Critical Care Medicine
December 2025 • Volume 53 • Number 12 • Pages e2526–e2539

CLINICAL INVESTIGATION

OPEN

# Platelet Transfusion Practices in the ICU: A Prospective Multicenter Cohort Study

Stefan F. van Wonderen, MD[1]
Senta Jorinde Raasveld, MD, PhD[1,2]
Andrew W. J. Flint, MD[3,4]
Jimmy Schenk, PhD[1,2,5]
Claudia van den Oord, MD[1]
Merijn C. Reuland, MD[1]
Sanne de Bruin, MD, PhD[1]
Jan Bakker, MD, PhD[6,7,8]
Maurizio Cecconi, MD, PhD[9]
Aarne Feldheiser, MD, PhD[10]
Jens Meier, MD, PhD[11]
Marcella C. A. Müller, MD, PhD[1]
Thomas W. L. Scheeren, MD, PhD[12]
Tarikul Hamid, MD[13]
Michaël Piagnerelli, MD, PhD[14]
Tina Tomić Mahečić, MD[15]
Jan Benes, MD[16]
Lene Russell, MD, PhD[17,18,19]
Hernan Aguirre-Bermeo, MD, PhD[20]
Konstantina Triantafyllopoulou, MD[21]
Vasiliki Chantziara, MD, PhD[22]
Mohan Gurjar, MD, PhD[23]
Sheila Nainan Myatra, MD[24]

**OBJECTIVE:** There is a lack of comprehensive international data regarding platelet transfusion practices in the ICU. This study aimed to evaluate the current occurrence rate of platelet transfusion in the ICU and provide an overview of platelet transfusion practices including indications for a platelet transfusion, thresholds, (non-)adherence and geo-economic region variations.

**DESIGN:** International prospective cohort study.

**SETTING:** Two hundred thirty-three centers in 30 countries worldwide.

**PATIENTS:** All patients 18 years old and older, admitted to the ICU during a single study week, selected by each site from one of the 16 predefined weeks (March 2019 to October 2022), were included.

**INTERVENTIONS:** None.

**MEASUREMENTS AND MAIN RESULTS:** Of the 3643 patients, 208 (6%) received a platelet transfusion during their ICU stay and main indications consisted of active bleeding (42%, $n = 187/443$), prophylaxis (33%, $n = 144/443$) or an upcoming procedure (12%, $n = 51/443$). The median platelet count before transfusion was $44 \times 10^9$/L (interquartile range [IQR], 20–78) with variation by indication, including a higher median of $60 \times 10^9$/L (IQR 31–93) during active bleeding. A threshold for transfusion was stated in 51% ($n = 224/443$) of the events, with a median threshold platelet count of $50 \times 10^9$/L (IQR, 40–100). The advised threshold was not adhered to in 16% ($n = 36/224$) of cases, with the majority having active bleeding as indication. Contrasts in transfusion practices were observed across different geo-economic regions. Platelet transfusions were administered to 6% ($n = 156/2520$) of patients in high-income countries, 5% ($n = 52/1069$) of patients in upper-middle-income countries and in none from lower-middle-income countries ($n = 0/54$). Non-adherence was higher in the high-income countries (23%, $n = 34/149$) than upper-middle-income countries (3%, $n = 2/75$).

**CONCLUSIONS:** Platelet transfusions were administered to a small proportion of critically ill patients, and were given to treat active bleeding or as prophylaxis in the majority of cases. Occurence rate, indication and threshold adherence for platelet transfusion widely varied between geo-economic regions.

**KEYWORDS:** intensive care unit; platelet; thresholds; thrombocytopenia; transfusion

Platelet transfusions are used to treat and prevent bleeding in patients admitted to the ICU, with reported transfusion rates ranging from 5% and 15% (1–8). Platelet transfusion has been shown to improve hemostasis in severely injured bleeding patients and is currently primarily guided by platelet counts (9–16). However, the question of which platelet count threshold for transfusion to be used in different circumstances remains uncertain,



DOI: 10.1097/CCM.0000000000006880

Vincenzo Pota, MD, PhD[25]
Muhammed Elhadi, MD[26]
Ryszard Gawda, MD, PhD[27]
Mafalda Mourisco, MD[28]
Marcus Lance, MD, PhD[29]
Vojislava Neskovic, MD, PhD[30]
Matej Podbregar, MD, PhD[31]
Juan V Llau, MD, PhD[32]
Manual Quintana-Diaz, MD, PhD[33]
Maria Cronhjort, MD[34]
Carmen A. Pfortmueller, MD[35]
Nihan Yapici, MD, PhD[36]
Nathan D. Nielsen, MD, MSc, FCCM[37]
Akshay Shah, MD, PhD[38]
Harm-Jan de Grooth, MD, PhD[1,39]
Zoe McQuilten, MD, PhD[3]
Alexander P. J. Vlaar, MD, PhD[1]
Cécile Aubron, MD, PhD[40]
for the InPUT Study Group

## KEY POINTS

**Question:** We aimed to evaluate the current occurrence rate of platelet transfusion and to provide an worldwide overview of platelet transfusion practices in the ICU including indications and corresponding platelet count thresholds.

**Findings:** Over 1 in 20 (6%) received a platelet transfusion during ICU stay. Main indications were active bleeding (42%), prophylaxis (33%), or an upcoming procedure (12%). The median platelet count threshold was $50 \times 10^9$/L and was similar among the indications.

**Meaning:** Platelet transfusions were administered to a small proportion of patients, whereas transfusion thresholds were similar among different indications for platelet transfusion.

especially before invasive procedures and in non-bleeding critically ill patients (9–13).

When implemented, the threshold for transfusion should be sufficiently high to prevent major bleeding, yet judiciously low to minimize the need for unnecessary transfusions. This balance helps mitigate potential transfusion-related adverse events such as transfusion associated circulatory overload, transfusion-related acute lung injury and immunomodulatory effects that may increase the risk of nosocomial infections (17–20).

Currently, guidelines for both general and ICU populations suggest prophylactic transfusion in the presence of severe thrombocytopenia (platelet count $10–20 \times 10^9$/L) to prevent spontaneous bleeding (13–16). Higher, but varying thresholds are commonly applied in specific scenarios such as major surgery (< $50–100 \times 10^9$/L), lumbar puncture (< $20–40 \times 10^9$/L), and central venous catheter (CVC) insertion (< $10–20 \times 10^9$/L) (12–16). Thus far, current ICU guidelines base their recommendations mainly on observational studies or clinical trials involving patients undergoing myelosuppressive cancer chemotherapy (11, 21–24). As such, the notable degree of heterogeneity in surveys regarding clinical practices of platelet transfusion among ICU physicians is not surprising (25, 26).

A global overview of platelet transfusion practices in the ICU is currently lacking, with studies primarily conducted in a single-country setting or performed in high-income countries only (4–8). The aim of this study was to create a worldwide overview of platelet transfusion practices in the ICU, including transfusion rates, indications, and corresponding platelet count thresholds.

## METHODS

### Study Design and Population

This pre-specified sub-study of the International Point Prevalence Study of Intensive Care Unit Transfusion Practices (InPUT) study focused on platelet transfusion practices. The InPUT study is a multicenter ($n$ = 233), prospective study performed in 30 countries across six continents, focusing on international transfusion practices. All patients (18 yr old or older), admitted to the ICU in one of 16 predefined weeks (between March 2019 and October 2022), were included if informed consent was obtained if required by national regulations. These weeks were selected to represent all seasons, participating centers had the flexibility to choose one of the predefined weeks. An extensive protocol including study design, methods,

and standard operating procedures was published previously (27). Information on ethics and study approval are included in **Supplemental Text S1** (https://links.lww.com/CCM/H798).

### Data Collection

For every included patient, several questionnaires needed to be completed: admission day, daily up and until day 28 or discharge, whichever came first. At 28-day follow-up, survival status was assessed. Daily questionnaires included lowest platelet count, blood loss, the use of additional support (e.g., invasive mechanical ventilation, renal replacement therapy), concomitant transfusion, and complications, irrespective of whether these complications were related to platelet transfusion. Thrombocytopenia at ICU admission and during ICU course was defined as a platelet count less than $150 \times 10^9$/L, further categorized as mild ($100–149 \times 10^9$/L), moderate ($50–99 \times 10^9$/L), severe ($20–49 \times 10^9$/L), or very severe ($\leq 19 \times 10^9$/L) thrombocytopenia (8).

Additional information regarding transfusions was collected for every platelet transfusion, defined as a "transfusion event." In case a patient received platelets on two or more separate occasions during the day, each was recorded as a distinct event. In the context of massive transfusion protocol (MTP), platelet transfusion was included as separate event. Transfusion questionnaires included information on the stated indications for transfusion, such as active bleeding (defined according to the clinical judgment of the treating physicians), prophylactic transfusion in the absence of upcoming procedures, pre-procedural transfusion, as part of a clinical trial, or transfusion guided by local viscoelastic testing protocols or practices. Data were also collected on the platelet transfusion threshold, defined as the platelet count stated to transfuse platelets by either the protocol or treating physician. In addition, platelet counts were recorded before (≤ 4 hr before the decision to transfuse) and after transfusion (the first platelet count measured ≤ 24 hr after the platelet transfusion). The transfused product characteristics were recorded (**Supplemental Text S2**, https://links.lww.com/CCM/H798).

### Objectives

The primary objective was the occurrence rate of in-ICU platelet transfusion. A patient was defined as transfused when receiving one or more platelet transfusions during their ICU stay. Secondary objectives included the indications for a platelet transfusion, the platelet transfusion threshold, platelet count increment (i.e., the difference in platelet count before and after transfusion), and non-adherence. Non-adherence was defined as administering a platelet transfusion at a platelet count exceeding the stated threshold. This was determined for: 1) the personalized threshold as by the local guideline or treating physician, and 2) the threshold as stated by latest transfusion guidelines—that is, maintaining a platelet count above $50 \times 10^9$/L in case of active severe bleeding (16), and administering prophylactic transfusion at or below $10 \times 10^9$/L (13–16). Exploratory objectives included patient status at day 28 and the occurrence of new patient-related complications after platelet transfusion during the ICU stay.

### Statistical Analysis

All analyses were performed using R in the R-Studio interface (Version 4.3.2; R: A language and environment for statistical computing, Boston, MA). Parametric continuous data were presented accordingly as mean (SD), non-parametric continuous data as median (first–third quartile, further noted as interquartile range [IQR]), and categorical data as count (percentage, %). Mann-Whitney *U* or chi-square tests were used as appropriate to compare different populations (e.g., transfused vs. non-transfused). In addition, transfusion practices were compared among geo-economic regions and by indication: active bleeding vs. no active bleeding, and prophylaxis vs. no prophylaxis. Geo-economic regions were defined using the World Bank Country Classification system (28). For all secondary and exploratory objectives, no *p* value correction for multiplicity was applied, as such, corresponding results should be interpreted as hypothesis generating.

## RESULTS

Two hundred and eight of 3643 patients received one or more platelet transfusions, resulting in an overall platelet transfusion rate of 6% (**Fig. S1**, https://links.lww.com/CCM/H798). Those 208 patients received one or more platelet transfusions in 443 events. The proportion of patients who received a transfusion varied from 0% to 25% across countries, with no

## TABLE 1.
## Demographics, Stratified by Platelet Transfusion Status

| Variable | Transfusion, *n* = 208 | No Transfusion, *n* = 3435 | *p* |
|---|---|---|---|
| Age, yr | 63 (52–73) | 63 (51–73) | 0.90 |
| Male | 139 (67) | 2128 (62) | 0.18 |
| Female | 69 (33) | 1307 (38) | 0.18 |
| Medical history[a] | | | |
| Acute coronary syndrome | 28 (14) | 353 (10) | 0.18 |
| Hematologic malignancy | 27 (13) | 68 (2) | < 0.001 |
| Heart failure | 26 (13) | 401 (12) | 0.80 |
| Chronic kidney failure | 25 (12) | 304 (9) | 0.15 |
| Liver failure | 24 (12) | 86 (3) | < 0.001 |
| Solid tumor | 19 (9) | 466 (14) | 0.09 |
| Chronic obstructive pulmonary disease | 15 (7) | 397 (12) | 0.07 |
| Benign hematological disease | 4 (2) | 31 (< 1) | 0.27 |
| Organ transplant | c (1) | 51 (1) | 1.00 |
| Bone marrow transplant | 1 (<1) | 8 (< 1) | 1.00 |
| Other | 35 (17) | 924 (27) | < 0.01 |
| ICU admission | | | |
| Acute Physiology and Chronic Health Evaluation Score[a] | 69 (46–94) | 45 (27–69) | < 0.001 |
| European System for Cardiac Operative Risk Evaluation II[b] | 2.58 (1.08–6.96) | 1.88 (0.94–3.80) | 0.09 |
| Admission type | | | |
| Emergency | 142 (68) | 2230 (65) | 0.36 |
| Elective | 66 (32) | 1205 (35) | 0.36 |
| Referred from | | | |
| Operation theater | 105 (51) | 1408 (41) | < 0.01 |
| Emergency department | 43 (21) | 1102 (32) | < 0.01 |
| General ward | 36 (17) | 587 (17) | 1.00 |
| Other hospital | 23 (11) | 290 (8) | 0.24 |
| Other[c] | 1 (< 1) | 46 (1) | 0.45 |
| Reason admission | | | < 0.001 |
| Postoperative monitoring | 74 (36) | 1231 (36) | 1.00 |
| Shock | 54 (26) | 378 (11) | < 0.001 |
| Respiratory failure | 22 (11) | 769 (22) | < 0.001 |
| Acute brain injury | 15 (7) | 214 (6) | 0.68 |
| Trauma | 13 (6) | 156 (5) | 0.33 |
| Metabolic disturbances | 9 (4) | 259 (8) | 0.11 |
| In- or out-of-hospital cardiac arrest | 4 (2) | 129 (4) | 0.24 |
| Other | 17 (8) | 291 (8) | 0.98 |

[a]The Acute Physiology and Chronic Health Evaluation IV score is used to indicate the severity of a patient's illness, with a scale ranging from 0 to 286. A higher score corresponds to a more severe level of illness.

[b]The European System for Cardiac Operative Risk Evaluation II score is used to forecast in-hospital mortality in cardiac surgery patients, represented as a percentage within the 0–100 range.

[c]Other referred locations including among others, home, catheterization room, other ICU.

[a]Multiple options possible. All variables are displayed as count (%) for categorical median (first-third quartile) for non-parametric and mean (SD) for parametric variables. The expanded version of the table is provided as **Table S3** (https://links.lww.com/CCM/H798).

transfusion administered in six countries (**Table S2**, https://links.lww.com/CCM/H798). In total, platelet transfusion occurred in 47% of the participating centers ($n$ = 110/233). In the centers that administered at least one platelet transfusion during the study period, the transfusion rate was 8.5% ($n$ = 208/2,451). **Table 1** presents an overview of patient demographics stratified by transfusion status. The expanded version of the table is provided as Table S3 (https://links.lww.com/CCM/H798).

## Transfused vs. Non-Transfused

Transfused patients received a median of 2 platelet units (IQR 1–4 units) during their ICU stay, distributed across one transfusion event (IQR 1–2 events) (**Table 2**; and Table S4, https://links.lww.com/CCM/H798). The daily proportion of transfused patients ranged from 3% ($n$ = 109/3586) at admission day to 0% ($n$ = 0/160) on day 19 (**Fig. S2**, https://links.lww.com/CCM/H798).

A large proportion of the transfused patients had a history of liver failure or hematologic malignancy (Table 1). Over half of the transfused patients underwent surgery in the 24 hours before or after ICU admission, mainly cardiothoracic (42%, $n$ = 50/119). Main reasons for ICU admission were postoperative monitoring (36%, $n$ = 74/208) and shock (26%, $n$ = 54/208). Compared with non-transfused patients, transfused patients had a higher disease severity, reflected by a higher Acute Physiology and Chronic Health Evaluation IV score at admission and a higher daily Sequential Organ Failure Assessment score (Tables 1 and 2). In addition, transfused patients encountered more clinical complications, although the relationship to the receipt of platelet transfusions was not collected.

Overall, 15% were admitted with thrombocytopenia ($n$ = 561/3643), which increased to 27% during their ICU stay ($n$ = 974/3643). Half of the patients admitted with thrombocytopenia received a platelet transfusion during their ICU stay. Transfused patients had a lower daily weighted platelet count ($90 \times 10^9$/L [IQR 52–$161 \times 10^9$/L]) compared with non-transfused patients ($204 \times 10^9$/L [IQR 151–$268 \times 10^9$/L]; $p < 0.001$) (**Fig. S3**, https://links.lww.com/CCM/H798).

A large proportion of transfused patients also received other blood products during their ICU stay: erythrocytes in 78% ($n$ = 163/208), plasma in 52% ($n$ = 109/208), and coagulation products such as vitamin K or prothrombin complex concentrate in 37% ($n$ = 76/208). Transfused patients' ICU length-of-stay was 5 days (IQR 3–9 d), compared with a median of 3 days (IQR 2–5 d) in the non-transfused population ($p < 0.001$). During follow-up, 28-day mortality was 37% in transfused patients and 16% in non-transfused patients ($p < 0.001$) (Table S3, https://links.lww.com/CCM/H798).

## Platelet Transfusion Details

**Table 3** summarizes the indications and clinical context of all 443 transfusion events (Table S5, https://links.lww.com/CCM/H798). Thirty events (7%, $n$ = 30/443) were part of an MTP. One platelet unit was administered in 63%( $n$ = 279/443). Main indications for transfusion consisted of active bleeding (42%, $n$ = 187/443), prophylaxis (33%, $n$ = = 144/443), or an upcoming procedure (12%, $n$ = 51/443). Anti-platelet drugs were administered less than or equal to 7 days before transfusion in 14% ($n$ = 57/443). The mean platelet count increment per platelet transfusion was $20 \times 10^9$/L (SD ± $34 \times 10^9$/L).

In half of the events ($n$ = 224/443) a platelet transfusion threshold (center's protocol or treating clinician's expert opinion) was listed. In events where a threshold was specified, the median platelet count before transfusion was lower ($40 \times 10^9$/L [IQR 20–$65 \times 10^9$/L]) compared with events without a stated threshold ($61 \times 10^9$/L [IQR 24–$129 \times 10^9$/L], $p < 0.001$). **Figure 1** displays the platelet threshold and counts before transfusion, stratified by transfusion indication. The median threshold for platelet transfusion was $50 \times 10^9$/L (IQR 40–$100 \times 10^9$/L) for all indications except "*other indications to transfuse*" ($65 \times 10^9$/L [IQR 35–$100 \times 10^9$/L]). Overall, the most common threshold for platelet transfusion was $50 \times 10^9$/L ($n$ = 83/224), with a range from 10 to $150 \times 10^9$/L. This pattern was consistent across indications, including active bleeding ($n$ = 40/104) and prophylactic transfusion ($n$ = 26/72), emphasizing the similarity in transfusion thresholds regardless of clinical context. In events with a stated threshold, non-adherence (transfusion at a platelet count above the stated transfusion threshold) occurred in 16% ($n$ = 36/224).

## TABLE 2.
## ICU Course

| Variable | Transfusion, *n* = 208 | No Transfusion, *n* = 3435 | *p* |
|---|---|---|---|
| Total days ICU admission | 5 (3–9) | 3 (2–5) | < 0.001 |
| Mean daily blood loss, mL | 99 (0–333) | 0 (0–77) | < 0.001 |
| Mean Sequential Organ Failure Assessment score during ICU stay[a] | 7 (5–11) | 3 (2–6) | < 0.001 |
| Laboratory values at ICU admission | | | |
| Platelet count at admission, $10^9$/L | 113 (50–199) | 227 (169–293) | < 0.001 |
| Thrombocytopenia (< 150 × $10^9$/L) at ICU admission | 103 (50) | 458 (13) | < 0.001 |
| Mild (100–149 × $10^9$/L) | 29 (28) | 302 (66) | < 0.001 |
| Moderate (50–99 × $10^9$/L) | 32 (31) | 108 (24) | 0.14 |
| Severe (20–49 × $10^9$/L) | 25 (24) | 38 (8) | < 0.001 |
| Very severe (≤ 19 × $10^9$/L) | 17 (17) | 10 (2) | < 0.001 |
| Laboratory values during ICU stay | | | |
| Mean platelet count during ICU stay | 90 (52–161) | 204 (151–268) | < 0.001 |
| Nadir platelet count during ICU stay | 50 (21–103) | 176 (123–236) | < 0.001 |
| Thrombocytopenia (< 150 × $10^9$/L) during ICU stay | 128 (62) | 846 (25) | < 0.001 |
| Mild (100–149 × $10^9$/L) | 17 (8) | 491 (58) | < 0.001 |
| Moderate (50–99 × $10^9$/L) | 35 (27) | 257 (30) | 0.55 |
| Severe (20–49 × $10^9$/L) | 44 (34) | 78 (9) | < 0.001 |
| Very severe (≤ 19 × $10^9$/L) | 32 (25) | 20 (2) | < 0.001 |
| Support during ICU stay | | | |
| Invasive mechanical ventilation | 153 (74) | 1364 (40) | < 0.001 |
| Renal replacement therapy | 51 (25) | 240 (7) | < 0.001 |
| Noninvasive mechanical ventilation | 34 (16) | 612 (18) | 0.66 |
| Extracorporeal membrane oxygenation | 10 (5) | 18 (< 1) | < 0.001 |
| Mechanical cardiac devices | 8 (4) | 39 (1) | < 0.01 |
| Overall/concomitant transfusion | | | |
| Received platelet transfusion | 208 (100) | – | – |
| No. of units transfused | 823 (100) | – | – |
| No. of units transfused in total per patient | 2 (1–4) | – | – |
| No. of transfusion events | 443 (100) | – | – |
| No. of platelet transfusion events | 1 (1–2) | – | – |
| Received RBC transfusion | 163 (78) | 731 (21) | < 0.001 |
| Received plasma transfusion | 109 (52) | 228 (7) | < 0.001 |
| Received massive transfusion protocol | 23 (11) | 11 (< 1) | < 0.001 |
| Received coagulation product | 76 (37) | 132 (4) | < 0.001 |

[a]The Sequential Organ Failure Assessment score in the ICU measures organ dysfunction on a scale of 0–24, with higher scores indicating more severe dysfunction.

All variables are displayed as count (%) for categorical, median (first–third quartile) for non-parametric, and mean. SD for parametric variables. The expanded version of the table is provided as **Table S4** (https://links.lww.com/CCM/H798).

## TABLE 3.
## Characteristics of Platelet Transfusion Events

| Variable | Total Platelet Transfusion Events, *n* = 443 |
|---|---|
| No. of platelet units | |
| Number of platelet units per event | 1 (1–2) |
| 1 | 279 (63) |
| 2–3 | 115 (26) |
| > 3 | 49 (11) |
| Platelet count | |
| Threshold predefined[a], $10^9$/L | 50 (40–100) |
| ≤ 10 | 10 (2) |
| 11–20 | 16 (4) |
| 21–50 | 113 (26) |
| 51–100 | 66 (15) |
| > 100 | 19 (4) |
| No threshold stated | 219 (49) |
| Before transfusion[b], $10^9$/L | 45 (21–81) |
| ≤ 10 | 32 (7) |
| 11–20 | 64 (14) |
| 21–50 | 121 (27) |
| 51–100 | 120 (27) |
| > 100 | 69 (16) |
| No platelet count stated | 37 (8) |
| Post-transfusion[c], $10^9$/L | 71 (43–113) |
| Gain from transfusion[d], $10^9$/L | 20 (34) |
| Difference between count before trigger[e] | -4 (77) |
| Non-adherence[f] | 36/224 (16) |
| Difference non-adherence[g] | 23 (13–41) |
| Reason for platelet transfusion[h] | |
| Active bleeding | 187 (42) |
| Prophylactic (in the absence of upcoming procedure) | 144 (33) |
| As part of clinical trial | 3 (1) |
| Upcoming procedure | 51 (12) |
| Results viscoelastic testing[i] | 19 (4) |
| Other (i.e., general coagulopathy) | 45 (10) |

[a]The platelet count at which a platelet transfusion is advised as stated in the ICU's protocol, or, in the absence of a protocol, the expert's opinion for that patient.
[b]The most recent platelet count before the platelet transfusion was administered, within 4 hr before the decision to transfuse.
[c]The first platelet count measured within 24 hr after the platelet transfusion.
[d]Calculated as the variance between the platelet count measured before and after the platelet transfusion.
[e]The calculation involves subtracting the measured platelet count before the transfusion from the platelet count threshold. A negative change indicates adherence to the protocol (i.e., the measured count was below the specified threshold), while a positive value suggests that the threshold had not been reached (non-adherence).
[f]Non-adherence is defined by a higher platelet count before the transfusion than the threshold. Percentage is calculated based on the total number of transfusion events with a given threshold and platelet count before transfusion.
[g]The calculation involves subtracting the measured platelet count before the transfusion from the platelet count threshold solely in non-adherence events.
[h]Multiple options possible.
[i]Platelet transfusion guided by local viscoelastic testing protocols or practices.
All variables are displayed as count (%) for categorical median (first–third quartile) for non-parametric and mean (SD) for parametric variables. The expanded version of the table is provided as **Table S5** (https://links.lww.com/CCM/H798).

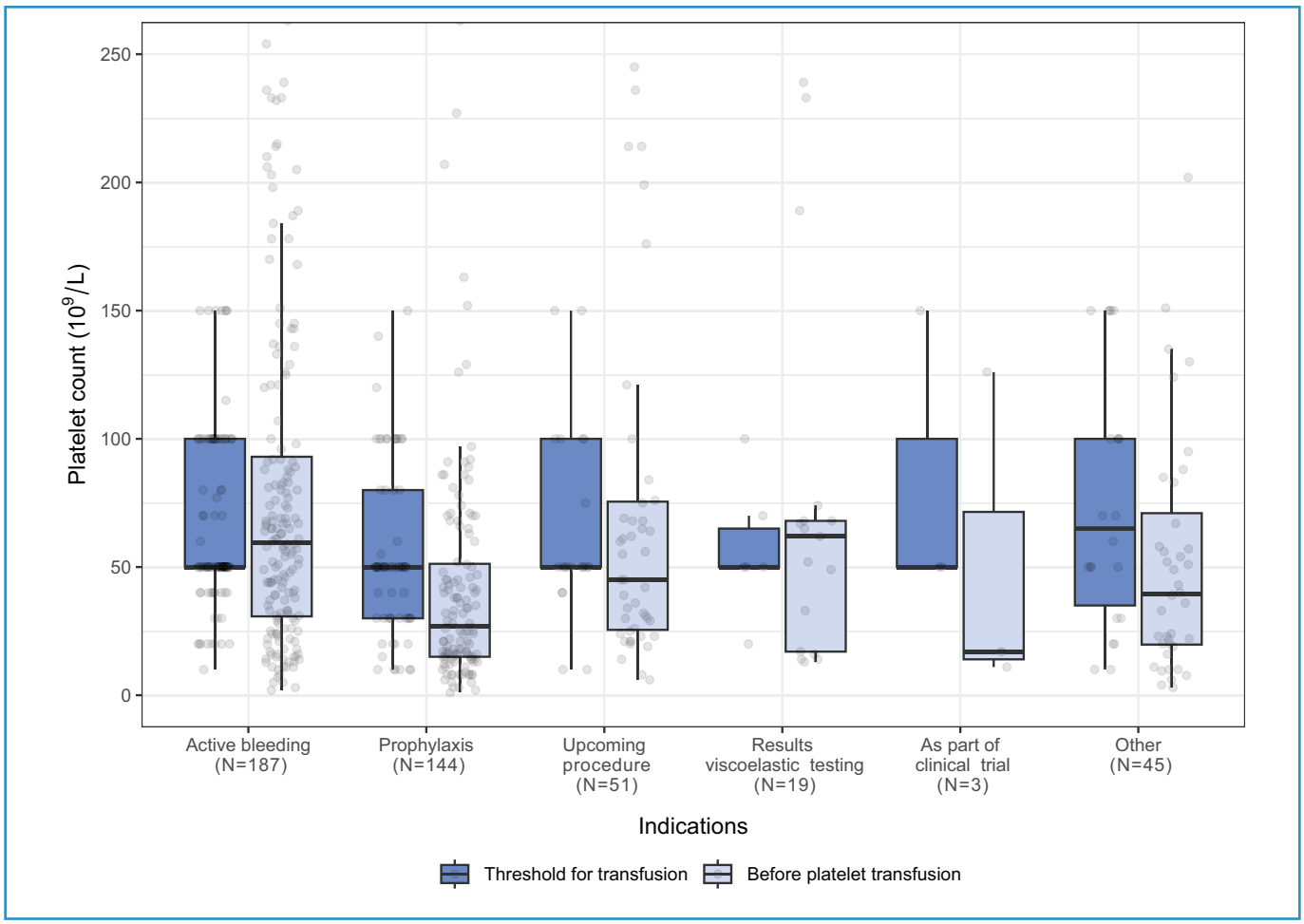


**Figure 1.** Platelet count threshold and platelet count before platelet transfusion, stratified by indication. During a transfusion event, one or more indications may be provided with the exception of "other." "Other" indications encompasses among others "general coagulopathy."

## Subgroup Analyses

***Active Bleeding.*** In actively bleeding patients, platelet transfusion threshold and pre-transfusion platelet count were reported in 56% ($n$ = 104/187) and 94% ($n$ = 176/187) of the transfusion events (**Table S6**, https://links.lww.com/CCM/H798). The median transfusion threshold was $50 \times 10^9$/L (IQR 50–$100 \times 10^9$/L), whereas median pre-transfusion platelet count was $60 \times 10^9$/L (IQR 31–$93 \times 10^9$/L) (**Figs. 1** and **2**). In 42% of transfusions for active bleeding ($n$ = 74/176), pre-transfusion platelet count less than or equal to $50 \times 10^9$/L. Of the 36 non-adherence events, 22 (61%) were administered in active bleeding, with a median difference of $21 \times 10^9$/L (IQR 11–$38 \times 10^9$/L) between threshold and pre-transfusion count (**Fig. S4**, https://links.lww.com/CCM/H798).

***Prophylaxis.*** For prophylactic transfusion events, the transfusion threshold was reported in 50% ($n$ = 72/144), and a pre-transfusion platelet count in 89% ($n$ = 128/144) (**Table S7**, https://links.lww.com/CCM/H798). The median transfusion threshold was $50 \times 10^9$/L (IQR 30–$80 \times 10^9$/L), and the median pre-transfusion platelet count was $27 \times 10^9$/L (IQR 15–$51 \times 10^9$/L). This platelet count was significantly lower compared with other indications (median $57 \times 10^9$/L, IQR 28–$91 \times 10^9$/L, $p < 0.001$) (Table S7, https://links.lww.com/CCM/H798). Only 14% ($n$ = 18/128) of the administered prophylactic platelets adhered to the guideline recommendation that the platelet count before transfusion should be equal to or less than $10 \times 10^9$/L (**Fig. 2**).

***Geo-Economic Regions.*** Two-third of all 3643 patients examined originated from high-income countries ($n$ = 2520/3643), 29% from upper-middle-income countries ($n$ = 1069/3643), and 2% from lower-middle-income countries ($n$ = 54/3643) (**Tables S8–S10**, https://links.lww.com/CCM/H798).

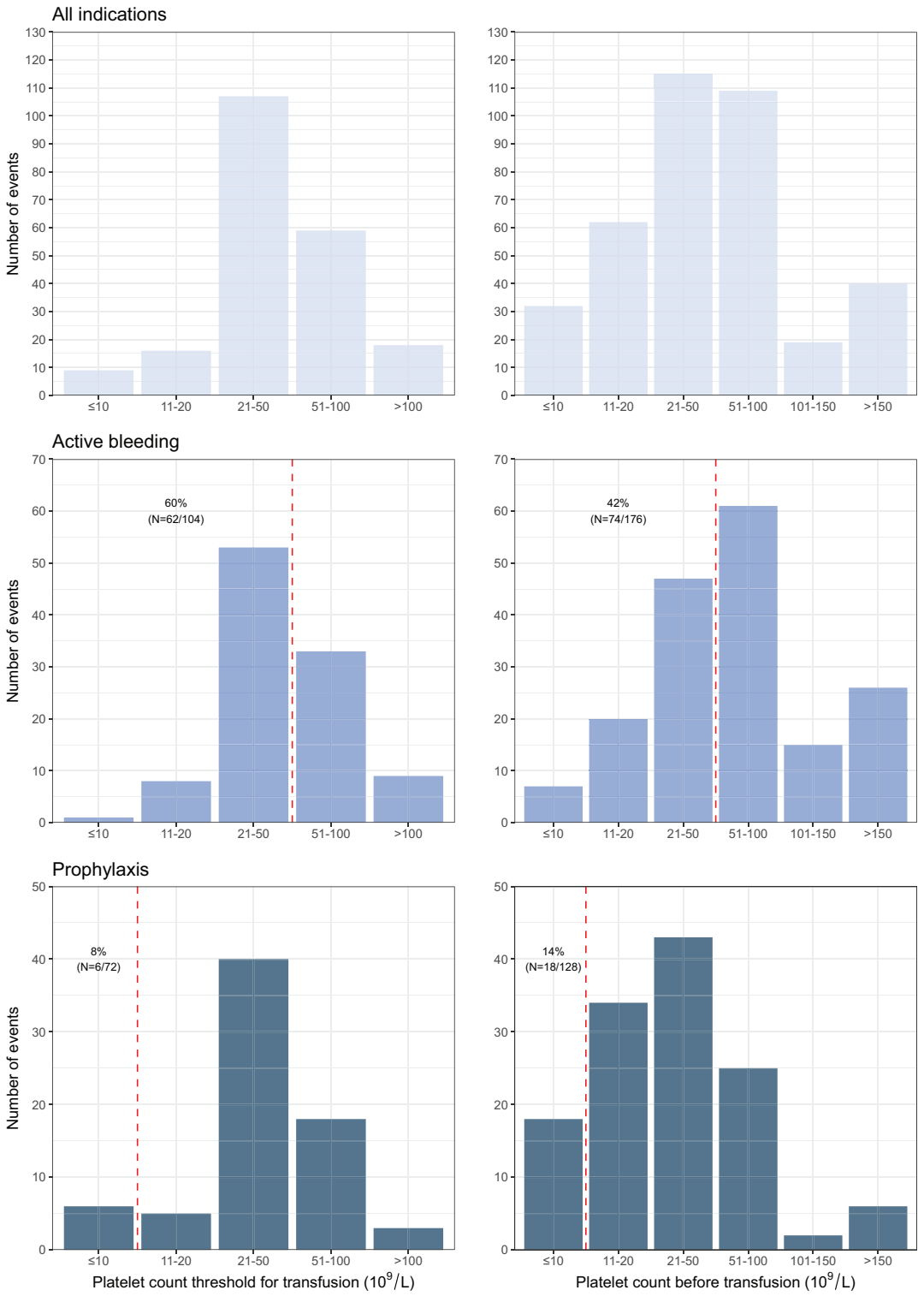


**Figure 2.** Additional details of platelet count before transfusion and used thresholds by indication. *Dashed lines* represent the threshold as stated by latest (inter)continental transfusion guidelines: that is, maintained platelet count of over $50 \times 10^9$/L in active severe bleeding (16) and platelet transfusion indicated at a platelet count below $10 \times 10^9$/L for prophylaxis in the absence of upcoming procedures (13–16).

Among these three geo-economic regions, platelet transfusions were only observed in patients in high-income (6%, $n = 156/2520$) and upper-middle-income countries (5%, $n = 52/1069$), not differing significantly ($p = 0.14$). During ICU stay, median platelet counts were $93 \times 10^9$/L (IQR 60–$169 \times 10^9$/L) and $51 \times 10^9$/L (IQR 33–$137 \times 10^9$/L) for transfused patients in high-income and upper-middle-income countries, respectively. Patients received a median of 2 platelet units (IQR 1–4 units) per event in upper-middle-income countries, whereas patients in high-income countries received 1 unit (IQR 1–2 units) per event. Non-adherence was higher in the high-income countries than upper-middle-income countries (23%, $n = 34/149$ vs 3%, $n = 2/75$; $p < 0.001$).

## DISCUSSION

In this multicenter, international cohort study, we found an in-ICU platelet transfusion occurrence rate of 6%. Second, main indications for platelet transfusion were active bleeding (42%) and prophylaxis (33%). Third, a platelet count threshold to transfuse of $50 \times 10^9$/L was most often stated, regardless of transfusion indication. Last, there is variability in platelet transfusion across geo-economic regions, with platelet transfusion being more frequent and administered at higher platelet counts in higher-income countries.

Despite being less studied than erythrocytes, platelet transfusion is an important treatment in the ICU. Our observed transfusion rate falls within the lower range compared with previous studies conducted the past decade (5–8). These studies, performed in various, mainly high-income, countries worldwide, showed a transfusion rate ranging from 5% to 15% (4–8). The relatively low proportion of transfused patients in our study (6%) could have different explanations. In recent years, awareness of the potential adverse effects of platelet transfusions is growing, leading to greater caution (17–20). Discussions regarding platelet transfusion thresholds and the use of additional measurements became more common (1). We documented a median pre-transfusion platelet count of $45 \times 10^9$/L, lower than a previous retrospective Canadian cohort of three ICUs, reporting a platelet count of $87 \times 10^9$/L (IQR 57–$130 \times 10^9$/L), regardless of indication (7). This decreasing threshold trend is in line with latest guidelines (12–16). Despite finding a higher transfusion rate of 10% ($n = 120/1166$), the Platelet Transfusions and Thrombocytopenia in Intensive Care Units (PLOT-ICU) study, conducted in 52 ICUs across 10 high-income countries, reported lower platelet counts pre-transfusion compared with our study (8). This increased transfusion rate may be attributed to a higher prevalence of in-ICU thrombocytopenia in the PLOT-ICU (43%), surpassing our prevalence of 27%. The difference in the prevalence of thrombocytopenia may be partly explained by the inclusion periods, high-income country representation and case-mix (**Supplemental Text S3**, https://links.lww.com/CCM/H798). The transfusion thresholds used in previous studies on platelet transfusion in the ICU were not disclosed, making it challenging to compare with the current study (4–8). The PLOT-ICU study solely mentioned that 15.4% of their participating centers had ICU-specific guidelines for platelet transfusions (8). Last, the lower rate of platelet transfusion in our study could be attributed to platelet concentrate shortages, an increasing issue, especially prevalent in low-income and middle-income countries (29, 30). Several factors contribute to blood shortages for transfusion, including low public participation in voluntary non-remunerated blood donation, blood donor suitability, infrastructure constraints, and the lack of sustainable financial models (31, 32). As such, it can be hypothesized that if our cohort had consisted of more lower-middle and lower-income countries, the occurrence rate would be even lower.

There is substantial variation within clinical contexts regarding the threshold applied for prophylaxis (25, 26). The latest transfusion guidelines by the European Society of Intensive Care Medicine advise against using platelet transfusion for the treatment of thrombocytopenia, unless the platelet count falls below $10 \times 10^9$/L (13). Among all our prophylactic platelet transfusion events, only 14% had a platelet count less than or equal to $10 \times 10^9$/L. However, patient-specific factors and the clinical context influencing the decision to transfuse at higher counts were not accounted for. Given that not all prophylactic platelet transfusions are considered beneficial, we believe that refining indications and implementations of platelet transfusions in specific patient populations can enhance their effectiveness.

Determining the appropriate threshold for platelet transfusions in patients with active bleeding is complex, as awaiting a certain level may not be advisable

due to different additional factors, such as dilution or laboratory-induced delays. In 56% of our active bleeding transfusion cases, a threshold of $50 \times 10^9$/L was reported. This aligns with previous guideline recommendations to maintain platelet counts above $50 \times 10^9$/L in severe bleeding and above $30 \times 10^9$/L in non-severe bleeding (16). However, we did not collect data on bleeding severity, since we recorded the physician's stated indication without applying a predefined classification. This approach reflects the study's intent to observe real-world practice rather than impose prescriptive rules or clinical directives on treating physicians. Furthermore, in the majority of cases (58%), the pre-transfusion platelet count during active bleeding was higher than $50 \times 10^9$/L. Although maintaining a platelet count above $50 \times 10^9$/L is recommended, 42% of transfusions occurred when the platelet count was below $50 \times 10^9$/L. This may reflect a delay in intervention, non-life threatening bleeding, or preexisting severe thrombocytopenia. This underscores the complexity of establishing an appropriate transfusion threshold during active bleeding. Other factors that influence platelet function, such as the use of hemostatic agents or extracorporeal support, should also be considered.

In the current study design, we did not assess the reasons for non-adherence or the clinical reasons for withholding platelet transfusion. The platelet count threshold for each transfusion event was determined either by the local protocol or by the treating physician's discretion. The difference in non-adherence between high-income (23%) and upper-middle-income countries (3%) may be due to the availability of platelet concentrates. In high-income countries, where platelet concentrates may be more readily accessible, physicians may opt to transfuse earlier when uncertain, whereas in middle- or low-income countries, where availability is more limited, transfusions may be less frequent. However, as we did not collect detailed information on resource availability, clinical decision-making, or contraindications to transfusion at the ICU level, any explanation regarding their influence on our findings remains speculative.

Given the considerable variation in transfusion practices among countries, institutions, and individual clinicians, as well as the incomplete implementation of transfusion guidelines, it is crucial to develop more standardized protocols. Strengthening evidence-based practices will further enhance patient care (25–27). It is advisable to integrate precision medicine into transfusion-related research (33). This approach aims to identify thresholds that are adequately high to prevent bleeding while being strategically low to minimize the necessity for unnecessary transfusions. Transfusion-related complications may be identified for specific ICU populations. This is demonstrated by randomized controlled trials evaluating the platelet transfusion threshold before CVC placement or in hematological patients to reduce unnecessary transfusions (10, 11). Conducting similar studies would prove beneficial in refining transfusion guidelines, enabling the development of more precise recommendations tailored to specific subgroups within the ICU. This may include patients using anti-platelet drugs or those with impaired platelet function, such as individuals affected by sepsis, severe liver disease, or renal disease.

## Strengths and Limitations

This study offers a comprehensive overview of worldwide platelet transfusion practices in the ICU, including the combination of platelet transfusion thresholds and the clinical indications guiding the decision to transfuse. Unlike previous studies that primarily focused on single, or high-income countries, our study collected worldwide data from a wide range of centers and countries. To minimize selection bias, all patients admitted to the ICU were included, ensuring a representative sample and enhancing the generalizability of our findings to the broader ICU population.

This study has several limitations that should be acknowledged. First, most participating centers were from upper-middle-income to high-income countries, primarily in Europe, which may limit the generalizability to lower-income countries. Only 2% ($n$ = 54) of the patients represented lower-middle-income countries, and none received a platelet transfusion, making it impossible to compare this group with their counterparts. Additionally, the observed variability found in transfusion practices may be attributed to factors such as resource availability, the clinical experience of physicians, and the healthcare infrastructure of both center and country. Although these factors are difficult to define, they remain important influences on transfusion practices. Second, we did not assess platelet function. In addition, it is essential to note that transfusion variables were only collected for patients who received one or more transfusions. As a result, the exact transfusion

thresholds specified in the center's protocol for patients who did not receive a transfusion remain unknown. Third, the predefined weeks were randomly selected to ensure representation of patients across all seasons of the year. However, participating centers were given the flexibility to choose the specific week that best aligned with their capacity to collect data. This flexibility may have introduced any seasonal or institutional biases, as centers might have chosen weeks with potentially lower or more manageable patient loads. Last, adjustments for outcomes were not performed, potentially introducing bias, as the transfused patients in the study were more critically ill. Therefore, results from secondary and exploratory outcomes should be interpreted as hypothesis generating.

Future research should focus on the practices and requirements for a platelet transfusion to determine thresholds within distinct ICU subpopulations. Establishing an optimal trigger that effectively prevents bleeding is crucial, while keeping the threshold low enough to minimize unnecessary transfusions and mitigate associated risks and avoid wasting precious collective resources. By delving into these areas, significant advancements can be made in refining platelet transfusion strategies reducing both non-adherence and unnecessary transfusions. In addition, conducting research on platelet manufacturing and preservation, focusing on extended storage for improved availability in remote areas, can enhance global access to platelet transfusion.

## CONCLUSIONS

In conclusion, our prospective, international cohort study highlights the worldwide practices of platelet transfusion in the ICU. Platelet transfusions were administered to a small proportion of patients, with varying indications but generally similar thresholds regardless of the indications.


1 *Department of Intensive Care, Amsterdam University Medical Centers, Amsterdam, The Netherlands.*

2 *Department of Anesthesiology, Amsterdam University Medical Centers, Amsterdam, The Netherlands.*

3 *School of Public Health and Preventive Medicine, Monash University, Melbourne, VIC, Australia.*

4 *The Australian and New Zealand Intensive Care Research Centre (ANZIC-RC), School of Public Health and Preventive Medicine, Monash University, Melbourne, VIC, Australia.*

5 *Department of Epidemiology and Data Science, Amsterdam University Medical Centre, location AMC, Amsterdam Public Health, University of Amsterdam, Amsterdam, The Netherlands.*

6 *Department of Pulmonary and Critical Care, New York University and Columbia University, New York, NY.*

7 *Department of Intensive Care Adults, Erasmus MC University Medical Centers, Rotterdam, The Netherlands.*

8 *Department of Intensive Care, Pontificia Universidad Católica de Chile, Santiago, Chile.*

9 *Department of Anesthesiology and Intensive Care, IRCCS Humanitas Research Hospital, Milan, Italy.*

10 *Department of Anaesthesiology, Intensive Care Medicine and Pain Therapy, EvangKliniken Essen-Mitte, Huyssens-Stiftung/Knappschaft, Essen, Germany.*

11 *Department of Anesthesiology and Intensive Care, Kepler University Clinic, Kepler University, Linz, Austria.*

12 *Department of Anesthesiology, University Medical Center Groningen, Groningen, The Netherlands.*

13 *Department of Critical Care, Asgar Ali Hospital, Dhaka, Bangladesh.*

14 *Department of Intensive Care, CHU Charleroi Marie Curie, Université Libre de Brussels, Charleroi, Belgium.*

15 *Department of Anesthesiology and Intensive Care, University Clinical Hospital Center Zagreb, Zagreb, Croatia.*

16 *Department of Anesthesiology and Intensive Care Medicine, University Hospital and Faculty of Medicine in Plzen-Charles University, Plzen, Czech Republic.*

17 *Department of Intensive Care, Copenhagen University Hospital, Rigshospitalet Copenhagen, Copenhagen, Denmark.*

18 *Department of Anesthesia and Intensive Care Medicine, Copenhagen University Hospital-Gentofte, Hellerup, Denmark.*

19 *Department of Clinical Medicine, University of Copenhagen, Copenhagen, Denmark.*

20 *Unidad de Cuidados Intensivos, Hospital Vicente Corral Moscoso, Cuenca, Ecuador.*

21 *Department of Cardiothoracic Surgery, European Interbalkan Medical Center, Thessaloniki, Greece.*

22 *Intensive Care Unit, First Department of Respiratory Medicine, National and Kapodistrian University of Athens, Sotiria Chest Hospital, Athens, Greece.*

23 *Department of Critical Care Medicine, Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow, Uttar Pradesh, India.*

24 *Department of Anesthesiology, Critical Care and Pain, Tata Memorial Hospital, Homi Bhabha National Institute, Mumbai, Maharashtra, India.*

25 *Department of Child, General and Specialistic Surgery, University of Campania, Luigi Vanvitelli, Naples, Italy.*

26 *Faculty of Medicine, University of Tripoli, Tripoli, Libya.*

27 *Department of Anesthesiology and Intensive Care, Institute of Medical Sciences, University of Opole, Opole, Poland.*

28 *Department of Intensive Care, Centro Hospitalar de Entro o Douro e Vouga, Santa Maria da Feira, Portugal.*

29 *Department of Anesthesiology, Aga Khan University Hospital, Nairobi, Kenya.*

30 *Department of Anesthesia and Intensive Care, Military Medical Academy Belgrade, Belgrade, Serbia.*

31 *Department for Internal Intensive Care, General Hospital Celje, Medical Faculty, University of Ljubljana, Celje, Slovenia.*

32 *Department of Anesthesiology and Post-surgical Critical Care, University Hospital Doctor Peset, Valencia, Spain.*

33 *Intensive Care Service, Hospital Universitario La Paz, Madrid, Spain.*

34 *Department of Clinical Science and Education, Södersjukhuset, Karolinska Institutet, Stockholm, Sweden.*

35 *Department of Intensive Care, Inselspital, Bern University Hospital and University of Bern, Bern, Switzerland.*

36 *Department of Anesthesiology and Reanimation, Dr Siyami Ersek Thoracic and Cardiovascular Surgery Center, University of Health Sciences, Istanbul, Turkey.*

37 *Division of Pulmonary, Critical Care and Sleep Medicine, and Section of Transfusion Medicine and Therapeutic Pathology, University of New Mexico School of Medicine, Albuquerque, NM.*

38 *Nuffield Department of Clinical Neurosciences, University of Oxford, Oxford, United Kingdom.*

39 *Intensive Care Center, University Medical Center Utrecht, Utrecht, The Netherlands.*

40 *Médecine Intensive Réanimation, CHU de Brest, Université de Bretagne Occidentale, Brest, France.*

*Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's website (http://journals.lww.com/ccmjournal).*

*Drs. van Wonderen and Raasveld contributed equally.*

*Drs. van Wonderen, Raasveld, Schenk, and Vlaar had full access to all data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Drs. van Wonderen, Raasveld, Vlaar, and Aubron were involved in concept and design. Drs. van Wonderen, Raasveld, Flint, Schenk, van den Oord, Reuland, de Bruin, Bakker, Cecconi, Feldheiser, Meier, Müller, Scheeren, de Grooth, McQuilten, Vlaar, and Aubron were involved in drafting of the article. Drs. van Wonderen, Raasveld, Schenk, Vlaar, and Aubron were involved in statistical analysis. Drs. Müller, McQuilten, Vlaar, and Aubron were involved in supervision. All authors were involved in critical revision of the article for important intellectual content; acquisition, analysis, or interpretation of data.*

*After publication, encrypted data can be requested by contacting the corresponding author. Reasonable data request will be taken in consideration.*

*This study was endorsed, but not financially supported, by the European Society of Intensive Care Medicine. Dr. Flint reported receiving grants from the Australian National Blood Authority and Blood Synergy (Monash University) during the conduct of the study. Dr. Cecconi reported receiving personal fees from Edwards Lifesciences, GE Healthcare, and Directed Systems outside the submitted work. Dr. Feldheiser reported receiving personal fees from Baxter, Medtronic, Retia, and Mindray outside the submitted work. Dr. Benes received support for article research from the Charles University research fund. Dr. Triantafyllopoulou disclosed government work. Dr Scheeren reported serving as senior medical director for Edwards Lifesciences (Garching, Germany). Dr. Piagnerelli reported receiving grants from center Federal d'Expertise Belge–KCE grant for COVID-19 study outside the submitted work. Dr. Nielsen received funding from Adrenomed and Inotrem. Dr. Gurjar reported receiving royalties for edited books* (Manual of ICU Procedures and Textbook of Ventilation, Fluids, Electrolytes and Blood Gases) *from the publisher Jaypee Brothers Medical Publishers (Pvt), New Delhi. Dr. Pfortmueller reported receiving grants from Orion Pharma, Abbott Nutrition International, B Braun Medical AG, CSEM AG, Edwards Lifesciences Services GmbH, Kenta Biotech Ltd, Maquet Critical Care AB, Omnicare Clinical Research AG, Nestle, Pierre Fabre Pharma AG, Pfizer, Bard Medica SA, Abbott AG, Anandic Medical Systems, Pan Gas AG Healthcare, Bracco, Hamilton Medical AG, Fresenius Kabi, Getinge Group Maquet AG, Dräger AG, Teleflex Medical GmbH, GlaxoSmithKline, Merck Sharp and Dohme AG, Eli Lilly and Co, Baxter, Boehringer Ingelheim, Aseptuva, Astellas, AstraZeneca, CSL Behring, Novartis, Covidien, and Nycomed outside the submitted work; the funds were paid into departmental funds and no personal financial gain applied. Dr. Shah's institution received funding from the National Institute for Health and Care Research-funded Threshold for Platelet trial (131822); he received funding from Pharmacosmos U.K. and the anesthesia Editorial Board. Dr. McQuilten reported receiving grants from Australian National Blood Authority and National Health and Medical Research Council (NHMRC) during the conduct of the study. Dr. McQuilten is also supported by an NHMRC Emerging Leader Investigator Grant (GNT1194811). Monash University, Australia, received a project grant from the National Blood Authority of Australia and an NHMRC Synergy Grant (GNT1189490) for the study in Australia and New Zealand (ID508). Dr. Vlaar reported receiving support through a personal grant from the Netherlands Organization for Scientific Research, Vidi grant number 09150172010047, and funding from the Landsteiner Foundation for Blood Transfusion Research, project number 1931F. The remaining authors have disclosed that they do not have any potential conflicts of interest.*

*For information regarding this article, E-mail: s.j.raasveld@amsterdamumc.nl*

*Members of the InPUT Study Group can be viewed in the supplemental data (https://links.lww.com/CCM/H797).*

*This prospective study involving human participants was in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. This study was approved by the institutional review board of the Amsterdam University Medical Centers (W18_390#18.449), and, if applicable by national law, thereafter, from local Ethics Committees.*

*Informed consent was obtained from all individual participants included in the study if applicable. The adherence to national regulations governed the procedures for obtaining informed consent, encompassing the patient's active agreement or their legally authorized representative. Notably, in some countries, the observational and noninvasive characteristics of the study justified waiving of informed consent.*

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