

RESEARCH LETTER

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Severity of illness influences the microcirculatory response to red blood cell transfusion in the critically ill: an observational cohort study

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Main text

Critically ill patients frequently require red blood cell (RBC) transfusions. The aim of giving a RBC transfusion is to increase oxygen delivery to tissues in anemic patients. The oxygen delivering capacity depends not only on the hemoglobin (Hb) level and oxygen saturation, but also on tissue perfusion. In current clinical practice, transfusion decisions are based on the Hb level only. However, baseline Hb level does not correlate with a positive effect of a RBC transfusion on tissue perfusion [1]. The effect of a RBC transfusion seems to depend on the baseline microcirculatory flow [1, 2]. However, routine measurements of the microcirculatory flow in clinical practice are difficult, since microcirculatory flow evaluation requires experience and the analysis of the videos is time-consuming. We hypothesized that organ injury level of the patient influences the microcirculatory response of the recipient to RBC transfusion, rendering the Sequential Organ Failure Assessment (SOFA) score

an easy bedside value which could aid in transfusion decision-making.

We performed sublingual Sidestream DarkField (SDF) imaging (Microscan, MicroVision Medical, Amsterdam, The Netherlands) within 1 h before and after transfusion of 1 leucodepleted RBC unit in 18 anemic non-bleeding critically ill patients on a tertiary intensive care. The study was ethically approved by the medical ethical committee of the Amsterdam University Medical Centre (NTR 6596; NL61833.018.17). Written informed consent was obtained from all participants or their legal representatives. Software AVA 3.2, MicroVision Medical, Amsterdam, The Netherlands, was used to analyze the videos and to calculate the “De Backer” score (including vessel density, proportion of perfused vessels (PPV) and perfused vessel density (PVD)) and the Microvascular Flow Index (MFI) [3]. Wilcoxon signed-rank test was used to compare paired data. Correlation coefficient between the delta of the SDF values (difference between before and after transfusion) and SOFA score was calculated using the Spearman correlation. *p* values of the correlations are corrected for multiple testing with Holm-Bonferroni correction. A *p* value of less than 0.05 was considered statistically significant. Statistical analyses were performed using SPSS (IBM SPSS Statistics, version 25).

Patient characteristics are shown in Table 1. Median Hb level at baseline was 6.8 (IQR 6.4–7.3) g/dL and did not correlate with baseline microcirculatory flow (PPV:

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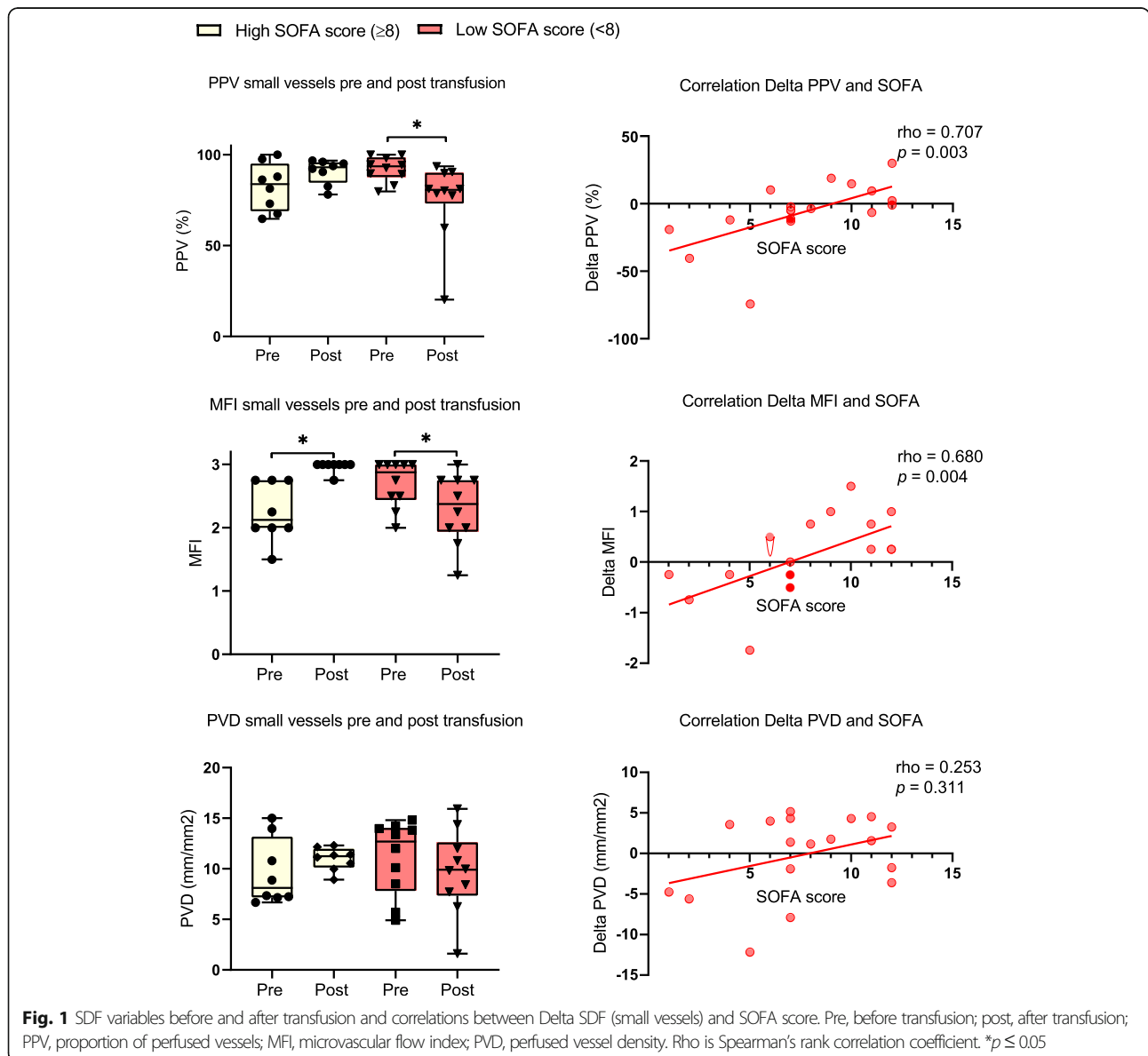
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Table 1 Patient characteristics. Data are median with IQR or number with percentage

	All patients (n = 18)
Gender, male	10 (56%)
Age (years)	61 [57–66]
SOFA score	7 [6–11]
Specialism, surgical	10 (56%)
Sepsis	7 (39%)
Mean arterial pressure (mmHg)	76 [72–82]
Baseline hemoglobin level (g/dL)	6.7 [6.4–7.2]
Vasopressive medication	6 (33.3%)
Lactate (mmol/L)	1.7 [1.2–1.8]
pH	7.45 [7.42–7.49]
Arterial saturation	94.2 [93.2–94.8]
Storage duration RBC unit, days	16 [11–21]
Hospital mortality	4 [22.2%]

$\rho = -0.141$, $p = 0.567$, PVD: $\rho = -0.445$, $p = 0.192$, MFI: $\rho = -0.276$, $p = 0.534$). In line with previous findings, the effect of a transfusion depended on the baseline microcirculatory flow, with patients with impaired baseline values showing an improvement and patients with normal baseline values showing a deterioration (PPV: $\rho = -0.772$, $p = 0.000$, PVD: $\rho = -0.795$, $p = 0.000$, MFI: $\rho = -0.697$, $p = 0.001$).

No correlation was found between baseline SDF values and the SOFA score (PPV: $\rho = -0.382$, $p = 0.288$; PVD: $\rho = -0.089$, $p = 0.726$; MFI: $\rho = -0.404$, $p = 0.288$) indicating that the severity of illness does not correspond with the flow in the microcirculation before transfusion. However, there was a positive correlation between SOFA score and the change in PPV and MFI



values after transfusion, in which the microcirculation improved in the patients with a SOFA score > 8 but deteriorated in those with lower SOFA scores. PVD did not correlate with the SOFA score (Fig. 1).

In conclusion, these results suggest that patients with high SOFA scores have improvement of their microcirculation after a RBC transfusion, while patients with a low SOFA score show a decrease in flow and perfusion following a transfusion. This suggests that we should take the severity of the illness of the patient into account when deciding whom to transfuse, when microcirculatory flow analysis is not available.

Abbreviations

RBC: Red blood cell; Hb: Hemoglobin; SOFA: Sequential organ failure assessment; SDF: Sidestream DarkField imaging; PPV: Proportion of perfused vessels; PVD: Perfused vessel density; MFI: Microvascular Flow Index

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Not applicable

Trial registration

Netherlands Trial Register (NTR), [NL6419/NTR6596](https://www.trialregister.nl/record/NL6419/NTR6596). Registered on 26 July 2017. Retrospectively registered.

Authors' contributions

LM gathered and analyzed the data and wrote the manuscript. JD analyzed the data and revised the manuscript. MH gathered the data and critically revised the manuscript. MB gathered the data and critically revised the manuscript. RB designed the study and critically revised the manuscript. NJ designed the study and critically revised the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

The study was ethically approved by the medical ethical committee of the Amsterdam University Medical Centre (NTR 6596; NL61833.018.17). Written informed consent was obtained from all participants or their legal representatives.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

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