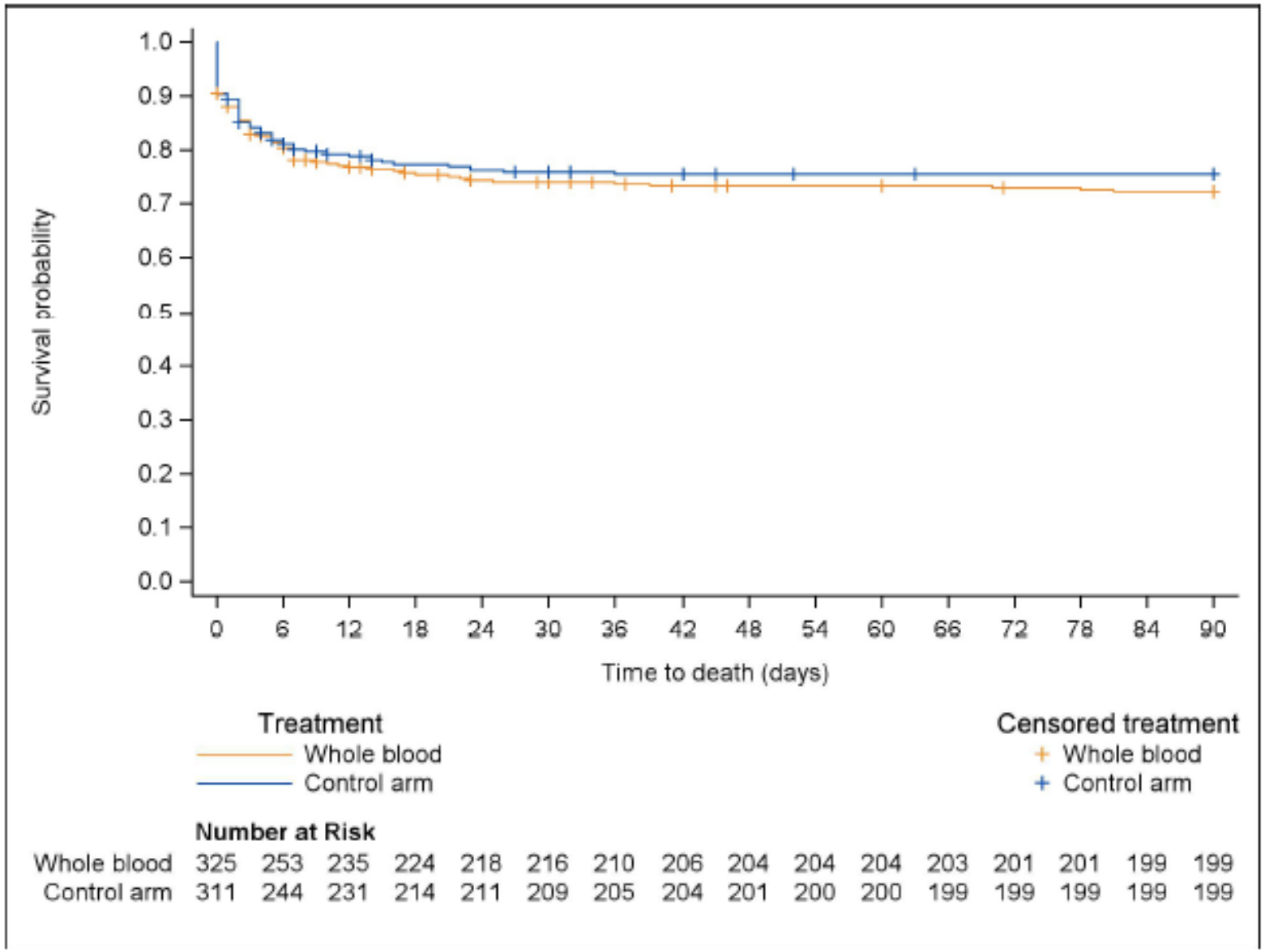
The Study of Whole Blood in Frontline Trauma (SWiFT)

Table 2. Primary Outcome.

Outcome	Whole-Blood Group (N=327)	Standard-Care Group (N=314)	Relative Risk (95% CI)*	P Value†
Death or massive transfusion within 24 hours after randomization — no./ total no. (%)				
Modified intention-to-treat population	153/314 (48.7)	144/302 (47.7)	1.02 (0.80–1.31)	0.84
Per-protocol population	145/291 (49.8)	130/273 (47.6)	1.05 (0.83–1.32)	

* The relative risks with 95% confidence intervals were calculated with the use of a mixed logistic-regression model, with air ambulance services fitted as a random effect and treatment group fitted as a fixed effect.
† The P value for the between-group comparison was obtained from a marginal mixed model.

Figure S1 Patient survival up to 90 days post randomisation



	Whole-Blood Group (N=327)	Standard-Care Group (N=314)	Treatment Difference (95% CI)†
Prothrombin time above normal range on hospital arrival — no./total no. (%)	94/231 (40.7)	71/233 (30.5)	RR, 1.31 (1.10–1.56)

Longer Prehospital Time Does Not Increase Bleeding-Related Death

Table 3. Association Between Outcome and Prehospital Time[a]

Death by Type	Odds Ratio by Generalized Linear Mixed Model (95% CI)[b]	*P* Value
Univariable Analysis		
Overall death	1.09 (1.07-1.11)	<.001
Death attributable to head injury	1.09 (1.06-1.11)	<.001
Death attributable to bleeding	1.04 (1.00-1.09)	.04
Multivariable Analysis		
Overall death	1.04 (1.01-1.07)	.002
Death attributable to head injury	1.03 (1.00-1.07)	.15
Death attributable to bleeding	1.00 (0.99-1.02)	.24

[a] Generalized linear model with random effect by registry and emergency medical system; adjustment for individual confounders as logarithmic function (prehospital time, age, systolic blood pressure, Injury Severity Score, and Glasgow Coma Scale score).

[b] Odds ratio for increase of 10 minutes in prehospital time.

The post hoc power calculation demonstrated a study power of 100%.
RBCs transfusion, but not other components, were available

Gauss T. JAMA. 2019

Upcoming trails

- Type O Whole Blood and Assessment of Age During Prehospital Resuscitation Trial (**TOWAR**) (University of Pittsburgh), prehospital, multicenter. Completed July 2025, no results
- Trauma-Sang TOtal dans les Hémorragies Massives (**T-STORHM**) (France), in-hospital. Completed January 2026, no results
- Trauma Resuscitation With Low-Titer Group O Whole Blood or Products (**TROOP**) (USA), in-hospital, multicenter. Recruiting.
- Whole Blood in Trauma Patients With Hemorrhagic Shock (**WEBSTER**) (Colombia), in-hospital. Recruiting.

Drawbacks of Whole Blood Transfusion

- Variable and Unpredictable Hemostatic Content
  - Significant loss of coagulation factors after one week of storage
- Platelet Dysfunction During Storage
- Inventory and Logistical Challenges
  - Limited donor population
  - Disproportional burden on group O donors
- How Much ABO-Incompatible Plasma Is Safe to Transfuse

How Much ABO-Incompatible Plasma Is Safe to Transfuse?

Table I - *Suggested IgM and IgG antibody cutoff titers*

References	Blood product	Titer IgM	Titer IgG
Quillen *et al.* 2011[2]	All platelet products	50	100
Cooling *et al.* 2008[3]	Pooled platelets	128	200
Josephson *et al.* 2004[4]	Apheresis platelets	64	256
US Armed Forces[5]	Type O whole blood	250	250
Most Norwegian blood banks[6]	Type O whole blood	250	500
Japan[7]	ABO-incompatible HLA matched platelets	128	128
Berséus *et al.* 2013[8]	"Universal" type O products	100	400
Germany[9]	Apheresis platelets	64	Not tested
Italy[9]	Apheresis platelets	64	256
Norway[9]	Apheresis platelets	Not tested	250
Sweden[9]	Apheresis platelets	100	400

Shen Ch. Blood Transfusion. 2025

How Much ABO-Incompatible Plasma Is Safe to Transfuse?

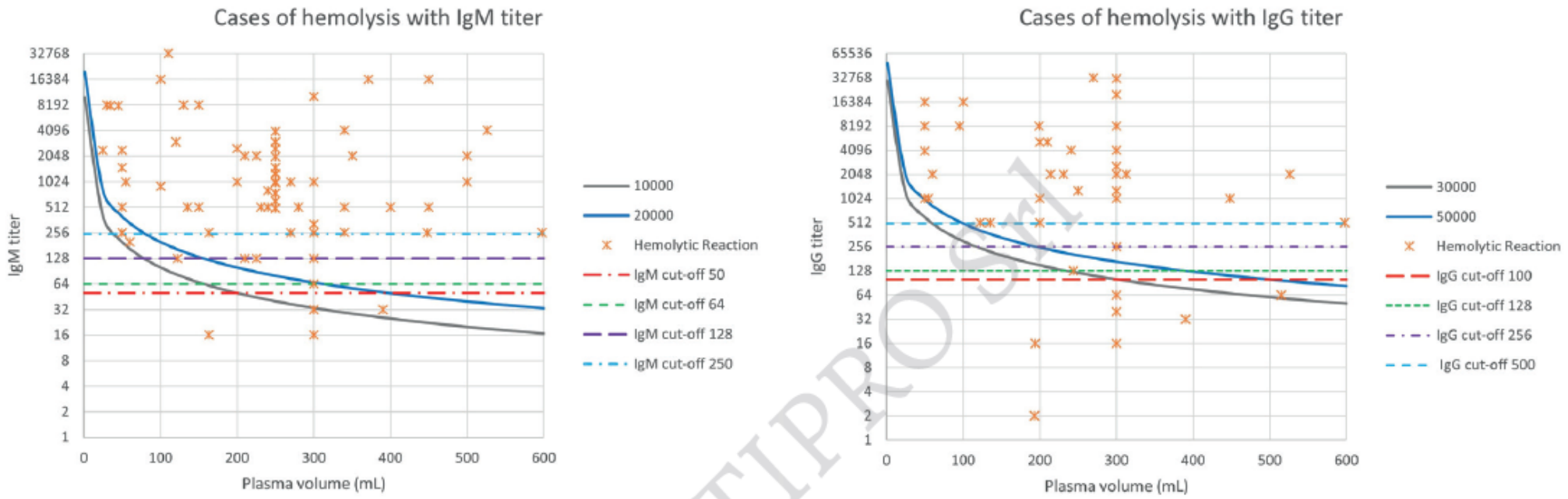


Figure 2
(**A**) Scatter plot showing all cases collected with IgM titer and plasma volume, three commonly used IgM cutoffs of 64, 128, and 250, as well as two lines depicting an IgM antibody content of 10,000 AU and 20,000 AU. (**B**) Scatter plot showing all cases collected with IgG titer and plasma volume, three commonly used IgG cutoffs of 128, 256, and 500, as well as two lines depicting an IgG antibody content of 30,000 AU and 50,000 AU.

Shen Ch. Blood Transfusion. 2025

Comment > Lancet Haematol. 2022 Apr;9(4):e238-e239. doi: 10.1016/S2352-3026(22)00074-6. Epub 2022 Mar 7.

Prehospital blood transfusion: who benefits?

Karl-Christian Thies [1], Kurt Ruetzler [2]

Rare blood: personal experience

Re: Rare blood donor program - need for Kell null blood

谷　慶彦 <tani@osaka.bc.jrc.or.jp>
Til Elena Danilova

Svar | Svar til alle | Videresend | ...

tir. 16.10.2018 06:17

Du svarte på meldingen 16.10.2018 14:13.

Wh have only 2 donors with group O, Ko, RhDneg. So we are arranging donors with group O, Ko, RhDpos in addition to them to donate blood.

Best regards

----- Original Message -----
Subject: Rare blood donor program - need for Kell null blood
Date: Fri, 12 Oct 2018 07:43:33 +0000
From: Elena Danilova <eledan@ous-hf.no>
To: "'m-hirashima@kk.bbc.jrc.or.jp'" <m-hirashima@kk.bbc.jrc.or.jp>, "'y-tani@kk.bbc.jrc.or.jp'" <y-tani@kk.bbc.jrc.or.jp>, "'tani@osaka.bc.jrc.or.jp'" <tani@osaka.bc.jrc.or.jp>
Elena Danilova wrote:

> Dear Sir or Madam,
>
> I am writing on behalf of the Blood Bank of Oslo. Your Center was kind to help us early with rare blood donations and we hope you have possibility once again.
>
> We have now a young mother who is $Kell_{null}$ and RhD_{neg} and immunized against KEL5 antigen after blood transfusion. She has got a baby recently. The baby girl was anemic at delivery but bilirubin levels allowed to avoid blood transfusion. Now the child is still anemic (Hb 7,9 g/dl) at 4 weeks of age and pediatricians may decide to transfuse any time. We only have one unit of packed red blood cells of blood group O RhD_{pos} $Kell_{null}$.
>
> We saw in rare donor register that you have some donors of this phenotype (blood group O, RhD positive or negative, $Kell_{null}$). If that is possible we would very much like to buy 4 freshly donated packed red cells, may be with several deliveries. Whatever is possible.
>
> Kind regards,
>
> Elena