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Innovating Emergency Medicine: Generative AI, Narrative Medicine, and Human-Centered Design

ABSTRACT

Background: Emergency medicine in resource-limited settings faces a growing burden of disease and disability. This article presents the "Create to Innovate" (C2i) masterclass, built using Human-Centered Design Thinking (HCDDT). It explores narrative medicine through AI-generated storytelling. The study aimed to assess (1) how generative AI contributes to emergency medicine innovation and (2) its impact on participants' emotional engagement.

Methods: The C2i masterclasses were held in Karachi, Pakistan (December 2023) and Lagos, Nigeria (March 2024). This study used an explanatory mixed-methods approach, collecting

quantitative data from a post-intervention 'MoodBoard' survey and qualitative data from AI-generated children's stories. The total sample size was 60 participants. The quantitative data was analyzed using descriptive statistics and a two-sample t-test comparing responses between the Karachi and Lagos cohorts.

Results: The study included 22 participants in Karachi and 38 in Lagos. The MoodBoard visual analog scale revealed a significant difference in the mean scores between the two cohorts (Karachi: 3.74 vs. Lagos: 3.96, $p < 0.05$, CI: -0.42 to -0.01). The AI-generated stories revealed themes of prosocial behavior, resourcefulness, and health awareness.

Conclusion: The masterclass achieved its goal of fostering innovative solutions through storytelling. The MoodBoard survey highlighted its effectiveness and enjoyment. The imaginative stories offered educational insights into healthcare challenges, highlighting their potential for broader applications in healthcare education and professional training.

Keywords: Innovation, Artificial Intelligence, Pediatric Emergency Medicine, Human Centered Design Thinking, Problem Solving.

BACKGROUND

Artificial intelligence (AI) has been used in healthcare for decades, offering immense potential to address challenging issues, particularly in high-risk situations such as emergency medicine (EM). The fast-paced nature of medicine necessitates accurate and speedy decision-making, where AI may help by boosting diagnostic accuracy, decreasing workloads, and improving patient outcomes [1]. For instance, the DeepGestalt facial analysis framework can detect various facial morphologies associated with rare syndromes, assisting pediatricians in reaching accurate diagnoses [2]. Similarly, in radiology, numerous AI algorithms, such as HOPPR AI, are being developed that are revolutionizing the way radiologists interpret anomalies, which were previously undetectable to the human eye [3]. Across fields where pattern recognition is crucial, AI models are being tested to replace or supplement human labor, as seen in the assessment of skin lesions in dermatology or fundal imaging in ophthalmology [4], [5].

Parallel to the data-driven, fast-paced domain of artificial intelligence, the field of narrative medicine has gained prominence. Narrative medicine is a healthcare approach of using storytelling to connect with patients and providers more deeply. One of the ongoing debates surrounding AI in healthcare is the ability of an artificial system to empathize and comprehend the contextual nature of human emotions [6]. Practicing medicine heavily depends on perceiving emotional cues from patients and responding with sentiments that align with the patient's context. Narrative medicine serves as a key approach to addressing this challenge. As described by researchers Dr. Kalitzkus and Dr. Matthiessen, narrative medicine when combined with evidence-based medicine integrates the human emotions and medical nuances together. Various genres of narrative medicine exist, including reflective writing by physicians, patients, or individuals who embody both perspectives [7], [8], [9].

In this study we used Human Centered Design Thinking (HCdT) to construct our storytelling narrative. This is a unique model that healthcare providers around the world have utilized to create personalized solutions such as at Mayo Clinic and Kaiser Permanente [10]. It incorporates five stages: Empathize, Define, Ideate, Prototype and Test. The process involves understanding different viewpoints and the surrounding context, determining the most important issue to address, generating practical solutions to that issue, developing the best ideas, and lastly evaluating them [11].

In the Emergency Department (ED), the high-stress work environment, staffing shortages, and budgetary constraints pose substantial risks for physicians, leading to high rates of burnout compared to other specialties [12]. Additionally, prolonged waiting times in the ED contribute to patient dissatisfaction and poorer health outcomes [13]. While prior research has explored the use of narrative medicine to address provider distress, this study explored a novel, innovative approach that can help create a conducive environment to foster improved communication and empathy driven decision making in the ED [14].

Here we have combined HCDDT and generative AI to approach complex problems in the ED, using storytelling as a tool. This approach led to our innovation of "Create to Innovate (C2i)" masterclass [15]. This study aims to fill the gap by demonstrating how C2i leverages AI, narrative medicine, and HCDDT to tackle challenges unique to emergency medicine, such as professional burnout and communication barriers. Through two instances of the C2i masterclasses, our objective is to demonstrate the potential for an innovative multidisciplinary approach to teaching and learning about the innovation ecosystem, both within and outside the healthcare domain, through the C2i program. By addressing the often-overlooked intersection of emotional engagement and professional training, this study underscores the potential for AI-driven storytelling to transform not just individual resilience but also patient outcomes through improved communication and empathy.

MATERIALS AND METHODS

This study employed an explanatory mixed-methods approach, utilizing both qualitative and quantitative data collected from the two masterclass sessions held in Karachi, 2023 and Lagos, 2024. The data sources included post-session questionnaires and the AI-generated stories that emerged from the masterclasses.

Study Intervention: The intervention consisted of a masterclass session that began with a detailed presentation by a senior author, Dr. Asad Main (AM) on HCDDT, including its individual components (Figure 1), applications, and our experiential learning through it particularly relevant to low-cost healthcare. Participants were then taught how to integrate HCDDT, Generative AI, and clinical problem-solving approaches.

“Insert Figure 1”

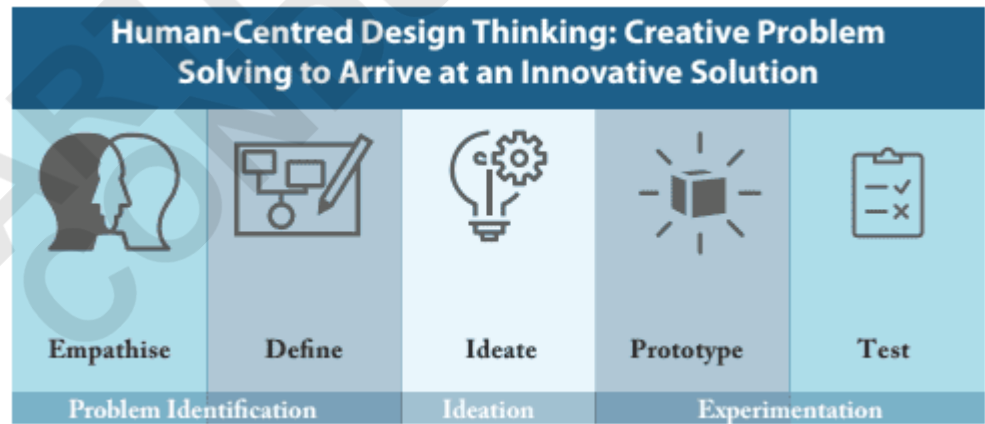


Figure 1: Human Centered Design Thinking (HCDDT). Overview of the HCDDT process, illustrating its five sequential stages. Each step is critical in crafting tailored, empathetic solutions.

Each masterclass session divided the participants into four to five groups based on the number of participants, and their task was to compose a story with the help of generative AI about an ED visit.

The stories were around the concept of pediatric asthma, trauma and injury coupled with compassion and empathy between the characters. They were instructed to keep the story length within 500 words, using an easily understandable tone, and include a concluding moral. Participants collaborated in groups to craft pediatric emergency narratives within 20 minutes, supported by pre-defined characters from the Biloongra Series[16], a children's book series first introduced in 2015 as bilingual pictorial storybooks promoting healthy habits and behaviors among children[17]. Facilitators guided discussions, ensured adherence to the timeline, and provided prompts for generating creative yet contextually relevant stories using OpenAI's ChatGPT 3.5.

The facilitators were Critical Creative Innovative Thinking (CCIT) fellows from the innovation hub at Aga Khan University Hospital (AKUH). They facilitated group discussions and ensured time management during the workshop. The masterclass concluded with participants completing the MoodBoard questionnaire.

Study Participants and Setting: In Karachi, the study population comprised students and employees of the AKUH. In Lagos, the study population comprised of employees from the Evercare Hospital, as it is not a teaching hospital. In total, the study included 22 and 38 participants from Karachi and Lagos, respectively.

Eligibility Criteria: All personnel at the AKUH and Evercare Hospital, irrespective of age or gender, were eligible for inclusion. This included students, faculty, administration, and others across the organizations. The exclusion criteria were set for children under the age of 18 years and if any individual was not fluent in English and the local language.

Piloting of Questionnaire: The initial survey consisted of 20 questions. To pilot test the survey, it was distributed among individuals working in the hospital, including faculty, residents, medical officers, nurses, staff, and administrative officers. The results of the pilot test were then analyzed, calculating Cronbach's Alpha and Squared Multiple Correlation (detailed in the results section) followed by refining based on feedback to a concise eight-item tool. The modified questionnaire was subsequently named 'MoodBoard'; the survey was developed to assess participants' emotional states and satisfaction levels efficiently.

Study Sample Size: To date, no published research has leveraged generative AI to develop children's narratives within medical contexts. As this was a pilot study, we used a flat rule of thumb and kept the maximum involvement up to 50 individuals in each cohort.[18], [19] Consequently, our study aimed to maximize participation from both institutions involved. The overall sample size combined from Karachi and Lagos totaled 60 participants.

Study Outcomes: (1) Asses how generative AI contributes to emergency medicine innovation by enhancing problem-solving, creativity, and communication in high-pressure environments, and (2) its impact on participants' emotional engagement by fostering empathy and improving professional satisfaction through AI-generated storytelling.

Study Duration: Each masterclass session was 4-5 hours long. The Karachi, AKUH session took place in December 2023, and the Lagos, Evercare Hospital session took place in March 2024. AKUH is a teaching hospital with a diverse staff population, including students. It is located in the center of the city and sees up to 80,000 ED visits annually. Evercare Hospital Lekki is a smaller tertiary care hospital with a new ED. These two sites were selected to provide a diverse sample of differently experienced ED staff for the C2i masterclasses.

Data Collection and Statistical Analysis: Quantitative data was collected through the MoodBoard survey, administered immediately after the masterclass. Data collection of the

MoodBoard was conducted through filling an online Google Form on-site, with subsequent compilation into Microsoft Excel for analysis. After quality checking, data analysis was performed with the help of IBM SPSS version 21 and R version 4.2.3. To understand the MoodBoard responses for each domain, categorical response data was summarized as frequencies, percentages and mean. The quantitative data was summarized with frequencies and mean. Two sample t-test was calculated to assess the difference in the responses between the two sessions in Karachi and Lagos. All statistical tests were performed at a 5% significance level. Results were presented in graphs and tables. A p-value of <0.05 was considered statistically significant.

The stories were then categorized under separate themes and the correlation of each theme with the generated stories was reported, as part of the qualitative analysis. It is important to grasp the difference between the quantitative and qualitative aspects of our study. The former focused on MoodBoard survey data, measuring participants' emotional states and satisfaction levels using a validated five-point scale. In contrast, the qualitative component involved thematic analysis of AI-generated stories, categorized under pre-defined domains such as health awareness, resourcefulness, and prosocial behavior, to assess their educational and narrative quality, as explained above.

Ethical Considerations: The study received an exemption from the Ethical Review Committee (ERC) at Aga Khan University based on the study design and intervention's nature (ERC# 2023-9008-25637). For Evercare Hospital, Lagos, leadership reviewed and approved the approach in alignment with institutional educational quality objectives. Given that this study did not involve patient data collection, it did not require formal IRB approval.

Informed consent was obtained from all participants, who were assured of confidentiality and anonymity throughout the study. No identifiers of the individuals were used when collecting data from the Google form.

RESULTS

From the results of our study, we found that in Karachi (N = 22), majority of the participants were between the ages of 20-29 (45.5%) and were male (73%). The highest mean score calculated from the Karachi Cohort was 4.2 ($\pm$ 0.97), for positive expectations of the participants' interactions with their colleagues after the masterclass session. The lowest mean score achieved was for participants emotional state at 3.4 ($\pm$ 1.00).

In Lagos (N = 38), most participants were from the 30-39 age bracket (55.2%) and were female (76%). The highest score was 4.4 ($\pm$ 0.89) for the same question as was that for the Karachi Cohort, and the lowest mean score was for satisfaction levels regarding work life balance among participants at 3.4 ($\pm$ 1.05). This is depicted in tables 1 and 3.

Table 1: Demographic details. Age and gender distribution of the Lagos and Karachi cohorts. N = total number of participants for each cohort, while (n) denotes the percentage of participants in each category.

Demographics	Masterclass session Lagos (N = 38) n (%)	Masterclass session Karachi (N = 22) n (%)
Age (years)		
20 – 29	10 (26.3)	10 (45.5)
30 – 39	21 (55.2)	4 (18.2)
40 – 49	5 (13.2)	5 (22.7)
50 – 59	2 (5.3)	3 (13.6)
Gender		
Male	9 (23.7)	16 (72.3)
Female	29 (76.3)	6 (27.2)

Through our initial pilot testing of the questionnaire prior to the first masterclass session, we aimed to internally test our survey. 119 individuals filled this survey, from where we calculated Total Item Correlation (refers to the degree to which each survey question correlates with the overall scale), Squared Multiple Correlation and Cronbach's Alpha. The total correlation had a range between 0.37 – 0.64 with the lowest value corresponding to the question *"How do you feel physically"* and the highest value corresponding to *"How are your stress levels."* The Squared Multiple Correlation lowest and the Cronbach's alpha followed the same trend for the highest and lowest values corresponding to the two questions. A high Cronbach's alpha was calculated for all the questions of the survey, between 0.786 to 0.822. The result of this analysis is displayed on Table 2.

Table 2: Initial testing of the survey. Pilot testing of the survey on 119 individuals. It includes the total item correlation, squared multiple correlation, and Cronbach's alpha for each component of the survey.

MoodBoard Question	Total Item Correlation	Squared Multiple Correlation (R^2)	Cronbach's Alpha (α)
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How content do you currently feel at work/university?	0.57	0.496	0.796
How satisfied are you with your current work-life balance at work/university?	0.62	0.438	0.789
How would you rate your current stress levels at work/university?	0.64	0.297	0.822
How do you feel physically at this moment at work/university?	0.37	0.487	0.786
How do you expect your interactions or experiences with colleagues and patients at work/university to be?	0.48	0.374	0.808
How satisfied are you with the physical activity you engaged in today at work/university?	0.57	0.391	0.796
How satisfied are you with the availability and variety of wellness/wellbeing activities at the departmental and organizational level	0.58	0.426	0.795
What is the likelihood of a work/university	0.51	0.400	0.804

wellness program promoting your self- care practices			
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A comparative analysis was conducted between the masterclass sessions in Karachi and Lagos to identify any differences in the responses of the two populations. The results revealed a significant difference for the question "*How satisfied are you with your current well-being?*", with the Karachi cohort scoring the lowest, while the Lagos cohort scored 4.3. The overall mean score between the two cohorts also reported a significant difference, $p < 0.05$ (confidence interval = -0.4252 to -0.0148). The complete findings of this analysis are presented in Table 3.

Table 3: Comparative analysis between the cohorts. Comparison of the mean scores for each MoodBoard component. The final column reports the p-values calculated using a two-sample t-test.

MoodBoard Question	Karachi Mean ($\pm$ S.D)	Lagos Mean ($\pm$ S.D)	p (Confidence interval)
How content do you feel?	4.1 ($\pm$ 0.81)	4.1 ($\pm$ 0.87)	1.00 (-0.4552 - 0.4552)
How satisfied do you feel with your current work-life balance?	3.7 ($\pm$ 1.08)	3.4 ($\pm$ 1.05)	0.30 (-0.2690 to 0.8690)
How do you feel emotionally?	3.4 ($\pm$ 1.00)	3.6 ($\pm$ 1.02)	0.46 (-0.7431 to 0.3431)
How do you feel physically?	3.6 ($\pm$ 1.29)	3.9 ($\pm$ 1.02)	0.32 (-0.9034 to 0.3034)
How do you expect your interactions to be today?	4.2 ($\pm$ 0.97)	4.4 ($\pm$ 0.89)	0.42 (-0.6932 to 0.2932)
How satisfied are you with your current well-being?	3.4 ($\pm$ 1.14)	4.3 ($\pm$ 0.81)	< 0.05 (-1.4056 to -0.3944)

Overall Score	3.74 ($\pm$ 0.35)	3.96 ($\pm$ 0.40)	< 0.05 (-0.4252 to -0.0148)
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The stories generated by the participants were submitted to the blog, titled "Biloongra V 3.0" [16]. The "Biloongra" stories are a collection of children's tales that depict everyday experiences from a family's life. As the author is an emergency room physician, the stories convey medical knowledge in an engaging and easily understandable manner for both children and their parents.

"Insert Figure 2"

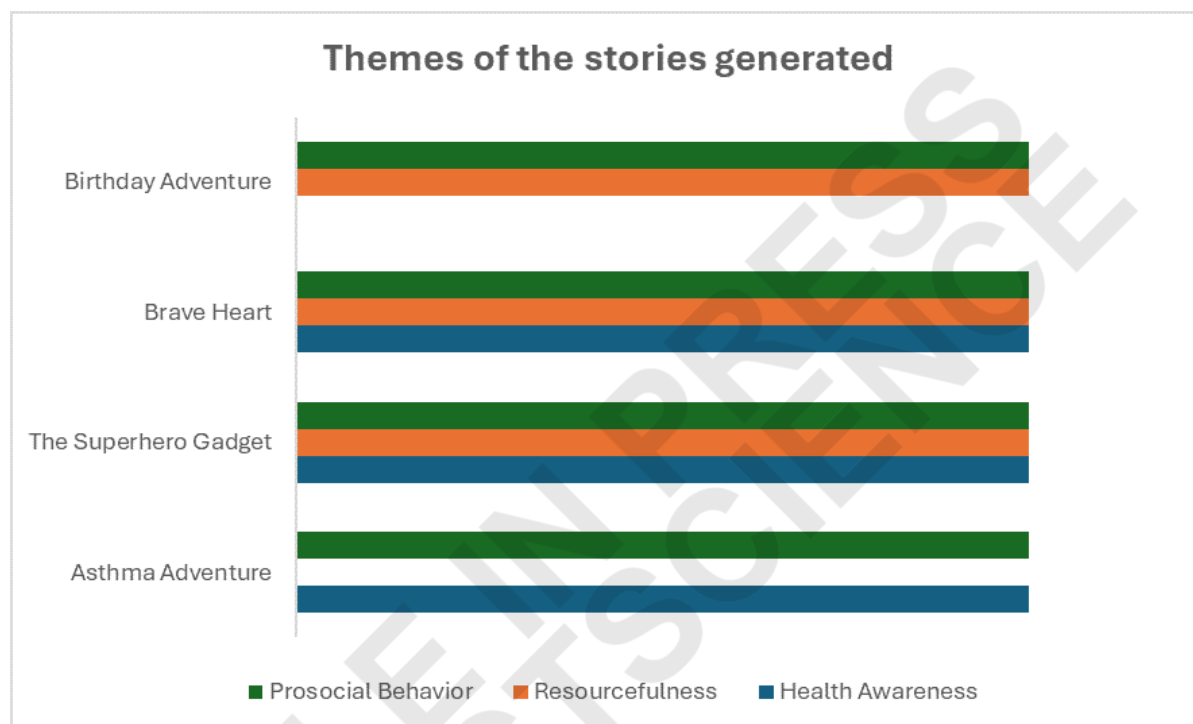


Figure 2: Themes identified in AI-generated stories. Through this qualitative assessment we found the stories identified subthemes of health awareness, resourcefulness, and prosocial behavior. Each bar represents the frequency of a theme within the generated narratives, highlighting their alignment with educational and emotional objectives of the masterclass.

Each story generated from the workshop underwent a thematic check to ensure that it satisfied certain pre-defined themes from the Biloongra storyline. This ensured homogeneity within the stories created while letting the participants maximize their creativity. The themes in play were health awareness, resourcefulness and prosocial behavior as shown in Figure 2.

These stories promote health literacy by highlighting the importance of understanding and managing common medical problems, as well as fostering self-efficacy through showcasing individuals' ability to take control of their health. The characters' demonstrated critical thinking skills, in their identification of problems, analysis of situations, and development of effective solutions, highlighting resourcefulness. The qualitative analysis revealed recurring themes of prosocial behavior, resourcefulness, and health awareness across the stories. These themes aligned with the masterclass's objectives, illustrating participants' ability to integrate clinical knowledge and creativity. For instance, stories highlighted the importance of empathy in managing

pediatric emergencies, fostering health literacy, and building supportive communities. These stories are publicly available online [\[16\]](#).

DISCUSSION

The study found a significant difference in the MoodBoard scores between the Karachi (3.74) and Lagos (3.96, $p < 0.05$) cohorts after the C2i masterclass. This masterclass explored the use of HCDDT as an innovative approach to address modern challenges and leverage new technologies. The significant differences in satisfaction and well-being between cohorts may reflect varying institutional cultures or access to resources. For instance, younger institutions like Evercare Hospital might foster more flexible and innovative mindsets compared to the more established Aga Khan University Hospital. This is supported by literature suggesting that older organizations tend to have more rigid processes, leaving less room for innovation, compared to younger institutions that may harbor more unconventional ideas [\[20\]](#). Our C2i masterclasses sought to address this disparity in innovation.

The recent COVID-19 pandemic has prompted a surge in the development of innovative solutions to address challenges in healthcare. A prior narrative literature review examined innovative approaches that emerged during the 2020 pandemic and categorized them into four types: frugal innovation, technological innovation, repurposing, and process innovation [\[21\]](#). Our study represents an effort to foster innovation in healthcare through the use of generative AI for storytelling and its influence on the moods of healthcare professionals. This innovative project encompasses aspects of each of the previously defined innovation categories. Promising innovations in healthcare are attracting major investment from global companies. However, AI in healthcare faces challenges entering clinical practice, as people struggle to trust robots and worry about privacy [\[22\]](#). A human-centered approach to designing AI could lead to more promising results in the future [\[23\]](#).

Prior research has demonstrated that narrative medicine can enhance empathy among healthcare providers toward their patients, facilitating both professional and personal development [\[24\]](#). A literature review has also indicated that incorporating narrative-based approaches into curricula can improve performance on communication skills-related exam questions [\[25\]](#). Hence the benefits of combining narrative and evidence-based medicine are no mystery. In the present study, we sought to innovate the process of narrative medicine and integrate it into the practice of healthcare staff, while investigating the potential positive impact of such techniques on the study population. The mean scores calculated for each domain of the 'MoodBoard' instrument suggest that these innovative approaches are promising in enhancing the overall mood and contentment of the staff. This, in turn, can be extrapolated to lead to more favorable working environments and, consequently, improved quality of healthcare delivery.

The effectiveness of storytelling as a tool for public health education is further evidenced by its application in improving vaccination awareness among schoolchildren in Pakistan [\[26\]](#). Using Biloongra stories in bilingual pictorial storybooks and animated videos, prior interventions significantly enhanced children's understanding of immunization and vaccine safety. These findings underscore the potential of narrative-based approaches to address diverse public health challenges, demonstrating their adaptability across contexts and target audiences.

In our study, we utilized a visual analog scale, the MoodBoard, with its 5-point Likert scores to assess the participants' emotional states. This MoodBoard underwent extensive internal evaluation, starting with a pilot of 20 questions that underwent fireside discussions with the CCIT

fellows to remove semantic similarities. The MoodBoard then underwent an additional round of biostatistical validation, as shown in Table 2, to remove any redundancies.

While numerous mood assessment scales exist, many are designed for clinical settings to evaluate depression or mania[27]. One nonclinical example is the Measure of Happiness scale, which consists of 14 questions on a 10-point Likert scale, making it more time-consuming[28]. Given our intention to administer the survey to healthcare professionals who have limited time during their busy schedules, our goal was to construct an innovative, concise, and self-administered questionnaire that effectively evaluates the respondent's current mood state.

One of the strengths of our study was that we were able to collect data from two distinct demographics by conducting workshops in two different continents. This enhances the generalizability of our findings [29].

Our post-workshop MoodBoard survey revealed no statistically significant differences when comparing each question between the two groups, except for the domain "*How satisfied are you with your current well-being*", which was scored low ($3.43.4 (\pm 1.14)$) by the Karachi participants. This observation from the Karachi cohort, which was predominantly comprised of young males, contradicts prior studies that have reported higher stress levels among younger women[30]. However, this finding can be attributed to various confounding factors, such as financial considerations and cultural roles and responsibilities, which may impact mood and well-being.

Despite the novel nature of our study, it is subject to certain limitations. As this was an innovative, first-of-its-kind process, the workshops were conducted with a relatively small sample size. Additionally, the MoodBoard assessment was administered only once, following the workshop. Future studies with larger sample sizes that longitudinally monitor participants' responses on the MoodBoard can better elucidate the impact of this innovative technique. Furthermore, a comparative analysis between our AI-generated storytelling approach and other interventions aimed at improving the mood of healthcare staff could better establish the feasibility and efficacy of our workshop. This could also factor in confounding variables that affect "mood". Lastly, children were excluded from this study due to the nature of the workshops which purposed to address clinical problems in the ED. The MoodBoard should be evaluated in children as well to test its efficacy in different age groups.

These stories have major potential for future applications. They can serve as dynamic feedback from patients and healthcare providers, providing valuable insights for hospital administration and quality improvement initiatives. Moreover, translating these stories into different languages could help disseminate the content and raise awareness of common diseases. These storytelling techniques could be extended to other hospital departments, such as adult (internal) medicine, to further influence their impact. This is currently being practiced at different hospitals around the globe by our senior author, as part of quality improvement projects. The approach could also serve as a model for integrating narrative medicine and AI into professional development programs across all medical specialties. By fostering emotional resilience and enhancing problem-solving, these workshops have the potential to create more supportive and adaptive healthcare environments. Future longitudinal studies could also investigate how cultural differences affect the reception of AI-generated stories in healthcare, expanding the scope of potential applications. Scalability of the C2i approach requires careful planning, including adapting facilitator training to local cultural contexts and ensuring resource availability. Developing a standardized implementation guide could facilitate broader adoption across diverse healthcare settings, and grant funding can be instrumental in driving forward this innovative development.

CONCLUSION

The C2i workshops demonstrate the transformative potential of integrating generative AI, narrative medicine, and HCDT to tackle modern healthcare challenges. These findings emphasize the importance of innovative interdisciplinary approaches to address burnout, foster emotional engagement, and improve patient care. Future studies should explore this model's broader applications, such as scalability, social innovation and revenue generation potential, to enhance its impact across diverse healthcare settings.

Ultimately, this study demonstrates that interdisciplinary collaboration between healthcare professionals, AI technologists, and educators is key to developing sustainable solutions for modern challenges in healthcare. Expanding such models globally could pave the way for systemic changes in professional training programs, fostering innovation and resilience at scale.

DECLARATION:

- **Consent for publication:** Consent from all authors has been taken.
- **Competing interests:** Not Applicable
- **Funding:** No funding of any sort was used.
- **Patient and Public Involvement:** It was not appropriate or possible to involve patients or the public in the design, or conduct, or reporting, or dissemination plans of our research

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KEY MESSAGES

- Integrating AI, narrative medicine, and HCDT provides a novel framework to address emotional engagement and burnout in healthcare.
- The C2i masterclass successfully fosters creative problem-solving in emergency medicine while improving professional satisfaction.
- Future applications could include expanding this model to other healthcare contexts and populations, creating an adaptable framework for global implementation in medical education and professional training.

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