ASSESSING REALISM OF EXTRACORPOREAL MEMBRANE OXYGENATOR SIMULATORS – DEVELOPMENT AND APPLICATION OF AN OBJECTIVE FIDELITY CLASSIFICATION FRAMEWORK

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Introduction

Extracorporeal membrane oxygenation (ECMO) support is a life-saving treatment for severe cardiac and/or pulmonary failure. Because of its high complexity and low patient numbers, complications such as mortality, bleeding, and infections are high. Simulation-based training with ECMO simulators (ECMO sims) is used to train skills such as ECMO cannulation, circuit monitoring, and complex problem solving [1]. Realism (fidelity) is often assessed subjectively, and it is unclear to what extent low-, mid-, and high fidelity ECMO sims are available.
The aim of this study is to develop an objective framework for ECMO fidelity classification and apply this to available ECMO sims.

Methods

ECMO sims were identified through literature search in PubMed, Web of Science Core Collection, and Google (Scholar) and is accurate until March 2024. A fidelity framework was developed by a multidisciplinary expert group [1] and incorporated existing fidelity definitions, ECMO components, and ability to customize for patient variation.
Definition-based fidelity was divided into conceptual, functional, physical, and psychological fidelity. ECMO components were identified and scored for each ECMO sim when available. Last, the ability to customize the simulator to patient-specific aspects as skin tone, sex, age, and disease-specific anatomy was scored.
Fidelity domains were divided into tertiles, and labelled low-, mid-, or high-fidelity based on the number of available features, respectively.

Results

29 of 33 ECMO sims with publicly available information, were suitable for fidelity classification (Figure 1).
Definition-based fidelity was low for 34% of ECMO sims, and 45% and 21% scored mid- and high-fidelity, respectively. Based on the ELSO Red Book [2], 10 ECMO process components were identified, e.g. cannulation, circuit priming, monitoring and trouble-shooting, and the use of clinical scenarios. The majority of ECMO sims (69%) had 4 to 7 components covered and scored mid-fidelity, while none scored high-fidelity.
ECMO sim customization fidelity was generally low (90%), without high-fidelity customization (0%).
Taking the median for all fidelity domains, 11 (38%) ECMO sims were classified as overall low-fidelity, 18 (62%) as mid-fidelity, and 0 (0%) as high-fidelity.

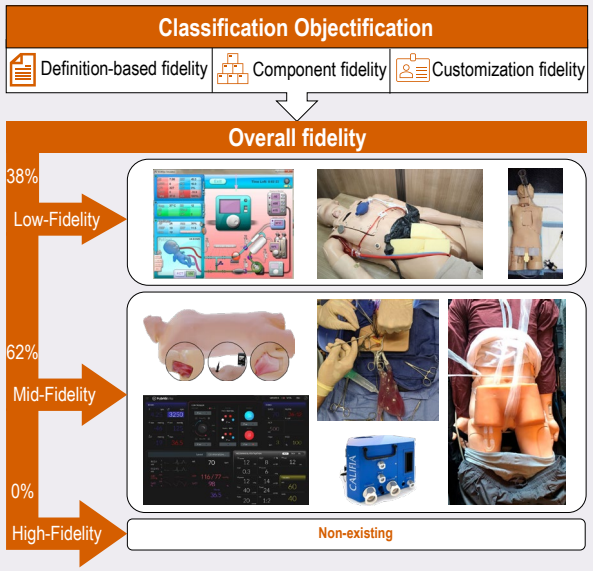

Figure 1: ECMO simulator fidelity classification framework with classifications of existing simulators.

Discussion

Many ECMO sims are self-claimed to be high-fidelity with a subjective assessment. We developed an objective framework to assess fidelity and found that no high-fidelity simulators are currently available.
Fidelity scoring does not necessarily correlate with a quality mark. To the contrary, basic ECMO cannulation skills acquisition may best be trained on low-fidelity simulators. However, complex team training with distractions, interrupted actions and real-life training with debriefing are likely to benefit from high-fidelity ECMO sims [3] and should be developed. A limitation is that our overview is potentially incomplete, as simulators might have been developed, with public information lacking. We strongly encourage developers and researchers to share design and simulator evaluations publicly, whereafter evaluation may follow.
To conclude, an objective ECMO simulator classification framework was developed, and assessed that no high-fidelity ECMO sims yet exist. This framework may be used to improve the development and assessment of ECMO simulators.

References

1. Duinmeijer et al, J Clin Med, 12:1765, 2023.
2. Vercaemst et al, The ELSO Red Book 6th ed, Ch3, 2022.
3. Halfwerk et al, Int J Healthc Simul, 2023.