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Embodied conversational agents for shared decision-making: a scoping review protocol

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ABSTRACT

Introduction Embodied conversational agents (ECAs) are computer-based dialogue systems designed to simulate face-to-face interactions by incorporating human-like physical attributes. Their capacity to establish and maintain an empathic relationship in patient interactions positions them as innovative tools that facilitate shared decision-making (SDM). To systematically synthesise the existing evidence concerning the development and application of ECAs in promoting SDM, this protocol delineates a scoping review designed to identify and present the available evidence within this domain. Specifically, the protocol outlines a review that will concentrate on the key features of ECAs in the context of SDM, including their appearance, dialogue mechanisms and emotional models, within the framework, as well as their implementation and evaluation in clinical settings.

Methods and analysis The framework established by Arksey and O'Malley will be employed to guide the scoping review process. This protocol outlines the systematic retrieval of seven databases, including PubMed, EMBASE, PsycINFO, Web of Science, the Cumulative Index to Nursing and Allied Health Literature, Institute of Electrical and Electronics Engineers (IEEE) Xplore Digital Library and Association for Computing Machinery (ACM) Digital Library. The search strategy has been developed and will be conducted across each database, from its inception to September 2024. Two researchers will conduct literature screening and data extraction independently. The results will be systematically organised and presented through narrative abstracts, tables and/or figures.

Ethics and dissemination Ethical approval is not necessary for this review, as it uses data that have been previously collected. Furthermore, the obtained results will be reported in a peer-reviewed journal.

Trial registration number Open Science Framework Registries (https://doi.org/10.17605/OSF.IO/BN3CM).

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Using Arksey and O'Malley's framework for scoping reviews will ensure methodological rigour and transparency.
⇒ We will collaborate with research librarians possessing expertise in scoping reviews to formulate rigorous retrieval strategies.
⇒ This scoping review will be confined to published studies, possibly introducing publication bias.
⇒ Given the exploratory nature of this review, a critical appraisal of study quality and assessment of risk of bias will not be conducted.

INTRODUCTION

Shared decision-making (SDM) has been defined as 'an approach where clinicians and patients share the best available evidence when faced with the task of making decisions, and where patients are supported to consider options, to achieve informed preferences'.[1] SDM emphasises the equal involvement of both parties in the decision-making process.[2] In this model, healthcare professionals not only offer expert medical recommendations but also carefully consider and respect the patient's values and preferences.[3 4] Both parties engage in a thorough discussion, evaluating the benefits and risks of various treatment options, ultimately reaching a mutual agreement.[5–7] SDM has emerged as a prominent trend in modern medicine, serving as the predominant model for advancing patient-centred medical decision-making and achieving patient-focused care.[8–10] SDM has been widely applied in various fields, including oncology,[11 12] endocrinology,[13 14] rehabilitation medicine[15] and cardiovascular disease,[16] demonstrating its potential to enhance patient satisfaction and treatment outcomes. Previous research has generated a wealth of valuable resources, including theoretical models and a range of practical tools related to SDM.[17–19] These studies have confirmed that SDM provides strong guidance and applicability in clinical practice, playing a significant role in reducing patients' decision-making conflicts, increasing their understanding of their conditions and improving overall health outcomes.[20 21]

Despite the public's willingness to engage in SDM, its practical implementation continues to face numerous challenges, such as a lack of trust between physicians and patients,

insufficient understanding of SDM among healthcare providers and disparities in healthcare resource allocation.[22–24] Furthermore, the accessibility of SDM is constrained by financial, logistical and availability factors. Specifically, the cost-effectiveness of SDM interventions, the convenience of integration into existing clinical workflows and the availability of trained personnel and supportive infrastructure all present significant barriers to widespread adoption.[25–29] These multifaceted challenges necessitate a comprehensive approach to enhance the feasibility and scalability of SDM in diverse healthcare settings.

To overcome these limitations, the implementation of SDM facilitated by embodied conversational agents (ECAs) has emerged as a promising and innovative approach. ECA is a computer-based dialogue system that emulates key characteristics of human interaction in face-to-face communication by incorporating advanced technologies, including artificial intelligence, natural language processing and computer graphics.[30 31] Unlike traditional chatbots, ECAs use not only textual information but also engage in multimodal interactions, including both verbal and non-verbal behaviours, such as speech, facial expressions and gestures.[32 33] This multimodal approach provides ECAs with distinct advantages in conveying emotions, building trust and communicating complex information.[34] In healthcare, ECA is used to provide self-management education for diabetic patients,[35] promote cancer screening,[36 37] motivate users to do physical activities[38] and provide supportive treatment for depressed patients.[39] Despite the broad application prospects of ECAs in healthcare, their development still faces numerous challenges. Previous studies have demonstrated that if the design of an ECA fails to meet user expectations, it may be ineffective or even result in negative outcomes.[40] Furthermore, poorly designed interactions can influence users' psychological and emotional responses, subsequently impacting their engagement with the applications.[41] However, the optimal design and utilisation of ECA to maximise its effectiveness in clinical decision-making remain unclear. Therefore, reviewing the development process of ECA from the perspective of SDM is of great importance to optimise its interaction design and enhance the user experience.

Currently, there is a notable gap in comprehensive reviews addressing the design, development, implementation and evaluation of ECAs, particularly in the context of SDM. A scoping review of Provoost *et al*[42] offers valuable insights into ECA technology and its potential clinical applications for patients with mental health disorders. Jiang *et al*[43] have summarised the state of development and evaluation of ECAs for chronic disease management. Their findings indicate that existing ECAs encompass a broad spectrum of chronic conditions, with a primary focus on promoting disease screening and enhancing patient self-management. However, the cost-effectiveness of ECAs in chronic disease management remains undetermined. Two reviews, conducted by Mercado *et al*[44] and Kramer *et al*,[45] identified key features (such as appearance, dialogue mechanisms and emotional models) and practices of ECAs in promoting healthy behaviours, but ignored the design activities of ECAs. Similarly, the other two reviews concentrated solely on the predominant design features of ECA and their influence on user perception.[46 47] Consequently, it is imperative to conduct a comprehensive literature review on the development and evaluation of ECA within the context of SDM.

METHODS

We will perform a scoping review of the existing published literature using the framework established by Arksey and O'Malley. The main five stages will be as follows: (1) identifying the research questions, (2) searching for relevant studies, (3) selecting studies, (4) charting the data and (5) collating, summarising and reporting the results. The review resulting from this protocol will be reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) extension for Scoping Reviews reporting guidelines.[48] This protocol has been registered in the Open Science Framework (https://osf.io/) (registered from osf.io/mzyrb, registration DOI: 10.17605/OSF.IO/BN3CM).

Identifying the research question

ECAs, serving as virtual intermediaries, have the potential to mitigate barriers in traditional SDM practices by providing consistent, personalised and evidence-based information to patients interactively and engagingly. With the advancement of artificial intelligence technology, the evidence base for ECAs is rapidly increasing in both quality and quantity. A growing number of experimental research designs involving ECAs have been reported in the healthcare field. These studies, including randomised controlled trials, cohort studies and case–control studies, are expected to provide evidence regarding the effectiveness, usability and acceptability of ECAs in promoting SDM, which is crucial for the further development and evaluation of ECAs. Hence, we employ the scoping review method.[49] Compared with the traditional systematic review, the scoping review encompasses a broader range of topics, accommodates various research designs and does not emphasise quality assessment of included studies, thereby facilitating the collection of the latest evidence of ECA.

We collaborated with the team studying 'shared decision-making' to identify a series of extensive and comprehensive research questions. The team consists of experts in fields such as evidence-based medicine, medical informatics and medical decision-making. Their combined knowledge and experience enable a comprehensive and in-depth exploration of ECAs in the context of SDM. The overall aim of this scoping review is to comprehensively synthesise the existing evidence on the development and application of ECAs in promoting SDM. Specifically, this review will address the questions:

Research question 1: For whichhealth problems are ECAs mainly used in shared decision-making?

Research question 2: What are the main features of ECAs for SDM? (eg, device, avatar appearance, interaction mode and emotional model).

Research question 3: How to introduce ECAs into the clinical decision-making process to promote SDM?

Research question 4: What evaluation indicators are used to assess the effect of ECA implementation? (eg, acceptability, practicality, cost-effectiveness, satisfaction, decision conflict, decision regret).

Identifying relevant sources

To identify the pertinent literature, the research team developed a comprehensive search strategy, aided by the expertise of a research librarian (online supplemental appendix A). We will search seven databases: PubMed, EMBASE, PsycINFO, Web of Science, the Cumulative Index to Nursing and Allied Health Literature, Institute of Electrical and Electronics Engineers (IEEE) Xplore Digital Library and Association for Computing Machinery (ACM) Digital Library. These databases were selected because they encompass pertinent literature in the fields of health sciences and information technology and have been used in previous scoping reviews addressing related subjects.[43 44] All databases will be searched from their inception to September 2024. The retrieved literature will be imported into the reference management software (EndNote X9).

Study eligibility criteria

Inclusion criteria: (1) all types of empirical studies, such as randomised controlled trials, observational studies and case-series studies, will be included, (2) literature published in English, (3) studies focusing on ECAs used in the context of SDM, where ECAs for SDM refer to ECAs specifically designed to facilitate the SDM process between patients and healthcare providers, including virtual or physical embodiments (such as abstract, animal-like, human or cartoon-like agents).

Exclusion criteria: (1) editorials, conference abstracts and opinions and (2) inability to access full-text study.

Study selection

All records retrieved from the database will be exported to EndNote X9. Initially, duplicates will be removed. Subsequently, two researchers will screen the titles and abstracts. Next, the full texts of studies potentially meeting the inclusion criteria will be obtained, and the two authors will independently screen these texts for final inclusion in the scoping review. In cases of disagreement during the screening process, the two authors will discuss to resolve the differences; if no consensus is reached, the third author will make the decision. The entire screening process will be documented and presented using a PRISMA flowchart.

Extraction and charting of data

The relevant data from all studies included in the scoping review will be independently extracted by two researchers, recorded in Microsoft Excel and cross-checked by the reviewers. Any discrepancies in the extraction process will be resolved by the first investigator through discussion. In cases where consensus cannot be reached between the two researchers, a third party will arbitrate the differences. The extracted data will include the following information: author details, year of publication, country of origin, type of publication, funding sources, study location, study population, health problem, sample size, research design, research objectives, characteristics of the ECA (including name, appearance, dialogue mechanism and emotional model), ECA equipment implementation, primary outcomes and outcome evaluation methods.

Collation, summary and reporting of the results

The results obtained from the data extraction tools will be collated, and the findings will be presented in graphical and/or tabular formats to create a narrative summary of how published evidence is reported on ECAs for SDM. Given that the objective of this scoping review is to comprehensively gather existing evidence and summarise the research, a quality assessment of the literature will not be conducted.

Patient and public involvement

No patient is involved.

ETHICS AND DISSEMINATION

Ethical approval is not required for this study. Subsequent dissemination of findings will involve the publication of results in a peer-reviewed journal.

DISCUSSION

This protocol outlines the approach for a scoping review of ECA research in SDM. To enhance the integrity, transparency and reproducibility of the research, meticulous planning and documentation of research methods are essential.[50]

This scoping review will aim to synthesise existing evidence and identify gaps in the application of ECAs in the context of SDM. By examining the characteristics and user experiences of ECAs employed in doctor–patient collaborative decision processes, we aim to provide evidence-based insights that can inform the development of ECAs, enhance their role in clinical settings and improve the overall experience of patients. Furthermore, we will identify the health problems for which ECA is used in the clinical decision-making process, which may reveal novel potential research avenues. We will also show whether different ECAs are used in clinical decision-making for the same health problem. If so, future systematic reviews and meta-analyses can be conducted to further elucidate the effect of ECA on specific health problems.

Contributors HJ and XL conceptualised the study. HJ wrote the manuscript with support from MM, ZW, DY and XL. HJ and XL created the search terms. All coauthors read and approved the final version of this manuscript. Guarantor: YH.

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