Review Article

Pre-Hospital Blood Products for the Care of Bleeding Trauma Patients

Evidence, Clinical Practice, and Demand Analysis

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Summary

Background: Controversy surrounds the administration of blood products to severely traumatized patients before they arrive in the hospital in order to compensate for early blood loss and/or to correct coagulation disturbances that arise shortly after the traumatic event. A number of terrestrial and air rescue services have begun to provide this kind of treatment.

Methods: This review is based on articles using the PICO framework, published from January 2001 to January 2021, that were retrieved by a selective search, with structured searching strategies and searching bundles in Medline (OVIDSP), the Cochrane Central Register of Controlled Trials (CENTRAL), and Epistemonikos. A demand analysis was carried out on the basis of data from the trauma registry of the German Society of Trauma Surgery (TR-DGU) and practical experience from program development and implementation was provided by the Bundeswehr Hospital Ulm.

Results: The currently available evidence on the pre-hospital administration of blood products in the early treatment of severely injured patients is based largely on retrospective, single-center case series. Two randomized controlled trials (RCTs) concerning the early use of fresh frozen plasma concentrates have yielded partly conflicting results. Three further RCTs on the use of lyophilized plasma (lyplas), lyplas plus erythrocyte concentrate, or whole blood likewise revealed non-uniform effects on short-term and intermediate-term mortality. Our demand analysis based on data from the TR-DGU showed that 300 to 1800 patients per year in Germany could benefit from the pre-hospital administration of blood products. This might be indicated in patients who have systolic hypotension (<100 mmHg) in combination with a suspected or confirmed hemorrhage, as well as pathological shock parameters in the point-of-care diagnostic testing performed on the scene (serum base excess ≤ -2.5 mmol/L and/or serum lactate concentration >4 mmol/L).

Conclusion: The studies that have been published to date yield no clear evidence either for or against the early pre-hospital administration of blood products. Any treatment of this kind should be accompanied by scientific evaluation.

Cite this as:
Maegele M, Lier H, Hossfeld B: Pre-hospital blood products for the care of bleeding trauma patients—evidence, clinical practice, and demand analysis. Dtsch Arztebl Int 2023; 120: 670–6. DOI: 10.3238/arztebl.m2023.0176

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This article has been certified by the North Rhine Academy for Continuing Medical Education. Participation in the CME certification prgram is possible only over the internet: cme.aerzteblatt.de. The deadline for submission is 5 October 2024.

Uncontrolled bleeding combined with impaired coagulation—designated as trauma-induced coagulopathy (TIC)—is still the most common preventable cause of death after severe multiple trauma (1, e1). It can be demonstrated in severely bleeding trauma patients even in the pre-hospital rescue phase and has a marked effect on subsequent morbidity and mortality (2). Early diagnosis and aggressive treatment can improve the outcome. In a study of 408 bleeding trauma patients, every additional 15-minute delay until the control of bleeding was associated with a significant rise in mortality at 30 days and an increased rate of secondary complications (3). In another study, every additional minute of delay between the arrival of the emergency team at the scene of the trauma and the administration of blood products (whole blood, erythrocyte concentrate [EC], and/or blood plasma, as well as clot-stabilizing drugs such as tranexamic acid [TXA]) increased the likelihood of death by 2% (e2). Similar data have been published in military trauma care studies (e3).

In Germany, the pre-hospital administration of blood products is currently a matter of debate; some ground- and air-based rescue systems have started to provide them. In this review, we summarize the current scientific evidence and the current state of affairs in Germany and presents a needs assessment based on data from the Trauma Registry of the German Trauma Society (TR-DGU).

Methods

A selective review of the literature from January 2001 to January 2021 in PICO format was carried out with the aid of structured search strategies/search bundles in Medline (OVIDSP), the Cochrane Central Register of Controlled Trials (CENTRAL), and Epistemonikos (4). After removal of duplicates, the identified titles and abstracts were screened for relevance and the corresponding full texts were evaluated. The literature cited in those articles, other reference publications, and a number of studies published after January 2021 were considered as well. The needs analysis was based on an evaluation of data from the TR-DGU as well as our own data from the Department of Anesthesiology, Intensive Care Medicine, Emergency Medicine, and Pain Therapy of the Bundeswehrkrankenhaus (BWK) in Ulm, Germany (5).

The pre-hospital administration of blood products

The pre-hospital administration of blood products is feasible and is currently implemented in many countries with methods that vary from one location to another (6, e4). There are technical and logistical problems that need to be solved; product safety, the limited availability of universal blood group donors, and economic aspects require attention. As the data remain unclear, the updated European Trauma Guideline 2023 refrains from a clear recommendation (4). In Germany, pre-hospital rescue times are short, and patients can be rapidly transferred to the appropriate centers in the trauma networks; these facts play a role in the discussion whether blood products should be administered before the patient reaches the hospital. A general decision to construct and implement a system for the pre-hospital administration of blood products can only be made by a consensus of all persons involved (7).

Blood plasma products

Two pragmatic randomized controlled trials in the United States, the Prehospital Air Medical Plasma (PAMPer) trial (8) and the Control of Major Bleeding after Trauma“ (COMBAT) trial (9), were conducted to compare treatment outcomes in trauma patients with hemorrhagic shock who received either standard care or the pre-hospital administration of two units of blood plasma (Table *1). In the* PAMPer trial, the scheduled administration of two units of blood plasma was found to lower 30-day mortality (23% versus 33%, 95% confidence interval [CI]: [-18.6; –1.0], p = 0.03), but the COMBAT trial did not reveal any difference at 28 days. In COMBAT, only 32% of the subjects actually received a pre-hospital transfusion of two units of plasma, compared with 89% in PAMPer. As could be expected from the volume of plasma that was transfused in both of these trials, the rise in clotting factor concentrations was by no more than 7% (e5); a therapeutic effect mediated by correction of a coagulopathy seems unlikely. Despite virtually identical inclusion criteria, the 30-day mortality in the control group was three times as high in PAMPer, compared to COMBAT (32.5% versus 10%). The control group in COMBAT, with a median Injury Severity Score (ISS) of 27, received only sodium chloride (NaCl) 0.9%, but had half the mortality of the PAMPer intervention group, which had an ISS of 22 and received both plasma and EC (10% versus 22.2%) (e6). Post-hoc analyses of these two studies suggest a possible survival benefit for persons who sustained blunt trauma (10) or a traumatic brain injury confirmed by computerized tomography (11), or whose pre-hospital rescue time was greater than 20 minutes (12). In a meta-analysis of these two studies (n = 626), treatment with two units of blood plasma was found to be associated with lower mortality at 24 hours (relative risk [RR] 0.69; 95% CI: [0.48; 0.99]), comparable mortality at 1 month (RR 0.86; 95% CI: [0.68; 1.11]), and no difference in the rate of secondary complications (e7).

The pre-hospital use of freeze-dried, lyophilized plasma has logistical advantages, and retrospective civilian data document its clinical utility, beneficial effects on clotting function (e8) and low total transfusion requirement when given in a bolus together with pre-hospital erythrocyte concentrates (e9). In the randomized and controlled PREHO-PLYO trial, conducted in France, patients at risk for hemorrhagic shock and coagulopathy, stratified by clinical kinetic criteria, systolic blood pressure (SBP) < 70 mmHg and/or shock index (SI) > 1.1, were treated with the pre-hospital administration of either lyophilized plasma (lyPlas) or saline solution (0.9% NaCl) (13). No improvement of the international normalized ratio (INR) or of fibrinogen levels was seen on admission to the shock room, but there was increased mortality at 6 hours, 24 hours, and 28 days (4.4% vs. 3.0%, 13.2% vs. 9.1%, and 17.6% vs. 15.2%; Table 1) (13). A broadening of the inclusion criteria while the study was ongoing may have led to the *inclusi*on of patients with milder coagulopathy; moreover, most patients had received TXA before arrival in the hospital, which may have counteracted a drop in fibrinogen levels.

The pre-hospital administration of erythrocyte concentrates

The findings of single-center observational studies and retrospective data analyses suggest that the pre-hospital administration of EC increases survival rates (e10), especially when given in the early pre-hospital care phase (14), and lowers the overall transfusion requirement (e11). The pre-hospital administration of EC appears to improve hemodynamic parameters in the short term (e12), with more frequent restoration of circulatory

TABLE 1

Randomized, controlled trials of the prehospital administration of blood products*

	COMBAT (9)	PAMPer (8)	PREHO-PLYO (13)	RePHILL (7)	PPOWER (23)
Inclusion criteria	SBP ≤ 70 mmHg or SBP 71–90 mmHg + HR ≥ 108/min	SBP ≤ 70 mmHg or SBP < 90 mmHg + HR ≥ 108/min	SBP < 70 mm Hg or SI ≥ 1.1	SBP < 90 mmHg or impalpable radial pulse	SBP ≤ 90 mmHg + HR ≥ 108/min or SBP ≤ 70 mmHg
Included patients (n)	125 (as treated): plasma: 65 vs. NaCl: 60	overall: 501 plasma: 230 vs. standard: 271	150 (intention to treat): plasma: 68 vs. NaCl: 66	overall: 432 EK + lyPlas: 209 vs. NaCl: 223	overall: 86 LT0WB: 40 vs. EC: 46
Primary endpoint	28-day mortality	30-day mortality	INR on admission	composite of mortality and lactate clearance	feasibility and 28-day mortality
Transport	by land	by air	by land	by land (~ 60 %) and by air (~ 40 %)	by air
Trial medication	2 × FFP vs. NaCl	2 × thawed plasma vs. crystalloid or EC	≤ 4 × lyPlas vs. NaCl	alternately ≤ 2 EC and 2 × lyPlas vs. ≤ 4 × NaCl	≤ 2 × LT0WB vs. ≤ 2 × EC
Time from accident to hospital treatment (min)	28 (22–34) vs. 24 (19–31)	42 (34–53) vs. 40 (33–51)	median 26 (6–37) from arrival at scene of accident	26 (± 16) vs. 25 (± 17)	n.d.
Blunt trauma (%)	46 vs. 53	81 vs. 83	58 vs. 60	78 vs. 80	85 vs. 84.8
Prehospital EC administration	no	26 % vs. 42 % (13 of 27 facilities)	no	yes	yes
Traumatic brain injury (%)	~ 22.5	~ 45.5	13.2 vs. 10.6	48 vs. 47	n.d.
Crystalloids (mL)	150 vs. 250	500 vs. 900	700 (475–1000) vs. 1000 (700–1350)	before randomization: 422 vs. 437	pre-hospital n.d.
Injury severity	NISS: 27.0 (10.0–41.0) and 51% > 25 vs. 27.0 (11.5–36.0) and 57% > 25	ISS: 22 (14–33) vs. 21 (12–29)	ISS: 29 (12–48) vs. 25 (9–41)	ISS: 36 (25–49) vs. 36 (25–50) NISS: 43 (34–57) vs. 48 (34–57)	ISS: 13 (8.5–22) vs. 17 (9–25)
Tranexamic acid (%)	≤ 6 hours: 9 vs.13	n.d.	83.8 vs. 90.9	87 vs. 92	n.d.
Treatment outcome: 24-hour mortality (%). 28/30-day mortality (%)	12 vs. 10 15 vs. 10	13.9 vs. 22.1 22.2 vs. 32.5	13.2 vs. 9.1 17.6 vs 15.2	16 vs. 22 42 vs. 45	15 vs. 17.4 25 vs. 26.1

*Trials focusing on the administration of blood plasma, such as COMBAT (9), PAMPer (8), and PREHO-PLYO (13), as well as those where this was combined with erythrocyte concentrate, as in RePHILL (7), or whole blood (LT0WB), as in PPOWER (23); some patients received additional EC in the pre-hospital phase in the PAMPer trial as well.

EC, erythroycte concentrate; FFP. fresh frozen plasma; HR, heart rate; INR, international normalized ratio; ISS, Injury Severity Score; LT0WB, low-titer blood group 0 whole blood; lyPlas, lyophilized plasma; NaCl, sodium chloride 0.9%; n.d., no data; NISS, New Injury Severity Score; SBP, systolic blood pressure; SI, shock index.

function after resuscitation at the site of trauma (e13) and lower transfusion requirements later on in the hospital (e10). No evidence has been found for a reduction of shock, coagulopathy, length of ICU stay, or all-cause mortality (15). In a meta-analysis including paired trauma patients, EC transfusion was not found to affect survival, either at 24 hours or over the long term (16). With the pre-hospital administration of EC alone, outcomes remain poor because of coagulopathy and acidosis (e14). Retrospective observation has shown that the introduction of a pre-hospital blood product administration program is both feasible and safe (e15) but such programs have very rarely been implemented (e13). Even in rescue systems that deal exclusively with polytrauma patients, the pre-hospital administration of erythrocyte concentrates is carried out in less than 5% of cases (5), with a median of two units given (14).

The combined administration of erythrocyte and fresh plasma concentrates

In PAMPer, 26% of the patients in the plasma group and 42% in the standard therapy group also received EC in the pre-hospital phase (8). A secondary analysis was carried out concerning four groups of patients (407 total) who were classified according to their pre-hospital treatment:

- crystalloid solutions only
- EC only
- plasma only
- EC and plasma.

The patients who received EC and plasma had the highest survival at 30 days (hazard ratio [HR] 0.38; 95% CI: [0.26; 0.55], $p < 0.001$), followed by the plasma group (HR 0.57; 95% CI: [0.36; 0.91], $p = 0.017$) and the EC group (HR 0.68; 95% CI: [0.49; 0.95], $p = 0.025$) (17). Mortality was significantly lower for each administered unit of EC (HR 0.69; 95% CI: [0.52; 0.92], $p = 0.009$) and plasma concentrate (HR 0.68; 95% CI: [0.54; 0.88], $p = 0.003$). On the other hand, the volume of crystalloid infusions administered was associated with higher mortality in patients requiring transfusion (17). Another secondary analysis revealed that the survival advantage pertained especially to patients who were transported directly from the accident scene to the hospital (18). In further secondary analyses, the pre-hospital administration of blood plasma was associated with lower survival due to hypocalcemia (e16), lower parameters for endothelial injury (e17), lower 30-day mortality, particularly in those who received 4–7 units of blood plasma (e18), and lower costs (e19). If the ISS was above 30, one-third of the effect of the pre-hospital administered blood plasma on 30-day mortality was associated with a lower lactate concentration on admission to the shock room (e20) and thus may have been due to a volume effect. In a meta-analysis of paired trauma patients who were given EC and plasma in the pre-hospital phase, there was a significant reduction of long-term mortality (OR 0.51; 95% CI: [0.36; 0.71], $p < 0.0001$) without any difference in 24-hour mortality (OR 0.47; 95% CI: [0.17; 1.34], $p = 0.16$) (16).

In a recently published multicenter phase 3 trial called RePHILL, adult hypotensive trauma patients in hemorrhagic shock were randomized to receive either up to two units of EC and lyPlas or up to one liter of NaCl 0.9% *(Table 1)* (7). Because of the CO*VID pandemic*, enrollment was terminated after 432/490 subjects had been included in the trial; the intervention was not found to lower the composite end point of mortality and lactate clearance (64% versus 65%). Only 60% of patients received two units of EC and only 40% received two units of lyPlas in the pre-hospital phase; the mean transfused volume of lyPlas was 266 mL, corresponding to 3.8 mL/kg for a person weighing 70 kg (e21). Two recently published meta-analyses of observational studies with heterogeneous populations placed emphasis on the possibility of early lyPlas administration even after hospital admission; fresh frozen plasma was not found to confer any advantage, however, in terms of mortality or the consumption of allogeneic blood products (19,20). Prospective data from six UK rescue systems showed that the pre-hospital combined administration of one EC and one thawed unit of plasma concentrate or lyPlas (RBC + P) or two ECs with plasma (RCP), compared to two ECs alone, significantly lowered the mortality at 24 hours (36.1% vs. 40.2% vs. 47.5%), particularly after penetrating injury (21).

The pre-hospital administration of whole blood

The pre-hospital administration of whole blood was studied in 214 matched trauma patients in shock with registry data from a single center (22). In this study, 58 patients received low-titer group 0 whole blood (LT0WB) in the pre-hospital phase, and 156 received no blood; the amount of blood transfused in the LT0WB group was not reported. The mean improvement in SI from the scene of the accident to shock room admission was higher in the LT0WB group, which also had lower mortality in the shock room (0% versus 7%, $p = 0.04$); a nonsignificant trend was found for the other study time points (mortality at 6 hours: 5.3% vs. 14.1%; at 24 hours: 17.2% vs. 23.1%; all-cause in-hospital mortality: 13.8% versus 25%). No survival benefit was found in patients with pre-hospital cardiovascular arrest. In the prospective PPOWER trial, the administration of LT0WB compared with standard therapy up to and including two pre-hospital ECs in 86 patients at risk for massive hemorrhage did not reveal any difference in mortality at 3 hours, 6 hours, 24 hours, or 28 days *(Table 1)* (23).

Critical assessment of the current state of the evidence

The evidence from the randomized trials and retrospective analyses performed to date on the pre-hospital administration of blood products to trauma patients remains inconsistent. A meta-analysis of the randomized trials summarized in *Table 1* with respect to 28/30-day mortality yields a relative risk (RR) of 0.88 (95% CI: [0.71; 1.09], $p = 0.24$): this finding favors the intervention but is statistically insignificant. Persistent problems

TABLE 2

Estimates of the potential need for pre-hospital blood products in Germany*

Category	Life-threatening injury MAIS ≥ 3 (n = 17 771; 80%)	ISS ≥ 16 (n = 11 009; 50%)	Polytrauma (Berlin definition) (n = 2 244; 10%)
Group 1: SBP < 90 mmHg	907 (6.0%)	764 (8.0%)	477 (25.8%)
Group 2: SBP < 90 mmHg and/or HR > 120/min	1781 (11.4%)	1390 (14.5%)	727 (36.9%)
Group 3: SBP < 90 mmHg and HR > 108/min or SBP < 70 mmHg	551 (3.6%)	488 (5.1%)	332 (17.4%)
Group 4: shock index ≥ 1	1472 (10.1%)	1152 (13.1%)	578 (34.6%)

* Analysis based on data from the Trauma Registry of the German Trauma Society (TR-DGU; basic dataset for 2021 including primary trauma patients treated in certified German trauma centers, n = 22 106; missing data approx. 15%) (e22). In the TR-DGU, the severity of each individual injury is graded on the Abbreviated Injury Scale (AIS) from 1 (mild) to 6 (maximal). From this, overall severity scores such as the maximum AIS severity score (MAIS), the Injury Severity Score (ISS), and the New ISS (NISS) can be calculated (e22). As for the definition of polytrauma, patients can be assigned to any of the following categories in the TR-DGU: 1) life-threatening injury (80%), i.e. MAIS ≥ 3 (this category has been defined as „serious injury" by the European Union and is used in reports of traffic accidents) (e22); 2) ISS ≥ 16 (50%; this category corresponds to the classic definition of polytrauma) (e23); 3) Berlin definition (10%), according to which at least two body regions must be injured to a relevant extent, and at least one physiological impairment must be present (e24).

In accordance with the varying definitions of hemodynamic instability, patients were classified in four groups (24):
Group 1: SBP < 90 mmHg (corresponding to the most common definition of hypotension in the settingof traumatic hemorrhage)
Group 2: SBP < 90 mmHg and/or HR > 120/min (corresponding to the international Assessment of Blood Consumption[ABC] score) (e25)
Group 3: SBP < 90 mmHg and HR > 108/min or SBP < 70 mmHg (a definition used in many pre-hospital trauma studies, including PAMPer) (8)
Group 4: shock index (SI) calculated from the ratio of HR to SBP, with predictive values of ≥ 0.9 and 1 for massive transfusions (e26).

HR, heart rate; ISS, Injury Severity Score; MAIS, maximum score on the Abbreviated Injury Scale; SBP, systolic blood pressure

in the interpretation of study findings include the limited quality of the data, with marked heterogeneity of study design and interventions, as well as the inclusion of secondary analyses with their known drawbacks, e.g., with respect to data quality, confounding factors, multiple testing, and bias of several kinds (publication, selection, and interpretation bias).

Needs assessment based on data from the TR-DGU and the Blood in Emergency Medical Services Registry

The potential need for pre-hospital blood products in Germany, was estimated with the aid of the TR-DGU baseline dataset from certified German trauma centers for the year 2021, with 22 106 primarily documented patients (e22). *Table 2* shows the estimated need on the assumption of a variety of definitions for hemodynamic instability, shock, and injury severity/polytrauma, based on the data available from the TR-DGU for the pre-hospital and early in-hospital care phases (e22). The annual need is estimated to arise in approximately 300 severely injured persons, on the criterion of SBP < 90 mmHg and heart rate (HR) > 108/min or SBP < 70 mmHg and the Berlin Definition of polytrauma, and in nearly 1800 persons on the criterion of SBP < 90 mmHg and/or HR > 120/min and a life-threatening injury (Maximum Abbreviated Injury Scale [MAIS] ≥ 3). The broad range in estimates is mainly due to the lack of a uniformly accepted definition of hemodynamic instability (24).

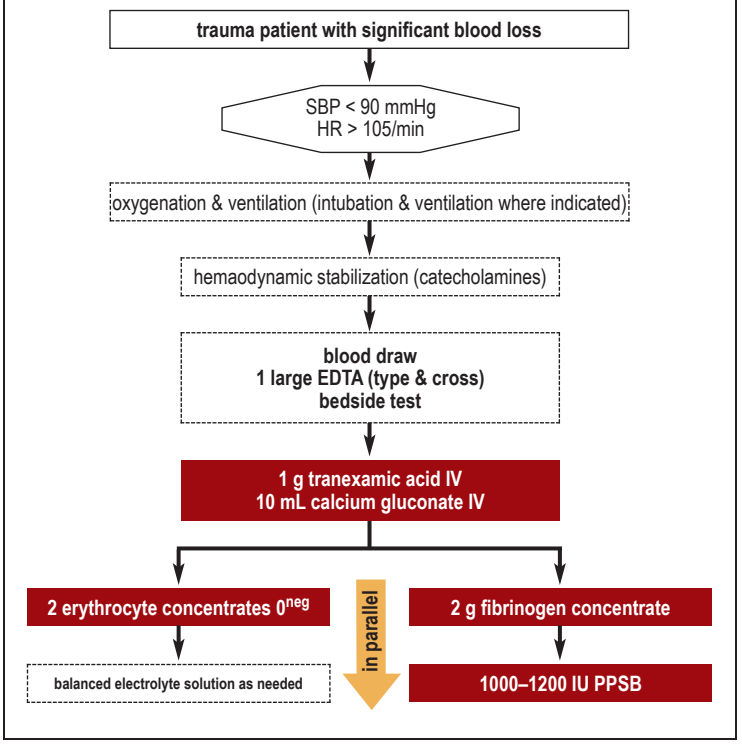
Half of all pre-hospital transfusions to date are for bleeding of nontraumatic origin, primarily gastrointestinal and peripartum bleeding (e14, e27, e28). Patients in this category are not included in the TR-DGU; nor are trauma patients who die at the scene of the accident or before arrival in the hospital. The total annual need for pre-hospital blood product administration is thus, presumably, higher than the estimates above. There is, however, a worsening shortage of blood products at present, accompanied by unresolved cost issues. The in-hospital supply of emergency reserves (blood group 0 rhesus-negative) must retain absolute priority unless and until there is clear evidence for the benefit of pre-hospital administration. In principle, storage should be organized so that blood products issued to emergency medical services can be returned to in-hospital use in timely fashion, well before their expiration date, without any interruption of the refrigeration chain. With the aim of improving the state of the evidence, work has recently begun on the establishment of a Blood in Emergency Medical Services registry (*„Blut im Notarztdienst"-Register,* BiNAR) under the aegis of the Federal Association of Emergency Physicians in Germany (Bundesvereinigung der Arbeitsgemeinschaften Notärzte *Deutschlands*, BAND), with a core team of representatives of the ADAC air rescue service, the German Federal Office of Civil Protection and Disaster Assistance/Air Rescue *(Bundesamt für Bevölkerungsschutz und Katastrophenhilfe/Luftrettung),* the German Air Rescue Service (*Deutsche Rettungsflugwacht,* DRF), and the Air Rescue Foundation (*Stiftung Luftrettung),* and independent experts (25).

Experiences in program development and implementation

The PREDICT study (26) served as the scientific basis for the development and implementation of a program for the pre-hospital administration of blood products and coagulation-stabilizing substances at the BWK Ulm air rescue site. It confirmed that trauma patients may already be suffering from clinically significant and potentially treatable disorders of blood coagulation, including hyperfibrinolysis, while they are still at the scene of the accident. A concept was therefore developed to enable (under trial conditions, at first) the pre-hospital transfusion of coagulation factors and then of EC, after initial administration of the fibrinolytic agent TXA. The CRASH-2 trauma study on the early use of TXA (27) and the prospective FInTIC study on the pre-hospital use of fibrinogen concentrate have been the most important clinical trial concerning the pre-hospital administration of coagulation-stabilizing substances (28).

In order to keep the expiration of unused ECs to a minimum, the blood depot and the rescue helicopter agreed on a way to return ECs promptly to the hospital if they are not used in the field, while maintaining an unbroken refrigeration chain. This is important because, despite the frequent provision of trauma care by the rescue helicopter, pre-hospital transfusion is only needed approximately eight times per year on average. It follows that there is a need for an evidence-based method of using patient-specific parameters, obtainable in the preclinical phase, to determine which patients would benefit from early treatment of this kind. It was concluded from the PREDICT study that the simultaneous occurrence of systolic blood pressure under 100 mm Hg at, assumed or verified hemorrhage, a serum base excess (BE) under –2.5 mmol/L, and a serum lactate concentration above 4 mmol/L, all measured at the point of care (i.e., the scene of the accident), may be an indication for the pre-hospital administration of blood products (5). The current procedure for the pre-hospital administration of blood products under trial conditions on the Christoph 22 rescue transport helicopter of the BWK Ulm is shown in the *Figure*.

FIGURE



Flowchart for the pre-hospital administration of blood products under trial conditions on the Christoph 22 rescue transport helicopter of the Bundeswehrkrankenhaus Ulm (with thanks to Oberfeldarzt PD Dr. Björn Hossfeld). EDTA, ethylen diamine tetraacetic acid; HR, heart rate; IV, intravenous(ly); PPSB, prothrombin complex concentrate; SBP, systolic blood pressure; 0^{neg}, blood group 0, Rhesus negative

Conclusions for clinical practice

There has not been any randomized, controlled trial to date whose results clearly support the early pre-hospital administration of blood products, although secondary analyses suggest that selected patients may well stand to benefit from it.

The care of severely injured patients now centers on guideline-based treatment; the pre-hospital administration of blood products may be possible as an adjunct and can be taken into consideration if the logistics permit, and as long as it does not cause any delay in the transport of the patient to the destination hospital (29).

Any program for the pre-hospital administration of blood products must be implemented with observance of the applicable transfusion regulations, including safety aspects and quality assurance.

Maintaining an adequate supply of blood products for emergency use in the hospital (blood group 0 Rhesus-negative) still has absolute priority unless and until there is a better evidence base for their pre-hospital use.

Any pre-hospital administration of blood products should be scientifically monitored; emergency services that stock blood products are encouraged to participate in the BiNAR registry.

Acknowledgement

The authors would like to thank Prof. Dr. Rolf Lefering (IFOM Cologne-Merheim) for help in analyzing data from the TR-DGU.

Artificial intelligence was not used either for manuscript preparation or for data analysis.

Conflict of interest statement

MM has received lecture honoraria, payment for participation in expert and advisory panels, and financial support for scientific meeting participation from the following firms: Astra Zeneca, Baxter, Bayer, Biotest, CSL Behring, IL-Werfen/TEM-International, LFB Biomedicaments France, Octapharma, and Portola.

HL has received lecture honoraria and reimbursement of travel expenses and scientific meeting participation fees from the following firms: Bayer Vital, DRK-BlutspendedienstWest, CSL Behring, Ferring, Mitsubishi Pharma, NovoNordisk, and Werfen.

BH has received lecture honoraria and reimbursement of travel expenses from Karl Storz, Weinmann Emergency, and CSL Behring. He is the chair-

man of the Professional Association of Emergency Physicians in Bavaria (*Arbeitsgemeinschaft in Bayern tätiger Notärztinnen und Notärzte,* agbn).

Manuscript received on 29 March 2023, revised version accepted on 13 July 2023.

Translated from the original German by Ethan Taub, M.D.

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Cite this as:
Maegele M, Lier H, Hossfeld B:
Pre-hospital blood products for the care of bleeding trauma patients—evidence, clinical practice, and demand analysis.
Dtsch Arztebl Int 2023; 120: 670–6.
DOI: 10.3238/arztebl.m2023.0176

► **Supplementary material**
eReferences:
www.aerzteblatt-international.de/m2023.0176

Supplementary material to:

Prehospital Blood Products for the Care of Bleeding Trauma Patients

Evidence, Clinical Practice, and Demand Analysis

by Marc Maegele*, Heiko Lier*, and Björn Hossfeld

Dtsch Arztebl Int 2023; 120: 670–6. DOI: 10.3238/arztebl.m2023.0176

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Questions on the article in issue 40/2023:

Prehospital Blood Products for the Care of Bleeding Trauma Patients

cme plus

The submission deadline is 5 October 2024. Only one answer is possible per question.

Please select the answer that is most appropriate.

Question 1

What does the trial acronym PAMPer stand for?

a) pre-hospital air medical plasma
b) pre-hospital ambulance medical plasma
c) plasma ambulance medical program
d) pre-hospital and accident medical plasma
e) plasma assisted medical program

Question 2

How many units of blood plasma per patient were administered in the PAMPer and COMBAT trials?

a) 1
b) 2
c) 3
d) 4
e) 5

Question 3

The French PREHO-PLYO trial was conducted to study the pre-hospital administration of lyophilized plasma. Which of the following findings is described in the text?

a) an improved INR (international normalized ratio) value on admission to the trauma emergency room (ER)
b) an improved fibrinogen level on trauma ER admission
c) lower 28-day mortality
d) marked hypertension on trauma ER admission
e) higher mortality at 6 hours, 24 hours, and 28 days

Question 4

According to a secondary analysis in the PAMPer trial, administration of which of the following was associated with the highest survival rate at 30 days?

a) only plasma
b) erythrocyte concentrates and plasma
c) only erythrocyte concentrates
d) only crystalloid
e) only tranexamic acid

Question 5

This review contains A flowchart for the pre-hospital administration of blood products under trial conditions on the Christoph 22 rescue transport helicopter. What was the first product given after blood drawing?

a) 2 0^{neg} erythrocyte concentrates
b) 2 g fibrinogen concentrate
c) balanced electrolyte solution
d) 1 g tranexamic acid and 10 mL calcium gluconate
e) 2 AB^{pos} erythrocyte concentrates

Question 6

What does ISS stand for in this article?

a) Ischemia Severity Score
b) Instant Solution of Serum
c) Injury Severity Score
d) International Severity Score
e) Instant Serum Safety

Question 7

Which of the following were inclusion criteria in the PAMPer and PPOWER trials?

a) SBP < 100 mmHg and HR > 102/min
b) DBP < 70 mmHg and HR > 95/min
c) SBP > 100 mmHg and HR < 90/min
d) DBP < 90 mmHg and HR > 95/min
e) SBP ≤ 90 mmHg and HR ≥ 108/min

Question 8

In the PPOWER trial, what was the result of the comparison of 86 persons at risk for massive bleeding who were given LT0BW compared to standard treatment?

a) no difference in mortality at 28 days
b) lower mortality at 28 days
c) higher mortality at 6 months
d) lower morbidity at 28 days
e) higher morbidity at 28 days

Question 9

What does lyPlas stand for in this article?

a) lysed plasma
b) pasteurized plasma
c) lymphocyte-rich plasma
d) fresh frozen plasma
e) microfiltered plasma

Question 10

What additional criteria were set in the PREDICT trial for a possible indication for the pre-hospital administration of blood products in patients with systolic blood pressure <100 mm Hg and assumed or known hemorrhage?

a) oxygen partial pressure > 108 mmHg and serum lactate < 4 mmol/L
b) CO_2 partial pressure > 35 mmHg and serum lactate > 4 mmol/L
c) serum base excess < –2.5 mmol/L and/or serum lactate > 4 mmol/L
d) anion gap < 8 mmol/L and serum lactate > 4 mmol/L
e) current bicarbonate > 22 mmol/L and serum lactate < 4 mmol/L