Development of an Intelligent Health Education System Based on Large Language Model for Elderly Pulmonary Aspiration Prevention

Ruifu KANG[a], Shuojin FU[a], Shuai JIN[a], Yanling WANG[a1], Qian XIAO[a1]

aSchool of Nursing, Capital Medical University, Beijing, China

ORCiD ID: Ruifu KANG https://orcid.org/0000-0002-4566-683X
ORCiD ID: Shuojin FU https://orcid.org/0000-0003-3176-1139
ORCiD ID: Shuai JIN https://orcid.org/0000-0003-2469-0563
ORCiD ID: Yanling WANG https://orcid.org/ 0000-0002-1295-4245
ORCiD ID: Qian XIAO https://orcid.org/0000-0002-5657-2863

Abstract. As the aging process accelerates, the incidence of chronic diseases in the elderly is rising. As a result, it is crucial to optimize health education for the elderly. Pulmonary aspiration and aspiration pneumonia are significant concerns endangering the health of the elderly. The health education paradigm now in use to prevent pulmonary aspiration in the elderly has numerous flaws, including a lack of home-based health education and the digital divide. Large language model (LLM), an example of artificial intelligence technology, is anticipated to bring a chance to address these issues and offer easily comprehensible health information for the prevention of pulmonary aspiration in the elderly. Our multidisciplinary research team fully understood the needs from the perspective of physicians, nurses and patients, built a knowledge graph (KG), and developed an **i**ntelligent **H**ealth **E**duc**A**tion **system** based on **LL**M for the prevention of **e**lderly **P**ulmonary **A**spiration (iHEAL-ePA system).

Keywords. Health education, large language model, knowledge graph, pulmonary aspiration

1.   Introduction

The elderly are increasingly suffering from chronic diseases, including swallowing dysfunction that can lead to pulmonary aspiration and other lung complications. Degenerative changes make it difficult for food to be transported safely and effectively from the mouth to the stomach, resulting in elderly swallowing dysfunction [1]. Health education can reduce the incidence of pulmonary aspiration in the elderly, but most education is limited to medical institutions, making it difficult for elderly people to obtain professional guidance at home. Artificial intelligence (AI) technology provides an opportunity to solve these problems. Large language models (LLMs) have the advantages of natural interactions [2] which can provide personalized health guidance for the elderly at risk of pulmonary aspiration. Therefore, we developed an intelligent **H**ealth **E**duc**A**tion **system** based on **LL**M and knowledge graph(KG) technology for the prevention of **e**lderly **P**ulmonary **A**spiration (iHEAL-ePA system).

[1] Corresponding Author: **Yanling Wang and Qian Xiao**, School of Nursing, Capital Medical University, No.10 Xi-Tou-Tiao, You-An-Men-Wai Street, Feng Tai District, Beijing, China, 100069. Email address: wangyanling_eliza@126.com(Yanling Wang), julia.xiao@ccmu.edu.cn (Qian Xiao)

2.   Methods

Our interdisciplinary team has two pulmonary aspiration experts, two nursing PhD candidates researching pulmonary aspiration, one user interface designer, and one software engineer. We developed the system using an agile development model [3] and completed the demo version through three stages:

       Stage 1 (Alpha Version): We conducted literature research and discussions, applied text embedding and prompting engineering techniques to embed prevention knowledge into the Spark LLM (iFlytek Co., Ltd.), and developed an alpha version featuring only a text chat interface.

       Stage 2: We utilized qualitative research methods to study clinical nurses who tested the alpha version, and analyzed their suggestions and needs for the system.

Stage 3 (Beta Version): We rapidly iterated the alpha version based on the knowledge content and functionality demands identified in Stage 2, constructed a KG to solve AI hallucinations, and added other new functions. This led to the development of the beta version.

3.   Results

This iHEAL-ePA system was improved per the alpha version and research subjects' experiences and needs, and its design diagram is shown in Figure 1. Users access it via WeChat mini program. They register and log in by providing personal information. It has four modules:

Module 1 (Posts): Content recommendation based on user information, including articles and videos. Some images are AI-generated.

Module 2 (Chat): Includes chat interface, suggestions, and history. Questions are analyzed by LLM and KG to provide personalized answers.

Module 3 (Settings): Settings customization like account, display, voice, and user information. There are automated continuous conversation and large font modes, especially for the elderly.

Module 4 (Management): Medical professionals log in this module on the computer. They can view user analytics and update the knowledge base, as well as add and edit KG.
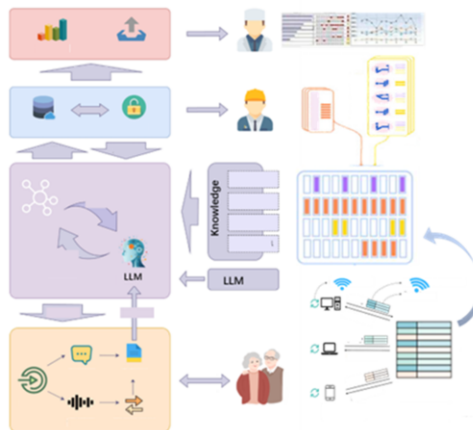

Figure 1. the design diagram of iHEAL-ePA system

4.   Discussion

Pulmonary aspiration threatens elderly health yet often covertly manifests. Many suffer irreversible damage by the time discovered, complicating intervention. This system focuses on education via the latest LLM that allows natural question-answering, bridging digital divides for the elderly to conveniently access health knowledge and potentially tackling pulmonary aspiration discovery issues.

System knowledge was vetted and organized by pulmonary aspiration prevention specialists, ensuring accuracy. The LLM enables natural, flowing dialogues. Combining this specialized KG with the LLM provides accuracy and seamlessness. Beyond questions, the system provides personalized recommendations and historical conversation records to broaden exposure. The management module extracts insights from user data to iteratively enhance the system. Centered on conversational learning, the system aims to boost pulmonary aspiration prevention literacy and lower incidence rates.

5.   Conclusion

This study detailed an interdisciplinary team building the iHEAL-ePA system leveraging LLM and a reliable, current pulmonary aspiration prevention KG. This simplifies user access to prevention information, boosting efficacy for the elderly. Extensive clinical trials will further validate the system to launch a final version fitting user needs. Randomized controlled trials will be conducted to verify real-world system effectiveness.

References

[1]   J.A.Y. Cichero, Age-Related Changes to Eating and Swallowing Impact Frailty: Aspiration, Choking Risk, Modified Food Texture and Autonomy of Choice, Geriatrics (Basel). 3 (2018) 69. doi:10.3390/geriatrics3040069.

[2]   T. Wu, S. He, J. Liu, S. Sun, K. Liu, Q. Han, and Y. Tang, A Brief Overview of ChatGPT: The History, Status Quo and Potential Future Development, IEEE/CAA Journal of Automatica Sinica. 10 (2023) 1122–1136. doi:10.1109/JAS.2023.123618.

[3]   A. Ahmed, S. Ahmad, N. Ehsan, E. Mirza, and S.Z. Sarwar, Agile software development: Impact on productivity and quality, in: 2010 IEEE International Conference on Management of Innovation & Technology, 2010: pp. 287–291. doi:10.1109/ICMIT.2010.5492703.