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Abstract

Adoption of a Social Robot in a Sub Intensive Care Unit for the Autonomous Computation of Criticality Scores †

Giovanni Piccininno [1], Nicola Laurieri [1], Alessandro Anselmo [1], Sergio Russo [2], Alessandra Sorrentino [3], Daniele Sancarlo [4], Grazia D'Onofrio [5], Letizia Lorusso [2], Laura Fiorini [3], Filippo Cavallo [3], Antonio Greco [4] and Francesco Giuliani [2,*]

[1] ITEM-OXYGEN, Altamura, 70022 Bari, Italy; g.piccininno@itemoxygen.com (G.P.); n.laurieri@itemoxygen.com (N.L.); a.anselmo@itemoxygen.com (A.A.)
[2] Innovation and Research Unit, Fondazione Casa Sollievo Della Sofferenza IRCCS, 71013 San Giovanni Rotondo, Italy; s.russo@operapadrepio.it (S.R.); l.lorusso@operapadrepio.it (L.L.)
[3] Department of Industrial Engineering, University of Florence, 50139 Firenze, Italy; alessandra.sorrentino@unifi.it (A.S.); laura.fiorini@unifi.it (L.F.); filippo.cavallo@unifi.it (F.C.)
[4] Geriatrics Unit, Fondazione Casa Sollievo della Sofferenza IRCCS, 71013 San Giovanni Rotondo, Italy; d.sancarlo@operapadrepio.it (D.S.); a.greco@operapadrepio.it (A.G.)
[5] Clinical Psychology Unit, Fondazione Casa Sollievo della Sofferenza IRCCS, 71013 San Giovanni Rotondo, Italy; g.donofrio@operapadrepio.it
* Correspondence: f.giuliani@operapadrepio.it
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Abstract: We describe an innovative case study focusing on a social robot able to help healthcare professionals compute criticality scores for patients hosted in a Geriatric Sub-Intensive Care Unit. The aim is to establish the feasibility of a scenario in which the robot modulates the frequency of its visits to the room of bedridden patients, based on the criticality scores it has computed.

Keywords: social robots; critical care; criticality score computation

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1. Introduction

A recent literature review [1] highlights that, to date, the only relevant application of social robots in intensive care units (ICUs) is aimed at delivering telepresence services for patient care. To our knowledge, the use case described here constitutes the first trial where a social robot has been adopted to support the medical estimation of the criticality state of ICU patients. In our use case, the robot-aided computation of clinically validated criticality scores is used to trigger the frequency of the robot's visits to bedridden patients, as further described in the following sections.

2. Materials and Methods

The system is composed of a central server designed to act as a hub to collect parametrical data from the sources presented in Table 1.

Table 1. Data sources and collected parameters.

Parameter	How It Is Measured
Vital Signs	Multiparametric ICU monitor
Urine Volume	Digital Urinometer
Laboratory Data	Laboratory Information Management System
Alertness level of the patient	Interaction with a Social Robot

The parameters above are essential for the quasi-real-time computation of the clinical scores:

- MEWS (Modified Early Warning Score) [2] which computes the clinical stability of the patient.
- qSOFA (quick Sequential Organ Failure Assessment) [3] which estimates the level of organ failure linked to sepsis.
- KDIGO (Kidney Disease: Improving Global Outcomes) [4] which is widely used to diagnose kidney injuries.

The main function of the robot is to detect the state of consciousness of the patient, through the AVPU (Alert, Verbal, Pain, Unresponsive) score or the Glasgow Coma scale [5] which assesses the patient's response to stimuli relating to eyes, voice, and movement, thereby supporting healthcare professionals who usually perform this task. The main robot features include autonomous navigation, gesture recognition, eye blinking monitoring, and vocal interaction. The robot used in this pre-validation use case performed in the Casa Sollievo della Sofferenza Research Hospital geriatric sub-intensive care unit was the Mover-1 produced and set up by Co-Robotics.

3. Discussion

Initially, the robotic system was correctly set up in real ICU premises without the involvement of any real bedridden patients yet, and this allowed us to identify preliminary advantages for healthcare professionals and patients. However, a few technical concerns and limitations were identified.

In particular, from a technical point of view, we experienced an acceptable, even though limited, capability of the robot to accurately detect speech and silence, although some speech-less responses were inappropriately reported as real speech by the robot. This aspect would be particularly crucial if the robot was to be implemented in real ICU settings which are typically characterized by noise. In any case, this inconvenience can be partially circumvented by the fact that the patient–robot interaction usually happens in rooms that are somewhat acoustically isolated from ICU common areas. Parametrical data have been acquired by system devices and correctly computed, and the navigation capabilities of the robot have been fully and successfully tested.

From the point of view of healthcare professionals, some possible difficulties were highlighted regarding the 'cohabitation' of healthcare staff and a robot in the same clinical rooms; in particular, in some cases, the robot could be a physical hurdle when promptness of an intervention is required.

Overall, apart from the aforementioned limitations, the results obtained in this pre-validation test of a robot in the ICU are promising and worth being implemented in real ICU scenarios.

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Informed Consent Statement: Not applicable because patients were not involved in the pre-validation experimental phase described in the present paper.

Data Availability Statement: Collected data are available upon reasonable request

Conflicts of Interest: The authors declare no conflict of interest. The company ITEM-OXYGEN has no conflict of interest.

References

1. Teng, R.; Ding, Y.; See, K.C. Use of robots in critical care: Systematic review. *J. Med. Internet Res.* **2022**, *24*, e33380. [CrossRef] [PubMed]
2. Hammond, N.E.; Spooner, A.J.; Barnett, A.G.; Corley, A.; Brown, P.; Fraser, J.F. The effect of implementing a modified early warning scoring (mews) system on the adequacy of vital sign documentation. *Aust. Crit. Care* **2013**, *26*, 18–22. [CrossRef] [PubMed]
3. LeGuen, M.; Ballueer, Y.; McKay, R.; Eastwood, G.; Bellomo, R.; Jones, D. Frequency and significance of qSOFA criteria during adult rapid response team reviews: A prospective cohort study. *Resuscitation* **2018**, *122*, 13. [CrossRef] [PubMed]
4. Khwaja, A. KDIGO Clinical Practice Guideline for Acute Kidney Injury. *Nephron Clin. Pract.* **2012**, *120*, c179–c184. [CrossRef] [PubMed]
5. Koksal, O.; Torun, G.; Ahun, E.; Sıgırlı, D.; Guney, S.B.; Aydın, M.O. The comparison of modified early warning score and glasgow coma scale-age-systolic blood pressure scores in the assessment of nontraumatic critical patients in emergency department. *Niger. J. Clin. Pract.* **2016**, *16*, 761–765. [CrossRef]