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DESIGNING FOR UNSEEN USERS: ENHANCING NON-EXPERT RESCUERS' EMOTIONAL EXPERIENCE IN CARDIAC ARREST EMERGENCIES

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ABSTRACT
Global ageing is leading to an increase in cardiac arrest incidents among senior citizens, posing a significant societal challenge. Most out-of-hospital cardiac arrest (OHCA) incidents occur at home, limiting patients' immediate access to professional help and Automated External Defibrillators (AEDs). In such instances, Cardiopulmonary Resuscitation (CPR) by caregivers, often the patient's family with no expert knowledge of emergency care, becomes crucial. Compared to professional rescuers, caregivers could face challenges in executing effective CPR due to skill gaps and emotional barriers in performing such procedures on family members. This study investigates the emotional experience of caregivers in cardiac arrest scenarios, a critical but often overlooked aspect in the design of emergency care devices. We aim to understand 1) how emotions affect caregivers' performance and experience during domestic cardiac arrest incidents, and 2) how design can support their practical and emotional needs, enhancing their performance. Semi-structured interviews with professional rescuers and non-expert caregivers reveal the emotional challenges that caregivers might confront before, during, and after cardiac arrest incidents, such as fear of approaching a collapsed person, anxiety about causing harm, lack of confidence, and moral pressure from social ties. These challenges can lead to adverse reactions that further hinder their CPR performance. The study highlights the importance of including emotional support for non-expert rescuers in OHCA incidents. By incorporating human-centred design principles, we propose an inclusive design guideline for emergency care devices and practical design strategies to mitigate emotional barriers and assist operational performance for non-expert rescuers.

Keywords: User emotions, inclusive design, emergency equipment, human-centred design, human performance

1 INTRODUCTION
The global rise in ageing has led to an increased incidence of out-of-hospital cardiac arrest (OHCA) among the elderly, primarily due to the higher prevalence of cardiovascular diseases in this demographic [1]. Notably, 85% of these emergencies occur at home [2], where immediate access to professional medical support and essential life-saving devices, such as Automated External Defibrillators (AEDs), are often limited. In these critical scenarios, the ability of caregivers and family members to perform cardiopulmonary resuscitation (CPR) becomes crucial [3]. However, the effectiveness of such interventions is frequently compromised by the caregivers' lack of formal training and the overwhelming emotional pressures faced in these emergencies. Addressing these gaps is essential for the design of home-use emergency care devices.
We explored the emotional and practical challenges non-expert users of emergency care devices might face during OHCA incidents at home. Semi-structured interviews with cardiac emergency professionals and non-expert caregivers of the elderly provided an in-depth understanding of these dynamics. The findings reveal discrepancies between the ideal responses in cardiac emergencies and caregivers' perceptions and experiences, primarily influenced by their emotional states and lack of professional training. Results highlight the importance of integrating emotional support with practical functionality in the design of such devices, aiming to empower the 'unseen' users during emergencies. Drawing on human-centred design principles, we propose an inclusive design guideline for home-use emergency care devices that focuses on emotional support and intuitive design for non-expert users, enhancing their performance and overall experience in such high-stress situations.

2 HUMAN-CENTRED EMERGENCY CARE DEVICE DESIGN

Design can drive societal change and promote equity by challenging conventional norms through integrative approaches, utilising diverse perspectives to foster thoughtful design that enhances inclusion [4]. Human-centred design (HCD) is a methodology focused on developing interactive systems that prioritise the user's needs by leveraging human factors (e.g., attention, emotions, memory, and physical capabilities) and usability principles to enhance the human experience. The stakeholders of such interactive systems are individuals or organisations invested in the system's ability to meet their needs and expectations [5]. Particularly in the design of home-use emergency care devices, the patient is often highlighted as the primary stakeholder. Applying HCD principles, we acknowledge the significant role emergency care devices play for both patients and rescuers, especially non-expert rescuers. As shown in Figure 1, we also identify the non-expert rescuers as another crucial yet often overlooked stakeholder, stressing the importance of considering their experience and challenges in the design of emergency care devices.

Figure 1. Human-centred emergency care device design for OHCA incidents

Specifically, in the context of OHCA incidents, non-experts may experience overwhelming stress, fear, and confusion, which can impede their ability to effectively use emergency care devices. This issue is particularly pronounced in home settings, where the rescuers are often the patient's family members or caregivers. The emotional bonds in these situations can further complicate the social dynamics involved. This study seeks to explore the experiences and challenges faced by non-expert rescuers in home OHCA incidents, with the goal of guiding the design of more inclusive emergency care devices and systems.

3 CHALLENGES FOR NON-EXPERT RESCUERS

This section discusses the skill-related and emotion-related challenges caregivers of patients might encounter during OHCA incidents in home settings, where CPR execution by non-expert rescuers is required. Considering this group of 'unseen' users highlights the necessity of human-centred design for emergency care devices.

3.1 Skill-related challenges

In OHCA incidents, it is recommended that non-expert rescuers perform the early stages of "The Chain of Survival", which includes calling for professional rescue, performing high-quality CPR promptly, and rapid defibrillation [6]. Among these stages, high-quality CPR is identified as the crucial early rescue operation that poses a skill-related challenge to non-expert rescuers. Studies suggest that high-quality CPR necessitates rescuers perform continuous chest compressions, maintain a stable chest compression rate with correct hand placement, achieve appropriate depth for chest compressions, and require minimal training [7]. For non-expert rescuers to perform high-quality CPR, the skill barrier could include lack of formal training, skill retention, common mistakes in operation, and the discrepancy between training and real emergency incidents. For example, common mistakes in CPR execution include failing to maintain an open airway for the patient and improper responses to the patient's physical feedback. Research also suggests that CPR skills can deteriorate within 3-6 months without ongoing practice or review [8]. Compared to training, real-life emergencies often present more complex challenges than those simulated during training. These include overlooking or misinterpreting physical signs from the patient, experiencing differences in the tactile sensation of performing compressions on a human versus a manikin and facing added environmental distractions. Identifying specific conditions, such as agonal gasps or assessing the patient's condition based on skin colour and breathing, can be particularly challenging in stressful and complex situations [9].

Several factors contribute to the skill-related barriers: the cost of CPR training can be prohibitive; training opportunities may be limited in certain communities; and some caregivers may feel physically incapable of performing CPR or may not prioritise CPR training due to perceived irrelevance [10].

3.2 Emotion-related challenges

Besides CPR skills training, research also indicates that non-expert rescuers require psychological preparation to cope with emergencies, such as envisioning possible emotional reactions during the procedure [11]. This subsection maps the user journey of non-expert rescuers to explore potential emotional-related challenges they encounter at various stages of delivering CPR to their family members, namely the indication, performance, and post-rescue stages.

- Indication Stage: Studies suggest that the fear of encountering a collapsed person, a lack of confidence in rescue skills, and apprehension about causing further injury to the patient are identified as potential emotional challenges at this stage. These factors contribute to the reluctance of non-expert rescuers to perform CPR in domestic OHCA incidents [12]. Without prior rescue experience, non-expert rescuers are required to process complex and unfamiliar information, leading to "cognitive paralysis" or the enactment of inappropriate actions due to their struggle to "generate new appropriate behaviours" [13]. Reactions such as "freezing", panic, and a refusal to intervene can emerge when confronted with a family patient, with these responses also likely persisting into the performance stage [14].
- Performance Stage: At this stage, emotions such as lack of confidence and fear of causing injury continue to affect non-expert rescuers, leaving them feeling aimless and helpless during the procedure. These feelings lead to conservative actions, often resulting in insufficient chest compression depth [14]. Additionally, decision-making while performing CPR on a family member can be compromised by emotional attachments and bonds, which may cloud the caregiver's objectivity and adversely affect their judgment regarding the patient's physical condition [15].
- Post-rescue Stage: Following the rescue of a domestic OHCA incident, non-expert rescuers, often family caregivers acting as first responders, may also experience post-traumatic stress disorder (PTSD). Engaging directly in CPR and confronting what appears as a chaotic and distressing situation can leave them grappling with trauma-related emotions, such as "fear and helplessness", long after the incident [16]. Non-expert rescuers might also think they could have significantly helped the patient but failed to achieve the desired outcome or performed inadequately during the rescue. In that case, they may be plagued by "shame, guilt, or embarrassment" [17].

4 METHOD

We conducted semi-structured interviews with both medical professionals and caregivers for senior patients to further understand the emotional and skill-related challenges faced by non-expert rescuers when performing CPR during domestic OHCA incidents. Three professionals were interviewed to gain insights into these challenges, especially those related to skills. Professional participants (P1-P3) are seasoned professionals with more than 20 years of experience in medicine and have also served as CPR training instructors. Four non-expert caregivers (NP1-NP4) of senior patients in domestic settings were interviewed to examine their perceptions of performing CPR on their family members. NP1 and NP3 have phased caregiving experience, whereas NP2 and NP4 possess intensive caregiving experience.

5 INTERVIEW RESULTS AND DISCUSSION

Interview results from both professionals and caregivers reveal a range of practical and emotional challenges that non-expert rescuers may encounter during early cardiac arrest rescue. This section summarises these key challenges, framing them as user needs that must be addressed in the design of domestic emergency care devices. Following this, the discussion turns to design recommendations for human-centred emergency care devices, based on these identified user needs.

5.1 Challenges in performing high-quality CPR by non-expert

Professionals highlighted several key points to enhance the quality of early cardiac arrest rescue for non-expert rescuers: quickly and accurately identifying cardiac arrest, immediately calling for professional assistance and enlisting the help of others nearby for co-rescue, relocating patients to an appropriate rescue environment, clearing the trachea, searching for AEDs if possible, and performing high-quality CPR in time. Professionals also suggested two main skill-related challenges for non-experts performing high-quality CPR: physical strain and technical errors. To be specific, CPR is a physically demanding task that, without proper technique (e.g., using body weight to assist compression), may not be manageable for one non-expert alone to sustain over the necessary duration (approximately 6 minutes)

before professional help arrives. Non-experts may also be unable to recognise the decline in the quality of their CPR performance due to fatigue, underscoring the importance of real-time monitoring and co-rescue in OHCA incidents. Furthermore, high-quality CPR execution requires professional techniques such as specific hand placement, compression depth and rate. Professionals (P2, P3) noted that while "these skills can be quickly learned," it is not recommended for completely untrained individuals to attempt CPR alone. Moreover, professionals advised against non-experts considering the physiological factors of the patient (e.g., body composition) during compressions. According to professionals, effective CPR typically results in clear physical feedback from the patient, suggesting the importance of focusing on the technique rather than outer factors.

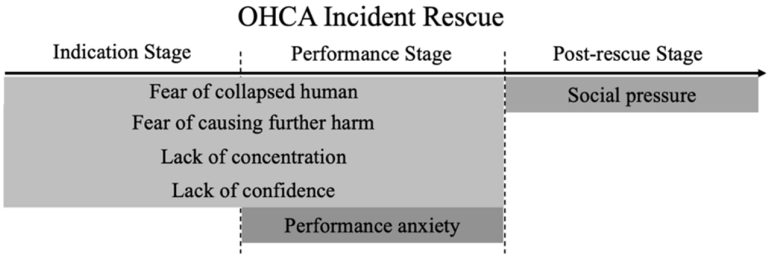

Figure 2. Emotional challenges faced by non-expert rescuers - reported by professionals

As summarised in Figure 2, professionals suggest that potential emotional challenges for non-experts in performing effective early rescue include a primal fear of interacting with and approaching the patient, loss of concentration due to anxiety, lack of confidence in CPR skills and knowledge, apprehension about causing further harm, and fear of facing criticism from the patient's relatives and friends. These factors can lead to an ineffective and overly cautious approach to the patient.

5.2 Results from non-expert participants

Despite having a basic understanding of cardiac arrest, non-expert caregiver participants are alarmingly unprepared for OHCA incidents occurring in domestic settings, highlighting the importance of preparation for such events. Essential preparations for non-expert caregivers include knowing the locations of nearby AEDs, understanding how to summon professional rescue, and being aware of the estimated time until their arrival.

From a skill-related perspective, non-expert caregivers' knowledge of CPR and early rescue primarily derives from less formal platforms, such as television programs and social media video clips. The skills that non-expert caregiver participants claimed they had or would have difficulty mastering include identifying cardiac arrest, evaluating whether patients have other injuries, determining the correct hand placement for compressions, and managing the force and frequency of compressions.

Non-expert caregivers also acknowledged the emotional challenges they would face when dealing with OHCA incidents involving their family members. They were asked to imagine the cardiac arrest of the family member they were caring for and then discuss their concerns and emotions surrounding the entire process of such events.

At the indication stage, non-expert participants described feelings of anxiety and terror, which could affect their early rescue responses and subsequent performance. Participants explained that their concerns leading to such feelings include a lack of confidence in their rescue skills. Another factor affecting their responses at this stage is their reaction to emergencies, as NP1 commented, "In such a situation, it may become impossible for me to respond." Non-expert caregivers described their reactions to emergencies as "trembling" (NP1), "crying" (NP2), and "mentally blank" (NP4). Echoing professionals' comments, fear of the collapsed family member and the potential for causing further harm could impact non-expert rescuers' responses at this stage. As some participants remarked, "He is family, and I am afraid it would cause more damage" (NP1) and "I have only performed (CPR) on mannequins…for a real person, I would be scared" (NP2).

Non-expert caregivers suggest that fear and lack of confidence would persist into the rescue performance stage. Alongside the fear of causing further harm to the patient, they anticipated experiencing performance anxiety and self-doubt during CPR execution. For example, NP2 said, "And then every time I press... if you don't press properly…his (the patient's) ribs are easily crushed, aren't they?" Non-expert participants also stated that such negative emotions during the operation could intensify if they did not receive positive validation or feedback.

Participants indicated that they would experience traumatic stress if the rescue outcome was unfavourable. They would tend to blame their own performance, believing they could have done a better job during the rescue. This could result in self-doubt and self-condemning emotions such as regret and guilt. As NP4 expressed, “If I had studied CPR a little more correctly, I might have been able to save him... I may blame myself.” Participants also mentioned that they could face criticism from other family members if they were involved in the early rescue and the outcome was not ideal. In such a situation, some participants thought they would face the criticism and accept it; others said they would need professional support.

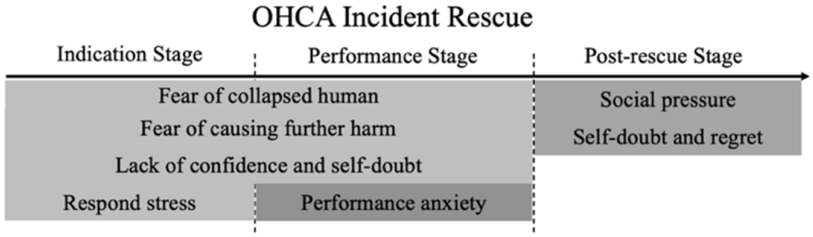

Figure 3. Self-reported emotional challenges faced by non-expert rescuers

In summary, self-reported emotional challenges from the non-expert rescuers in domestic OHCA incidents align with those reported by the professional participants, with a few nuanced emotions shown in Figure 3. These challenges could significantly affect the non-expert rescuers’ experience, performance, and mental wellbeing during as well as after the incidents. Hence, the design of domestic emergency care devices should consider supporting them accordingly.

5.3 Discussion: Human-centred design recommendations

At the indication stage, primary emotional barriers for non-expert rescuers in OHCA incidents include fear, lack of confidence, and stress due to information overload, leading to suboptimal responses. Adopting human-centred design approaches, such as creating personalised emergency plans that consider the patient's condition and information on rescue services and facilities, can enhance rescuers' confidence, and reduce stress by minimising the need for additional information processing during emergencies. Furthermore, providing clear guidance and support and opportunities for mental rehearsal and practical exercises can improve non-expert rescuers' emotional and practical readiness.

Throughout the performance stage, non-expert rescuers contend with obstacles, including apprehension, self-doubt, and the challenge of focusing during physically intensive rescues. Regular reviews of skills can elevate their confidence and ensure skill mastery. Alongside encouragement and clear instructions on actions, real-time feedback on the patient's condition or rescuer actions allows for quick adjustment of techniques, thus avoiding undue distraction by patient monitoring. Collaborative CPR is also recommended to mitigate this strain. Using technological aids that promote team rescue efforts and provide positive reinforcement for proper CPR techniques can reduce self-doubt and lessen emotional repercussions during the rescue.

After the rescue, mitigating self-regret or external criticism can be achieved by providing validation and emotional support. In other words, offering comprehensive reviews and recognition of the rescuer's efforts in the design of emergency care devices plays a critical role, reinforcing the importance of their contributions and confirming the efficacy of their actions.

6 CONCLUSIONS

This study harnesses human-centred design principles to cater to the overlooked emotional demands of non-expert rescuers in situations of out-of-hospital cardiac arrest (OHCA), specifically targeting caregivers of senior patients in domestic cardiac arrest contexts. By breaking down the rescue endeavour into three stages—identification, performance, and post-rescue—this research highlights significant barriers related to skills and emotions. In response to these challenges, it introduces targeted human-centred design interventions: personalised rescue plan, combined emotional and skill rehearsals, unambiguous guidance coupled with encouragement, instantaneous feedback during CPR procedures, and post-rescue emotional reinforcement along with validation of performance. Future works will focus on implementing and evaluating the design strategies through the design and testing of a home-based CPR assistance device.

REFERENCES

[1] Tagami T., Tanaka H., Shin S. D., Ma M. H., Ko P. C., Karim S., Khruekarnchana P., Naroo G. Y. and Ong M. E. H. Impact of population aging on the presentation of out-of-hospital cardiac arrest in the pan asian resuscitation outcomes study. *Acute Medicine & Surgery*, 2020, 7(1).

[2] Vaillancourt C., Kasaboski A., Charette M., Islam R., Osmond M., Wells G. A., Stiell I. G., Brehaut J. C. and Grimshaw J. M. Barriers and facilitators to CPR training and performing CPR in an older population most likely to witness cardiac arrest: A national survey. *Resuscitation*, 2013, 84(12), pp.1747-1752.

[3] Fagerström C., Elmståhl S. and Wranker L. S. Analysing the situation of older family caregivers with a focus on health-related quality of life and pain: A cross-sectional cohort study. *Health and Quality of Life Outcomes*, 2020.18(1), pp.79-79.

[4] Bieling T. Design and Inclusion: An Approach to Aspects of Integrative Design in *Integrative Design: Essays and Projects on Design Research* edited by Ralf Michel, 2021, pp.97-112.

[5] BS EN ISO 9241-210:2019 *Ergonomics of human-system interaction. Human-centred design for interactive systems*, 2019 (BSI Standards Limited).

[6] American Heart Association. *Out-of-Hospital Chain of Survival*. Available: *https://Cpr.Heart.Org/En/Resources/Cpr-Facts-and-Stats/out-of-Hospital-Chain-of-Survival* [Accessed on 2024, 31 January], (2024) 31 January.

[7] Meaney P. A., Bobrow B. J., Mancini M. E., Christenson J., de Caen A. R., Bhanji F., Abella B. S., Kleinman M. E., Edelson D. P., Berg R. A., Aufderheide T. P., Menon V., Leary M. and Cardiopulmonary resuscitation quality: [corrected] improving cardiac resuscitation outcomes both inside and outside the hospital: a consensus statement from the American Heart Association. *Circulation*, 2013, 128(4), 417.

[8] Riggs M., Franklin R. and Saylany L. Associations between cardiopulmonary resuscitation (CPR) knowledge, self-efficacy, training history and willingness to perform CPR and CPR psychomotor skills: A systematic review. *Resuscitation*, 2019, 138, 259-272.

[9] Chen H. H., Chiang W. C., Hsieh M. J., Lee C. H., Yuan Z. F., Lin H. Y., Chew L. F., Huang E. P., Yang C. W., Liao S. C., Lin C. W., Lee M. N. and Ma M. H. (2020). Experiences and Psychological Influences in Lay Rescuers Performing Bystander Cardiopulmonary Resuscitation: A Qualitative Study. *Journal of acute medicine*, *10*(4), 138–148.

[10] Sasson C., Haukoos J. S., Bond C., Rabe M., Colbert S. H., King R., Sayre M. and Heisler M. (2013). Barriers and facilitators to learning and performing cardiopulmonary resuscitation in neighbourhoods with low bystander cardiopulmonary resuscitation prevalence and high rates of cardiac arrest in columbus, OH. *Circulation Cardiovascular Quality and Outcomes*, 6(5), 550.

[11] Shida H., Nishiyama C., Okabayashi S., Yamamoto Y., Shimamoto T., Kawamura T., Sakamoto T. and Iwami T. Laypersons' psychological barriers against rescue actions in emergency situations - A questionnaire survey. *Circulation Journal: Official Journal of the Japanese Circulation Society*, 2022, 86(4), 679.

[12] Beit-Hallahmi B. Fear of the dead, fear of death: is it biological or psychological?. *Mortality*, 2012, pp.322-337.

[13] Robinson S. J. (2012). *When Disaster Strikes: Human Behaviour in Emergency Situations*, 2012.

[14] Case R., Cartledge S., Siedenburg J., Smith K., Straney L., Barger B., Finn J. and Bray J. E. Identifying barriers to the provision of bystander cardiopulmonary resuscitation (CPR) in high-risk regions: A qualitative review of emergency calls. *Resuscitation*, 2018, 129, pp.43-47.

[15] Jones J. W., McCullough L. B. and Richman B. W. The ethics of operating on a family member. *Journal of Vascular Surgery*, 2005, 42(5), pp.1033-1035.

[16] Compton S., Grace H., Madgy A. and Swor R. A. Post-Traumatic stress disorder symptomology associated with witnessing unsuccessful Out-of-hospital cardiopulmonary resuscitation. *Academic Emergency Medicine*, 2009, 16(3), pp.226-229.

[17] Jiménez-Herrera M. F., Llauradó-Serra M., Acebedo-Urdiales S., Bazo-Hernández L., Font-Jiménez I. and Axelsson C. Emotions and feelings in critical and emergency caring situations: A qualitative study. *BMC Nursing*, 2020, 19(1), pp.60-60.