Design and rationale of the Engage-HF study: the impact of a gamified engagement toolkit on participation and engagement in a heart failure registry

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Aims	Heart failure (HF) registries provide valuable insights into patient management and quality of care. However, healthcare professionals face challenges due to the administrative burden of participation in registries. This study aims to evaluate the impact of education through an engagement toolkit on HF nurse practitioners' participation rate and data completeness in a national registry: the Netherlands Heart Registration-Heart Failure (NHR-HF) registry.
Methods and results	Engage-HF is an observational study (intervention at the HF nurse level) with a pretest–posttest design within the participating hospitals. Between December 2022 and April 2024, 28 HF nurse practitioners from 12 hospitals will participate in a 24-week educational programme using the Engage-HF engagement toolkit. The main interaction platform in this toolkit is a gamified smartphone-based educational application called BrightBirds. The complete toolkit includes this educational application with weekly challenges, interactive posters, pop-ups, and alert messages, and a follow-up call at Week 4. The primary endpoints are the NHR-HF participation rates and data completeness at 1 and 6 months after using the toolkit. Additionally, we will analyse the experience of participants with the toolkit concerning their HF registry and knowledge of ESC 2021 HF guidelines.

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Conclusion   The Engage-HF study is the first to explore the impact of education through a gamified engagement toolkit to boost participation rates in a HF registry (NHR-HF) and test participant knowledge of the ESC 2021 HF guidelines. This innovative approach addresses challenges in the rollout of healthcare registries and the implementation of guidelines by providing a contemporary support base and a time-efficient method for education.

Graphical Abstract
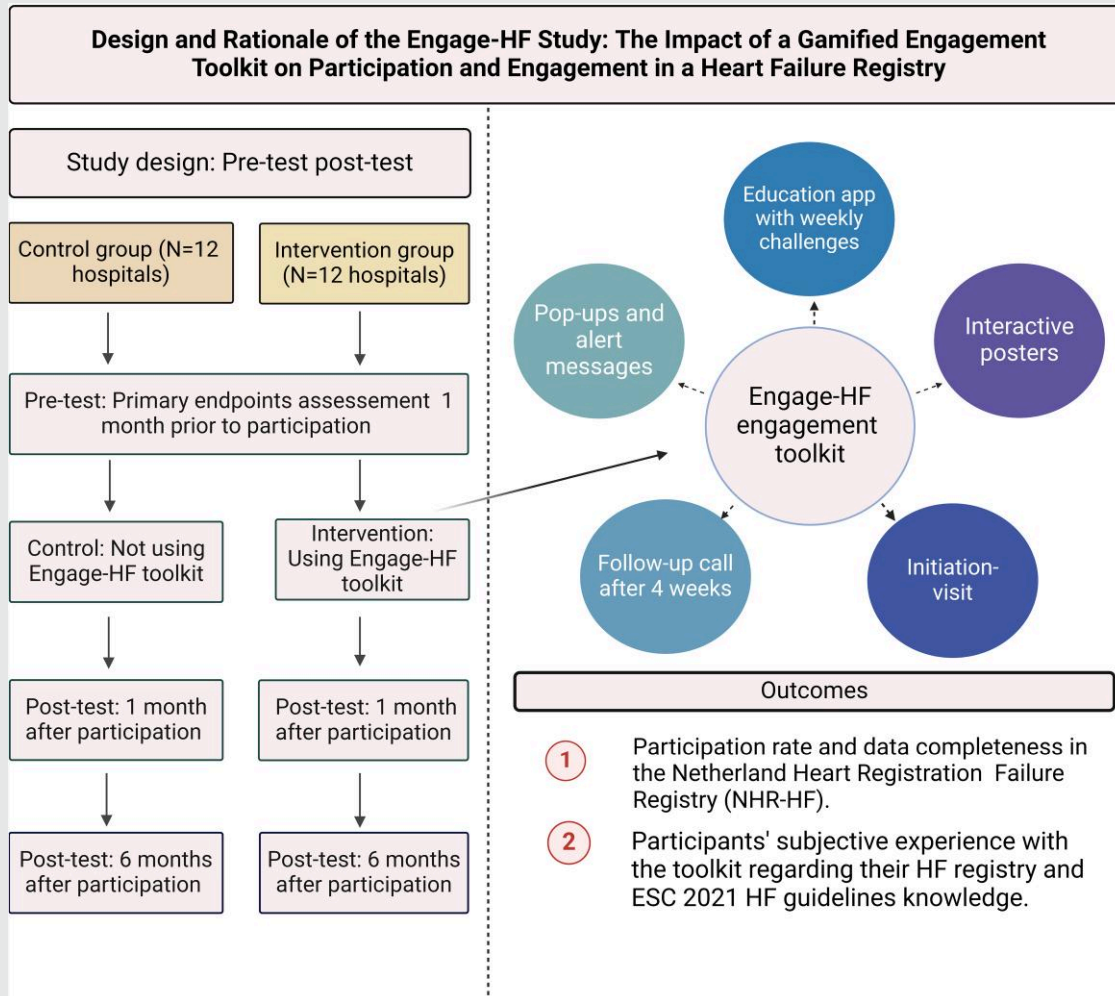
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Introduction

Heart failure (HF) is a life-threatening disease associated with a dismal prognosis and high impact on healthcare utilization. Guideline-directed medical therapies that have demonstrated and validated clinical benefits in randomized controlled trials (RCTs) form the cornerstone of HF management. However, the applicability of RCT-based evidence in the real world is challenging due to the strict eligibility criteria of RCTs.[1,2] Real-world data from registries such as the Netherlands Heart Registration-Heart Failure (NHR-HF) registry address this challenge by providing insights into the clinical characteristics, course of disease, quality of care, and real-world clinical outcomes of patients with HF.[2,3] Moreover, these registries play an important role in identifying and addressing potential barriers to guideline implementation, ultimately playing an important role in mitigating the poor prognosis of HF.[4,5]

A major challenge hindering effectiveness and participation in these registries is the significant administrative burden that healthcare professionals often face during the enrolment and data collection process.[6] To address this, it is essential to foster intrinsic motivation and engagement among healthcare professionals. This can be promoted by providing a firm support base for participation in quality-of-care registries for

specific diseases by increasing awareness and knowledge of the additive value of disease-specific registries. In this context, innovative approaches such as gamification hold substantial potential. Gamification is an umbrella term referring to the use of game design elements such as challenges and rewards (e.g. points or badges) in contexts other than gaming (e.g. education).[7–9] With the rapid increase in available medical knowledge and the ever-increasing demand for healthcare professionals, a gamified learning environment should provide attractive and efficient education. However, despite its practicality and increasing use in various settings, including healthcare, the benefits of gamification in HF, especially in the context of HF registry participation, remain unexplored.[10–14] The current project aims to bridge this knowledge gap by exploring the impact of education delivered through a gamified engagement toolkit on the participation rate and completeness of data in the NHR-HF registry. Additionally, it will assess the participants' subjective experience with this toolkit concerning their understanding of HF registries and new HF guidelines.

Methods

Study design and population

Engage-HF is an observational study (intervention at the HF nurse level) with a pretest–posttest design aimed at healthcare professionals (not patients) in both academic and non-academic hospitals (*Figure 1*). Active participants (using the Engage-HF toolkit) are required to have access to a mobile device to install the Engage-HF app. Participation started in the last quarter of 2022 and will continue through the first quarter of 2024. Successful engagement toolkit participation is defined as completing at least 80% of all challenges. During the installation of the education app, participants are required to accept the associated terms and conditions of use.
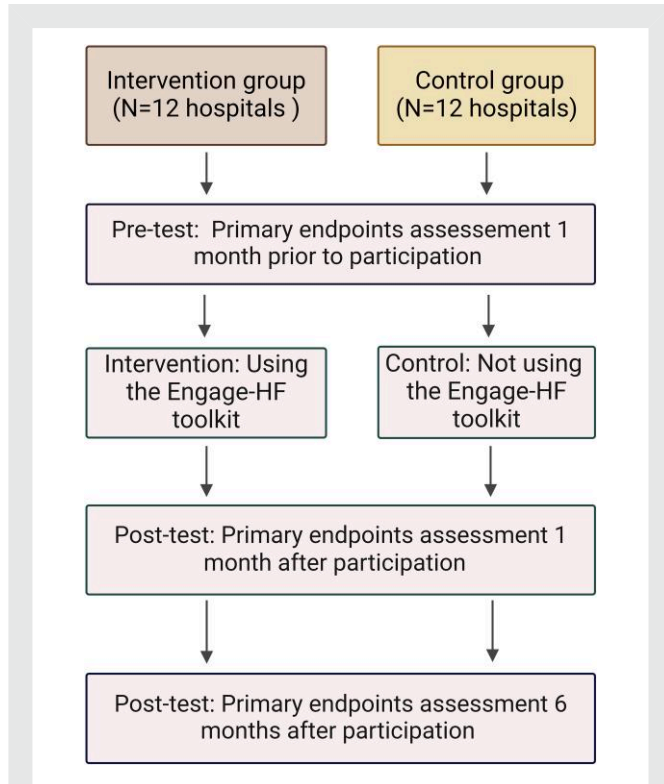

Figure 1 A pretest–posttest design of the Engage-HF study (created with BioRender.com) for both the intervention and the control groups. HF, heart failure.

Informed consent is not needed since personal data or patient-specific data are not used in the study.

A total of 24 hospitals will participate in this study, with 12 hospitals actively using the Engage-HF engagement toolkit and 12 (control group) not using it. The 12 actively participating hospitals will be divided into three cycles, each consisting of four hospitals. Each actively participating hospital will have one or more participating users (HF nurse practitioners). Each hospital will utilize the Engage-HF engagement toolkit for a total of 24 weeks (6 months). It is important to note that we have opted to start the three cycles using the engagement toolkit sequentially on different dates due to logistical reasons. The 24-week study intervention period will consist of alternating on- and off-phases. During the on-phase, participants will actively receive challenges and add data to the NHR-HF registry. Conversely, during the off-phase, participants will not receive challenges but will continue to add data to the registry. There will be three on-phases (Weeks 1–5, Week 8, and Week 24) and two off-phases (Weeks 6–7 and 9–23) during the 24-week active participation in this study (*Figure 2*). The study has successfully completed the data protection impact assessment cycle and it has been approved by the ethical committee of the Erasmus University Medical Center of Rotterdam (MEC 2021-0875).

Objectives and endpoints

The primary objective of the Engage-HF study is to increase awareness and knowledge of the additive value of the NHR-HF registry. Therefore, this study's primary objective is to evaluate the impact of the Engage-HF engagement toolkit on participation rates and data completeness in the NHR-HF registry. The secondary objective is to assess the impact of the Engage-HF engagement toolkit on the subjective experience of HF nurse practitioners regarding their HF registry knowledge. The third objective is to improve their knowledge of the ESC 2021 HF guidelines through gamification.

The primary endpoints of the study are the rate of participation in the NHR-HF registry and the completeness of data 1 and 6 months after participants have completed the Engage-HF engagement toolkit. Other exploratory endpoints include the experience of the participants with the engagement tool concerning its impact on their knowledge of the NHR-HF registry, the additive value of HF registries, and the 2021 ESC-HF guidelines (*Graphical Abstract*).

Data collection and study time frame

The proposed time frame for data collection is illustrated in *Figure 3*. The participation rates will be measured by examining the number of registrations in the NHR-HF registry within a specific time window. The data completeness will be assessed through the ratio of registered essential variables to the total missing variables for each hospital (as % percentages). The participation rate and data completeness variables will be analysed at three specific time intervals: 1 month prior, 1 month, and 6 months after the completion of the Engage-HF toolkit. Data concerning the rate of registrations and data completeness in the NHR-HF registry during these time intervals will be directly collected from the registry. The primary and secondary endpoint findings in the active participation group will be validated in a within hospital pre- and posttest comparison, as well as a comparison with a non-active control group of hospitals that participated in the NHR-HF registry but not the engagement tool (*Figure 2*). Furthermore, the experience of participants regarding the role of the Engage-HF engagement toolkit in improving their knowledge of HF registries, the 2021 ESC HF guidelines, and the toolkit itself will be assessed through a survey performed after the closure of the study period.

The Engage-HF engagement toolkit

Figure 4 presents an overview of the complete Engage-HF gamified engagement toolkit, which has been designed in a collaborative effort between AstraZeneca, Edumundo B.V., and WCN/Dutch CardioVascular Alliance, under the supervision of the Heart4Data consortium. The platform for the toolkit (BrightBirds app) is provided by Edumundo, a company with a strong footprint in secondary and higher education and private companies. The complete toolkit includes a smartphone-based education app (BrightBirds), through which participants will receive challenges, interactive posters, pop-ups and alert messages, an initiation meeting, and a follow-up call at Week 4.
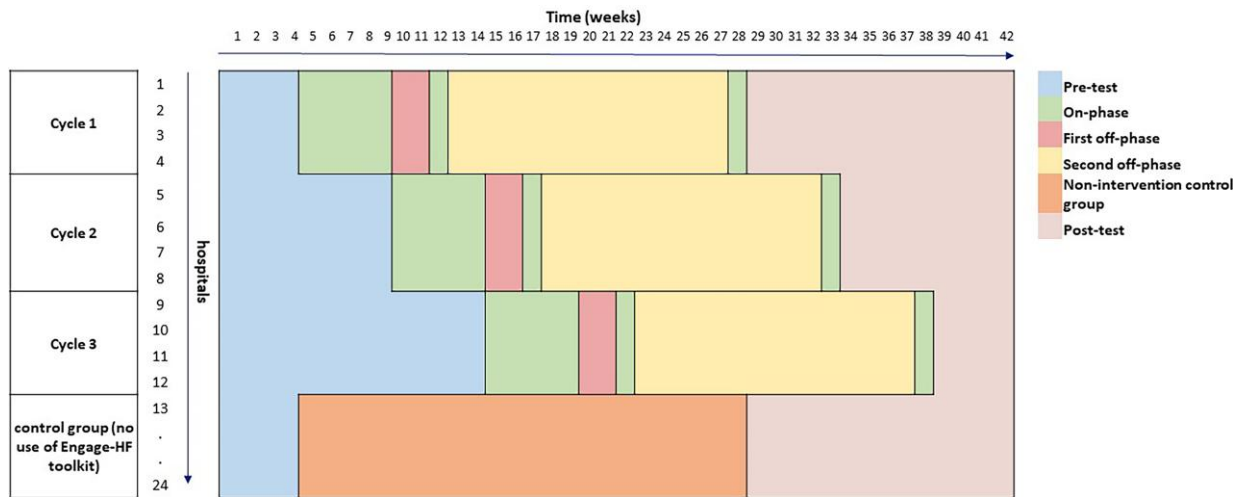
Figure 2 An overview of the sequentially started pretest–posttest design for the three cycles, showing a detailed timeline of the Engage-HF study for each cycle. The entire Engage-HF education programme consisted of different on- and off-phases. In the on-phase, participants actively used the Engage-HF toolkit, whereas in the off-phase, the toolkit was not used. Each phase consists of a specific time frame. The control group consists of the Netherlands Heart Registration-Heart Failure participating hospitals that did not use the Engage-HF toolkit.
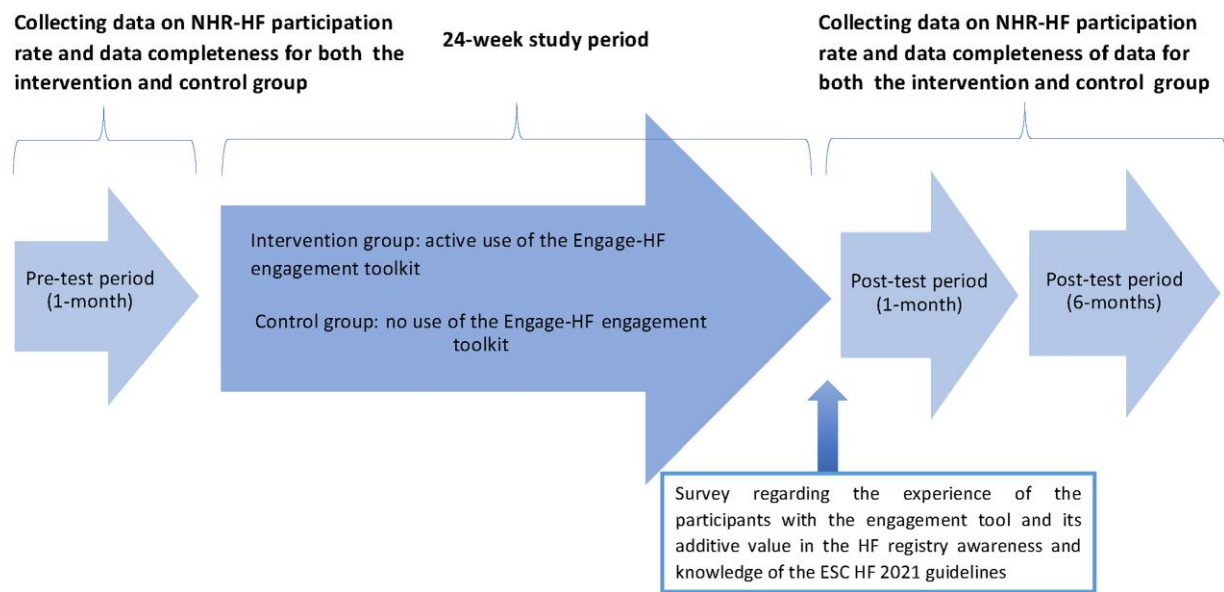

Figure 3 An overview of the time flow for the Engage-HF study. This figure illustrates the data collection timeline. Data collection will be done in three specific intervals: 1 month prior to the intervention, 1 month, and 6 months post-completion of the Engage-HF education programme. HF, heart failure; NHR-HF, Netherlands Heart Registration-Heart Failure registry; ESC-HF, European Society of Cardiology-Heart Failure.

The challenges in the Engage-HF engagement toolkit are designed to focus on two main topics:

(1) Encouraging proactive participation in HF registries
(2) Improving participant knowledge of the current HF guidelines

In the first 2 weeks, the challenges will focus on stimulating proactive participation in HF registries by enhancing participants' knowledge of the NHR-HF registry and its additive value. From the third week onwards,

the focus of the challenges will shift to both stimulating proactive participation and testing and improving participants' knowledge of the current HF guidelines. Following the initial 5-week intensive engagement with the Engage-HF toolkit, participants will receive refresh challenges at the 8 and 24 weeks to further motivate HF registry participation and improve their HF guideline knowledge (*Figure 5*).

The educational component, aimed at enhancing the knowledge and expertise of nurse practitioners on the 2021 ESC guidelines for HF, has been

built around a fictional patient who is the main character throughout the entire toolkit. This patient will be introduced during the first week of the education app and on the poster, providing the basis for the subsequent HF guideline challenges. Every new week, participants will be provided with more background information on this patient and his journey towards full recovery in the fifth week (*Figure 6*). Over the course of 24 weeks, participants will progress through the engagement toolkit via game-based challenges.

Interaction with the engagement toolkit will be further stimulated by the site initiation visit, a follow-up call at Week 4, pop-up messages, and poster-specific challenges. These interactive posters will provide essential background information required to complete certain challenges. The poster challenges can be completed by scanning a QR code. Moreover, the poster will serve as an additional tool to create awareness among other members of the cardiology department who did not participate in this study. Participants will be familiarized with the engagement toolkit, objectives, and timeline of this study during an initiation meeting conducted either on-site or online. Once participants agree to participate and the education app is successfully installed, the engagement programme will start, and participants will receive challenges according to a predefined weekly schedule. In addition to these challenges, participants will receive pop-ups or general messages informing them about the timeline of upcoming challenges, convey a message of gratitude, or provide additional in-depth information about the learning points of a specific challenge. Lastly, participants will receive a follow-up call at Week 4, focusing on their experience and any remaining questions they might have (*Figure 4*).

Game design elements of the Engage-HF engagement toolkit

Gamification, on a fundamental level, uses different game design elements to elicit behaviour change, engage, and motivate participants. The specific game design elements used in the Engage-HF engagement toolkits are challenges, leaderboard, quizzes, immediate feedback, a narrative storyline, competition, and rewards (e.g. points, badges, and real-world prizes). These game design elements are integrated into the BrightBirds education app.

Participants who actively use the Engage-HF engagement toolkit will receive weekly challenges on the BrightBirds education app. Some of these challenges include quizzes, poll questions, or interactive posters. Participants will receive rewards in the form of coins and badges upon successful completion or correctly answering the challenges. Furthermore, they will receive immediate feedback after completing their challenges. The maximum number of coins that can be earned will be based on the difficulty of the challenges and the time required to complete them. In addition to coins, participants will have the opportunity to earn badges by completing certain challenges. The types of badges will depend on the type of challenge: ENGAGE, HF, and a FACT-CHECKER badge. ENGAGE badges will be awarded solely for registration-based challenges, HF badges for patient-case-related challenges, and FACT-CHECKER badges for reading Engage-HF facts. Some challenges will combine three topics, providing the possibility of earning two or three badges in one single challenge.

The Engage-HF toolkit will stimulate competition through the use of a leaderboard that displays the top three contenders of each cycle based on the maximum number of coins earned. The competition will take place on three levels: across participating hospitals within each cycle, individual participants of the same hospital, and participants across the different cycles. This cross-cycles competition will be further incentivized by the possibility of winning individual real-world prizes awarded to the three participants with the highest scores in terms of collected coins among all participants in the study.

Statistical analysis plan

Categorical variables will be presented as frequencies, percentages, and compared with the use of Pearson's χ^2 test or Fisher's exact test, as appropriate. For continuous variables, means will be presented with standard deviation ($\pm$SD) in case of a normal distribution or medians with interquartile ranges in case of a skewed distribution. The comparison will be conducted using Student's t-test or analysis of variance (ANOVA). Normality of the distributions will be assessed using the Shapiro–Wilk test. The primary endpoints will be analysed using a two-way mixed model ANOVA with one between-group factor (Engage-HF toolkit use vs. control) and one within-group factor (pre-/posttest primary endpoint). If the data are not normally distributed, the Friedman test, which is a non-parametric test, will be applied to analyse the primary endpoint. All statistical analyses will be performed by using Statistical Package for Social Sciences (SPSS, Chicago, IL, USA) software version 25.0.
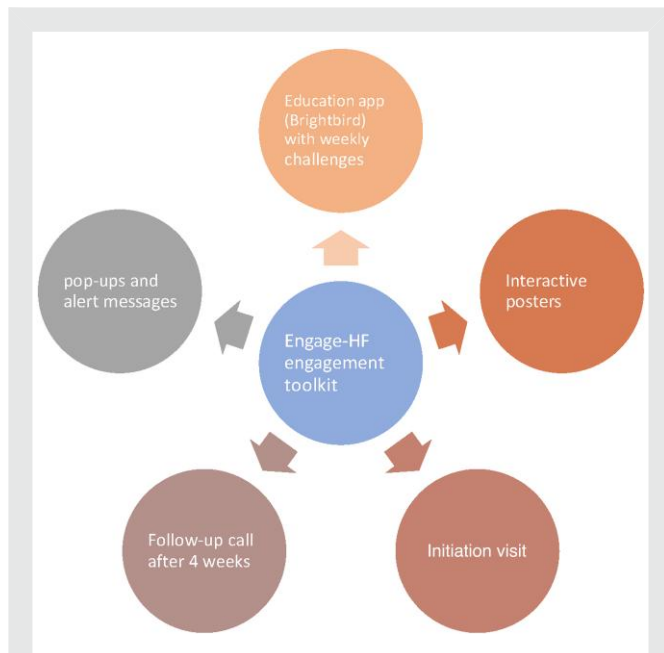

Figure 4 The entire Engage-HF engagement toolkit comprises the BrightBirds education app through which participants receive weekly challenges, an initiation visit, a follow-up phone call at Week 4, the use of interactive posters, and pop-ups or alert messages. HF, heart failure.
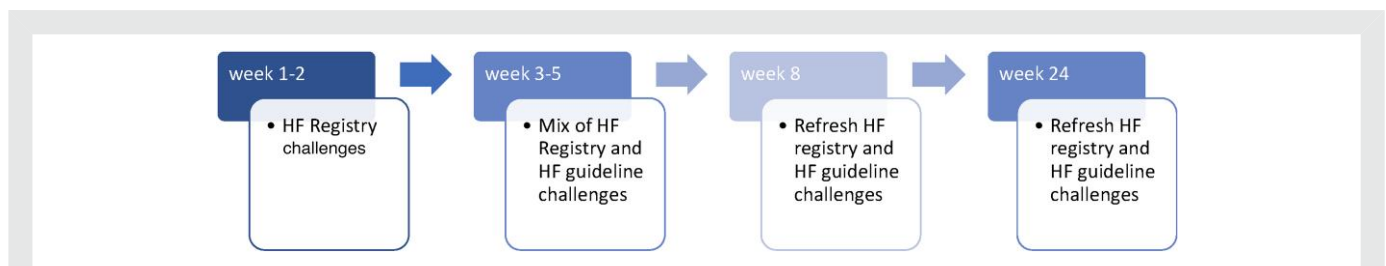

Figure 5 An overview of the focus of the challenges throughout the 24-week active participation in the Engage-HF study. This period consists of an initial intensive 5-week period, followed by refresh challenges at Weeks 8 and 24. HF, heart failure.

Figure 6 A poster introducing fictive patients for the first week, upon whom the challenges concerning the ESC-HF 2021 guideline questions were based. NHR-HF, Netherlands Heart Registration-Heart Failure.

Discussion

Registries provide valuable real-world insights into disease management, quality of care, and clinical trajectories. However, active participation is often hampered by the administrative burden associated with data collection. Gamification is emerging as a promising tool to motivate and engage participants in the healthcare setting.[15,16] The Engage-HF study aims to evaluate the impact of education through a gamified engagement toolkit on healthcare professionals' participation rates and the completeness of data in a quality-of-care HF registry like NHR-HF.

To the best of our knowledge, this is the first study to assess the impact of education through a gamified engagement toolkit in such a context. Successful implementation of gamification toolkits in a broader perspective could greatly enhance participation in prospective HF registries, promote and enhance evidence-based practice, and ultimately improve HF outcomes. While gamification has well-established associations with improved

outcomes in domains such as business, marketing, and e-learning, its effectiveness in the healthcare setting is still being explored. There is a growing body of evidence supporting its use in both patient and healthcare education, as well as mitigating the poor prognosis of chronic diseases. The latter refers to the positive effect of gamification on self-care, disease-specific risk factors, adoption of a healthier lifestyle, rehabilitation, and medication adherence. The benefit of gamification in health professional education is highlighted by a recent published systematic review of 44 studies. Among these studies, none reported negative outcomes related to the theoretical knowledge and practical skills training of healthcare professionals (medical students, residents, and specialists).[9] Furthermore, some findings indicate that gamification not only improves general medical knowledge but also improves the understanding and implementation of disease-specific guidelines. For example, a study by McKeown et al. demonstrated that incorporating a localized sepsis protocol based on the British Columbia Sepsis algorithm through gamification led to a significant improvement in sepsis outcomes and lactate measurement during the study period compared with prior periods (6.4 vs. 21.1% and 5.5 vs. 16.0%).[8] Similar positive findings were observed in a randomized trial, which found that the use of a gamification tool (QualityIQ) resulted in a significant improvement in evidence-based care decisions among primary-care physicians for chronic diseases such as diabetes (+8.3%, $P < 0.001$) and osteoarthritis (+7.6%, $P = 0.003$).[17] These studies highlight the positive effect of applying gamification within the healthcare education context.

Gamification tools have also demonstrated positive effects in other areas such as rehabilitation of chronic diseases, secondary risk reduction, patient self-management, and medication adherence.[16,18–22] Dithmer et al. reported that gamification as part of a telerehabilitation programme for patients with cardiovascular disease was a promising new concept to motivate patients in their rehabilitation process. This study used a prototype game consisting of a series of daily challenges given to patients and relatives. At the end of the study, patients reported that the application was a useful tool in their telerehabilitation process.[22]

Although the above-mentioned studies demonstrate the benefits of gamification in the healthcare setting, its impact on participation rates and the completeness of data in a disease-specific registry remains unclear. Nevertheless, there are some indications that gamification might also have a positive effect in this context. A study by Lane et al. found that gamification could increase the participation and effectiveness of clinical trial start-up activities by making repetitive and uninteresting tasks fun and enjoyable.[23] The extent to which these positive effects extend beyond clinical trials to disease-specific registries is, as mentioned, yet to be explored. The Engage-HF study will be the first to investigate the impact of gamification on the participation of HF nurse practitioners and data completeness in disease-specific registries.

The mechanism explaining the impact of gamification on participants' motivation and engagement, and subsequent outcomes in the healthcare context, is not fully elucidated. A theoretical framework for understanding the positive effect of gamification toolkits such as the Engage-HF engagement toolkit is provided by the self-determination theory (SDT). This theory emphasizes that motivation is primarily driven by the human need to satisfy three basic psychological needs: autonomy, competence, and relatedness. Importantly, this theory recognizes the importance of the quality of motivation in maintaining the levels of motivation over a longer period of time. According to this theory, the quality of motivation lies on a spectrum, beginning with amotivation at one end, extrinsic motivation at the centre, and intrinsic motivation at the other end.[24] In line with this theory, high-quality motivation (intrinsic) is associated with more successful and sustained motivation over time, compared with extrinsic or amotivation.[12]

According to the SDT, the satisfaction of these three psychological needs is fulfilled through the use of game design elements employed in the gamification tools.[8,12] Within the Engage-HF study, these psychological needs are fulfilled as follows: first, participants were given autonomy, not only regarding the decision to participate but also regarding their level of participation in the sense that they could self-decide which challenges they wanted to complete. However, it was communicated clearly that a part of the real-world reward would be granted only after the completion of at least 80% of the challenges. Autonomy was further stimulated through the use of leaderboard and badges. Second, the challenges in the Engage-HF toolkit are designed to enhance participants' competence by focusing on proactive participation in HF registries and increasing their knowledge of the ESC 2021 HF guidelines. Competence was further reinforced through rewards (e.g. coins and badges), rankings, and immediate feedback, providing the participants with a sense of achievement. Third, the feeling of relatedness was enhanced through the use of a leaderboard, challenges, rewards, and narrative storyline.[25] In addition to satisfying these three basic needs with the Engage-HF toolkit, we decided to also satisfy the need for a sense of higher purpose like improving management and outcomes by enhancing participants' knowledge of the 2021 ESC HF guidelines. This decision was based on evidence indicating that a sense of purpose, in addition to the other three basic needs, is an important determinant of motivation.[12,26]

By acknowledging both intrinsic and extrinsic motivation, our study recognizes the multifaceted nature of motivation. We recognize that the motivation of the participants is driven by a combination of internal factors, such as enjoyment, competence, and higher purpose, as well as external factors such as rewards and feedback. A well-balanced intervention, like the Engage-HF engagement toolkit, is likely to enhance participants' motivation and engagement in a more sustainable manner and ultimately lead to long-term behavioural change.

There are several aspects of our study that highlight its merits. First, our participants consisted of nurse practitioners working in academic and non-academic hospitals. As such, the participants represent nurse practitioners across diverse employment settings, consequently enhancing the study's applicability in real-world settings. Second, our study is designed to stimulate both intrinsic and extrinsic motivation through gamification to promote desired behaviour. This approach has an important benefit, as evidence has demonstrated that a commitment-based, intrinsically motivated approach to change is more successful and sustained over time than a compliance-based one (e.g. mandated).[12,16,27] Third, we have incorporated the most frequently used game elements in the healthcare domain into the Engage-HF gamification tool. This has potentially improved the effectiveness of our engagement tool.[16] Fourth, this study included a control group (non-intervention) for the validation of our results, unlike most current studies. Finally, this is the first study to evaluate a gamification tool's role in HF registry participation and quality, as well as guideline knowledge. It fills key evidence gaps, which is essential for improving HF prognosis.

Conclusions

Heart failure registries and quality-of-care projects are essential for learning about and improving HF care. Participation is often limited due to the workload of data entry. The Engage-HF study is the first to assess whether we can increase active participation in quality-of-care registries by gamification and engagement apps/toolkits. If successful, gamification could be used more broadly in other chronic disease registries to improve the quality of care.

Lead author biography

Dr Abdul Shakoor is a PhD student in the Department of Cardiology at the Cardiovascular Institute, Thoraxcenter, Erasmus Medical Center in Rotterdam. He works under the supervision of J.J.B., J.S., and Prof. Dr. N.M.D.A. Van Mieghem. Dr Shakoor's research explores the impact of gamification on HF management.

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Data availability

No new data were generated or analysed in support of this design manuscript.

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