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Концептуальная основа разработки чат-ботов для борьбы с проблемой нерешительности в отношении COVID-19-вакцины

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АННОТАЦИЯ

Цель данного письма — обсудить возможности чат-ботов, предназначенных для ответов на вопросы лиц, сомневающихся в вакцинации, их пользу и ограничения в устранении психосоциальных детерминант нерешительности в отношении вакцины против COVID-19. Авторы предлагают концептуальную основу разработки чат-ботов на основе искусственного интеллекта и обобщают основные характеристики обсуждаемых сегодня в литературе четырех чат-ботов, разработанных для решения проблемы нерешительности в отношении вакцины против COVID-19.

Ключевые слова: *COVID-19; нерешительность в отношении вакцины; чат-боты; медицинские работники*

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A Conceptual Framework for the Development of Chatbots Addressing COVID-19 Vaccine Hesitancy

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ABSTRACT

Aim of this letter is to review Chatbots to answer questions vaccine-hesitant people, their utility, and their limitations in addressing psycho-social determinants of COVID-19 vaccine hesitancy. The authors propose a conceptual framework that could guide the development of artificial intelligence-based Chatbots and summarise the salient features of the four Chatbots discussed in the literature today, developed to address COVID-19 vaccine hesitancy.

Keywords: *COVID-19; vaccine hesitancy; chatbots; healthcare workers*

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ECO•VECTOR

LIST OF ABBREVIATIONS

COVID-19 — COronaVIrus Disease 2019
CVH — COVID-19 vaccine hesitancy
MET — motivational enhancement therapy
FAQs — frequently asked questions
HCWs — healthcare workers

Vaccination is one of the most effective and low-cost public health interventions against at least 20 vaccine-preventable diseases, including *COronaVIrus Disease 2019* (COVID-19) [1]. However, vaccine hesitancy is a growing public concern affecting vaccination coverage worldwide. Many countries have deployed several psycho-social strategies to address the determinants of vaccine hesitancy. Examples include creating awareness on social media, government websites, or media through frequently asked questions (FAQs). In addition, some countries have developed Chatbots to answer questions vaccine-hesitant people might have.

Table 1 summarises the salient features of the four Chatbots discussed in the literature today, developed to address COVID-19 vaccine hesitancy (CVH). In this letter, we aimed to review these Chatbots, their utility, and their limitations in addressing psycho-social determinants of CVH. Also, we propose a conceptual framework that could guide the development of artificial intelligence-based Chatbots addressing these determinants.

These Chatbots have the potential to reduce the burden on healthcare workers (HCWs) by providing support and relevant information to them and patients. The Chatbots may assist primary HCWs in organizing specific information related to the COVID-19 vaccines. Furthermore, Chatbots-based approachesare more adaptable, trustworthy, and scalable in low-resource settings. However, these Chatbots may be ineffective at assessing and addressing the determinants of CVH at an individual level [2]. The main reason for this potential ineffectiveness is a lack of emphasis on individual concerns/underlying motives and specific determinants (e. g., confidence, collective responsibility) of CVH. Also, there is insufficient evidence related to their overall effectiveness and utility. Finally, there is the lack of involvement of primary HCWs, despite the well-known fact that primary HCWs are reputed to be the most reliable source of vaccine-related informations [3].

Table 1. Brief review of Chatbots developed to address COVID-19 vaccine hesitancy across the world

MyGOV Corona Helpdesk [7]	The government of India and Haptik Infotech Pvt. Ltd. developed this Chatbot to provide timely updates and help citizens clear their queries on COVID-19 infection and COVID-19 vaccines. It is deployed on WhatsApp and is used by Indian users. It clarifies false information and answers frequently asked questions related to COVID-19 vaccines.
Corowa–Kun [8]	Developed and tested in Japan and found effective in increasing the vaccine acceptance rate from 59% to 80%. Corowa–Kun has been deployed in Japan's most popular messaging app, 'LINE', which almost two–thirds of its population use. The Chatbot helps to understand the COVID-19 vaccines.
Vira (Vaccine Information Resource Assistant) [9]	Researchers of the John Hopkins Bloomberg School of Public Health, along with IBM, developed an AI-powered Chatbot in October 2021 to combat vaccine hesitancy in young Americans. The Chatbot is specifically designed to provide credible information about COVID-19 vaccines via WhatsApp and the Web. It will continue to evolve as more people use it and provide relevant feedback.
French and Twilio chatbot [10]	Addresses concerns about the COVID-19 vaccines by providing the information to the general population.

To address the above mentioned issues, we propose the conceptual framework for developing Artificial intelligence (machine learning)-based intelligent Chatbots for primary HCWs (Figure 1). Our proposed framework includes the information-deficit model of communication [4], the 5 C model of vaccine hesitancy [5], motivational interviewing [6], and it involves primary HCWs.

The main input for this Chatbot will be standardized scales or questions (in the form of text) related to CVH and motivational interviewing. The answers to these questions, MI staging, and decision support (in the form of text) will be output. The framework includes screening and intervention for CVH. Using mathematical or statistical models (e. g., multiple regression, logistic regression, cluster analysis, principal component analysis, and discriminant analysis) and machine learning algorithms (deep neural network-based embedding generation and sequencing modeling for natural language processing), the individual or combination of factors that predict CVH can be identified. The tailor-made strategies can then be developed using the living database

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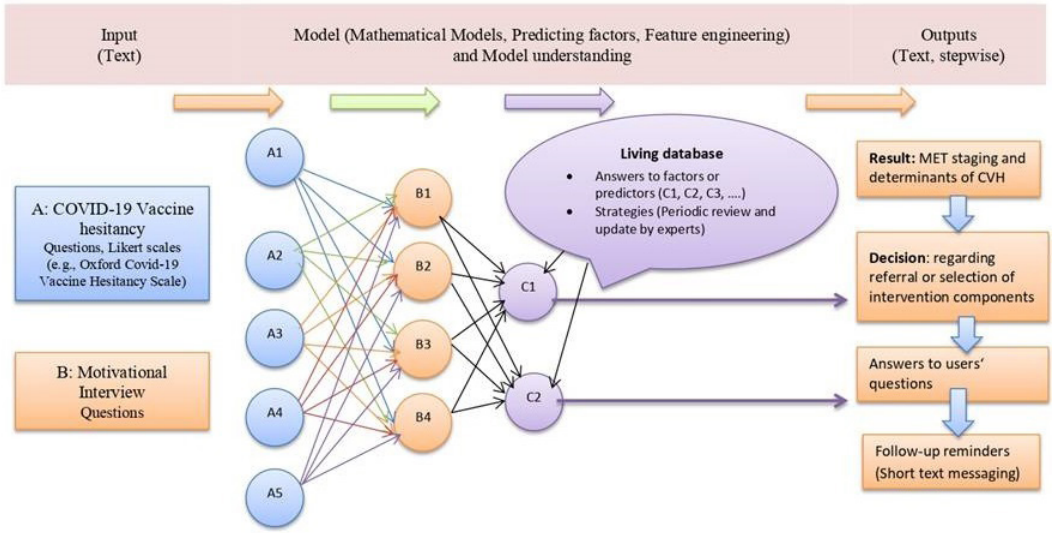

Fig. 1. Conceptual Framework for Chartbot (machine learning-based) for COVID-19 vaccine hesitancy
Notes: Determinants of Vaccine hesitance (A): A1 — confidence, A2 — complacency, A3 — constraints, A4 — calculation, A5 — collective responsibility; Motivational staging (B): B1 — pre-contemplation, B2 — contemplation, B3 — preparation/decision, B4 — action; C: Hypothetical factor/construct for which answers and strategies we be sought or developed using a living database; COVID-19 — COronaVIrus Disease 2019, CVH — COVID-19 vaccine hesitancy, MET — motivational enhancement therapy.

comprising answers to questions and scientific information. The determinants of CVH are dynamic, rapidly evolving, and interconnected. Also, there is no umbrella concept that embraces all determinants at the time of development. As a result, the database should be a living one that can be constantly edited and updated to address the emerging antecedents.

AI-based Chatbots developed using our conceptual framework will be evidence-based, more robust, and with more accurate algorithms that can deal with data with complex distributions to quickly generate more relevant and empathetic responses. Previous studies reported huge variation in CVH, attributed to the use of different questionnaires and cut-off scores to categorize vaccine hesitancy among the population. These factors are frequently complex, dynamic, unpredictable, and challenging to address. The AI-based Chatbots using standardized scales will reduce these variations and may help monitor rapidly changing factors. After minimal training of HCWs, the Chatbots will assist them in providing an individual-level intervention to address the determinants of CVH. The Chatbots are feasible and can be deployed in various health care settings such as hospitals, clinics, and communities. In addition, these Chatbots can be integrated into existing national immunization programs, maternal and child health services, and vaccination campaigns. At the same time, the Chatbot-based telephonic reminders included in the model may further improve the vaccine uptake rate.

As Chatbots can be easily installed into smartphones and integrated with websites, they couldbe more feasible, acceptable, scalable, cost-effective, sustainable, and useful in the current COVID-19 pandemic. These Chatbots primarily focus on primary HCWs, who play an important role in the implementation of the vaccination drive and are often the most trusted source of vaccine-related information. However, primary HCWs may have difficulty organizing screening tools, identifying the specific components of the intervention, and assessing participant motivation. Also, the information about the COVID-19 vaccines can be too complex to recall correctly during intervention delivery. So, despite their training, the information they provide on these vaccines may be inconsistent. Most of these issues can be addressed by developing artificial intelligence (AI)-based Chatbots using our conceptual framework. The AI-based approach will help in automatic data collection, accurate assessment, and integration with application programming interfaces and, thus, will promote the systematic identification of factors that contribute to CVH. Future studies are needed to evaluate the effectiveness of AI-based Chatbots using controlled trialsor quasi-experimental, interrupted time series design. These studies will also provide an opportunity to develop effective and efficient evidence-based strategies.

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