Use of Artificial Intelligence Tools for Diabetes Care: Protocol for Exploring Patient Attitude and Perspective

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Abstract

The prevalence of diabetes is still rising across the world. The high increase in incidence and economic load from diabetes leads to efforts to seek more effective ways to treat and care for diabetic patients. One of the ways is to explore the significant contribution of artificial intelligence (AI) in healthcare. AI has been defined as the ability of computers to perform tasks typically related to human intelligence and their applications are believed to be an essential part of healthcare services that could be embedded into several aspects of clinical diabetic care. However, there is still a lack of research exploring diabetic patients' attitudes and perspectives toward AI applications. Thus, in this study, patients' attitudes and perspectives toward the use of artificial tools for diabetic care will be studied. It is important to understand the patients' views because it will have a positive impact on how research is going to be conducted and to ensure that the work is relevant and useful and that any concerns can be addressed at the beginning. This paper aims to present the preliminary work for this study. A qualitative research design is chosen for this observational study where semi-structured interviews will be used as the data collection method. The participants will be the current patients within a government tertiary hospital located in the south of the royal town of Klang, Selangor, Malaysia. Prior to the study, the concepts of attitude, perspective, and related theories and models are examined. From the literature review, many factors and variables were discovered, and the conceptual framework is proposed as the foundation of this study. The conceptual framework will guide the data collection process whereby a qualitative thematic analysis approach will be employed for this study.

Keywords: artificial intelligence, attitude, patient, perspective, qualitative research

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INTRODUCTION

The earliest work in medical artificial intelligence (AI) dates back to the early 1970s, also known as the AI in medicine (Patel et al., 2009). The father of AI, namely Marvin Minsky defined AI as a machine that can do a task which is considered to be an intelligent one by human beings. AI is a discipline for which the applications fall into two categories, that is, (a) the attempt to reproduce the capabilities of the human mind, and (b) the creation of tools to carry out tasks that today need human action (Lai, Brian, & Mamzer, 2020).

Nowadays, AI technology has emerged in many domains and healthcare. Major disease areas that use AI tools include cancer, neurology, and cardiology; mainly the studies have been about neoplasms (Jiang et al., 2017). AI poses limitations and threats; however, it might be a benefit due to the interpersonal and interventional intrinsic quality of medical activities (Yang et al., 2019).

The applications of artificial intelligence (AI) in health care have increased in the past decade, but little is known about how patients view these applications and whether they have concerns (Wang, Casalino & Khullar, 2019; Khullar et al. 2021). Patient-centered research is a key component of ethical technological development and implementation to determine how patients see the new technology impacting their healthcare. It could assist in

developing a theoretical model to predict how patients are likely to form attitudes and beliefs about medical applications of AI for developing AI tools that are responsive to patient needs and anticipate potential patient concerns or worries. Therefore, this study is conducted to understand patient attitudes and to obtain an overview of how diabetic patients perceive AI in daily practice. More specifically, the objectives of the study are to explore how well patients know about AI tools and what are their concerns about these tools for diabetic care. The patients' attitudes and perspectives or perceptions may condition their future adoption of AI tools or technologies.

Background of Study

This section discusses the definition of artificial intelligence (AI), AI in medicine, AI in diabetes care, past research on patient attitude and perception of the use of AI di diabetes care, related models and theories, and the conceptual framework.

Artificial Intelligence

The phrase "AI" or artificial intelligence first appeared at a famous Dartmouth College conference in 1956 (McCarthy *et al.* 2006) whereby John McCarthy and Marvin Minsky invented AI, not only as a discipline but also as a concept. As a concept, AI is a general and abstract idea that the human mind makes of a concrete or abstract object of thought that enables it to associate the various perceptions that it has of that object. Meanwhile, as a branch of the computer science discipline, it aims to create systems or methods that analyse information and allow the handling of complexity in a wide range of applications (Contreas & Vehi, 2018).

According to Lai et al. (2020), AI is a discipline for which the applications fall into two groups: (1) the attempt to reproduce the capabilities of the human mind and 2) the creation of tools to carry out tasks that today need human action. It has been divided into many sub-disciplines, focusing on very distinct problems such as vision, problem-solving, language comprehension, and learning.

Artificial intelligence (AI) is also the term used to describe the use of computers and technology to simulate intelligent behaviour and critical thinking comparable to a human being (Amisha *et al.* 2019). Computers can perform tasks typically related to human intelligence (Goodfellow et al., 2016) which can impact millions of patients by changing the way medicine is practiced (Richardson et al., 2021). It is also a collection of multiple techniques where different learning algorithms may be used to analyse data. Multiple techniques may be used to implement AI such as fuzzy expert systems, Bayesian networks, artificial neural networks, and hybrid intelligent systems.

There is no united paradigm of research, and some branches of AI have become places of multidisciplinary exchange where philosophers, psychologists, computer scientists, and others who are interested in the various issues of AI can encounter.

Artificial Intelligence in Healthcare

Artificial intelligence (AI) technologies are increasingly prevalent in business and society and are beginning to be applied to healthcare (Davenport and Kalakota, 2019). Major disease areas that use AI tools include cancer, neurology, and cardiology (Yang *et al.* 2019). Several research studies suggest that AI can perform as well as or better than humans at healthcare tasks, for example diagnosing disease. Among AI technologies of high importance to healthcare are machine learning (neural networks and deep learning), natural language processing, rule-based expert systems, physical robots, and robotic process automation. They are briefly described below.

Machine learning

Machine learning is one of the most common forms of AI. It is a statistical technique for fitting models to data and to 'learn' by training models with data. The most common application of traditional machine learning is precision medicine, which predicts what treatment protocols are likely to succeed on a patient based on various patient attributes and the treatment context (Lee, Celik, Logsdon, *et al.*, 2018).

Natural language processing

Natural language processing or NLP, includes applications such as speech recognition, text analysis, translation, and other goals related to language. In healthcare, the NLP systems can analyse unstructured clinical notes on patients, prepare reports (for example, on radiology examinations), transcribe patient interactions, and conduct conversational AI.

Rule-based expert systems

ule-based expert systems were the dominant technology for AI in the 1980s (Davenport & Kalakota, 2019). In healthcare, they were used for 'clinical decision support' purposes over the last couple of decades and are still in use today. They are now slowly being replaced in healthcare by approaches based on data and machine learning algorithms.

Physical robots

Physical robots are well known nowadays, given that many industrial robots are installed around the world. The robots have become more collaborative with humans and easily trained by moving them through desired tasks such as performing surgeries, intelligent prostheses for handicapped people, and elderly care.

Robotics process automation

The robotics process automation involves computer programs on servers whereby it relies on a combination of workflow, business rules, and presentation layer integration with information systems. In healthcare, they are used for repetitive tasks like prior authorization, updating patient records, or billing.

The utilization of AI in healthcare ranges from online scheduling of appointments, online check-ins in medical centres, digitisation of medical records, reminder calls for follow-up appointments and immunization dates for children and pregnant females to drug dosage algorithms and adverse effect warnings while prescribing multidrug combinations (Amisha *et al.* 2019).

In this regard, the role of AI is continually evolving, and understanding the paradigm shift of traditional medical relationships from physician-patient to physician-AI-patient will require awareness of existing human-human interactive structures in medicine and the challenges the introduction of AI poses to them.

Artificial Intelligence in Diabetes Care

Considering the increasing significance of chronic diseases such as Diabetes Mellitus (DM) in the years to come, overworked healthcare systems will increasingly require new approaches to medical care. In this regard, e-health has been presented as a likely helpful approach. E-health is a field at the intersection of medical informatics, public health, and business. It refers to health services and information delivered or enhanced by the internet and related technologies.

Artificial intelligence (AI) can be applied to various types of problems that arise in diabetes care, namely clinical diagnosis, interpretation, monitoring, developing treatment plans, and designing drugs (Sriram and Reddy, 2020). It is one of the technologies widely used in four key areas of diabetes care, including automated retinal screening, clinical decision support, predictive population risk stratification, and patient self-management tools (Dankwa-Mullah *et al.*, 2019).

> ***Automated retinal screening*** – According to Grzybowski et al. (2020), deep learning algorithms have been developed to automate the diagnosis of diabetic retinopathy. AI-based screening of the retina is a feasible, accurate, and well-accepted method for the detection and monitoring of diabetic retinopathy.
>
> ***Clinical decision support*** – Supervised machine learning-based clinical decision support tools have been developed to predict short- and long-term HbA1c response after insulin initiation in patients with type 2 diabetes mellitus (Ellahham, 2020).
>
> ***Predictive population risk stratification* –** A healthcare recommendation system (HRS) using machine learning helped to predict the risk for a disease, including diabetes, by analyzing the patient's lifestyle, physical health factors, mental health factors, and social network activities.
>
> ***Patient self-management tools* –** Self-management is the key to the treatment of diabetes. With the advent of AI, patients are empowered to manage their diabetes, generate data for their parameters, and be their experts for health.

The application of AI to diabetes is feasible and desirable for efficient data handling and the development of tools and devices for its management (Ellahham, 2020). Figure 1 shows the wide applications of AI in diabetes care.

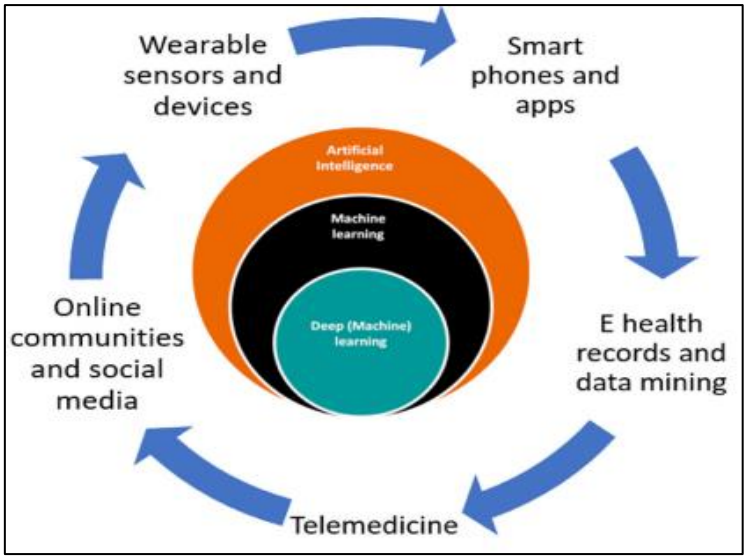

Figure 1: Applications of artificial intelligence in diabetes care (Ellahham, 2020)

Artificial intelligence (AI) could enable patients to rethink diabetes and redefine strategies for the prevention and management of diabetes. However, the greatest challenge to AI in the healthcare domain is not whether the technologies will be capable enough to be useful, but rather ensuring their adoption in daily clinical practice.

Attitude and Perspective

Attitude is the degree to which the person is willing or prefers to perform the behaviour in question. Studies on the theories of reasoned action and planned behaviour have established that attitude is a reliable predictor of intentions and behaviour (Beck & Ajzen, 1991). According to Held, Wewetzer, and Steinhauser (2022), positive and negative personal attitudes to digital technologies were described as essential influencing factors for implementation. In this context, the experiences of patients with the implementation of other digital technologies such as telemedicine into primary care play a role in influencing their attitude to digital technologies.

Attitude also can be classified into beliefs, feelings, and behaviour (Onyeachu and Clarke, 2022). This classification provides a better understanding of the nature of the attitude of the participant and how this relates to other variables and outcomes.

Perspective is about a person's values, preferences, views, concerns, and way of thinking about something (Khullar, 2022). In the context of the patient, perspective is not only what a patient wants or needs but also what they value resulting in more meaningful decision-making for preventive and responsive healthcare (Telfer, 2018).

Past Research on Patients' Attitude and Perspective of the Use of AI in Diabetes Care

Keel *et al.* (2018) have looked specifically at diabetic retinal screening and provided insights into patients' acceptance of the use of automated AI screening. Their findings indicated that a key challenge to the clinical adoption of AI-based technology relates to a mindset shift in how patients entrust clinical practice.

Yap *et al.* (2022) have evaluated the knowledge and perspective of diabetic patients on the use of AI in diabetic retinal screening. They found there is low awareness of clinical AI applications among patients at Auckland and Nelson, in New Zealand. Despite this, most are receptive to the implementation of AI in diabetic eye screening.

Musbahi *et al.* (2021) have explored patient public views on the use of AI in healthcare and found that there is a clear understanding of the potential benefits delivered by this technology. The main benefits were faster health services, greater accuracy in management, AI systems available 24/7, reduced workforce burden, and equality in healthcare decision-making. Meanwhile, the top five concerns were data cybersecurity, bias and quality of AI data, less human interaction, algorithm errors and responsibility, and limitations in technology.

Related Models and Frameworks of Patients' Attitudes and Perspectives

There are a variety of behaviour models, theories, and frameworks for describing patient decision-making and behaviours related to the use of previously developed healthcare technologies. Below are the three main models that could be observed for this research.

The 2-Component Model of Attitude

Attitude is a psychological tendency that determines how patients evaluate their favour or disfavour against AI tools for diabetes care (Eagly, 1993). The 2-component model of attitude (shown in Figure 2) was developed by Fischer and Wiswede (2014) whereby the attitude consists of an affective and a cognitive component that simultaneously forms the behavioural intention, which in turn explains a real behaviour (Bagozzi and Burnkrant, 1979).

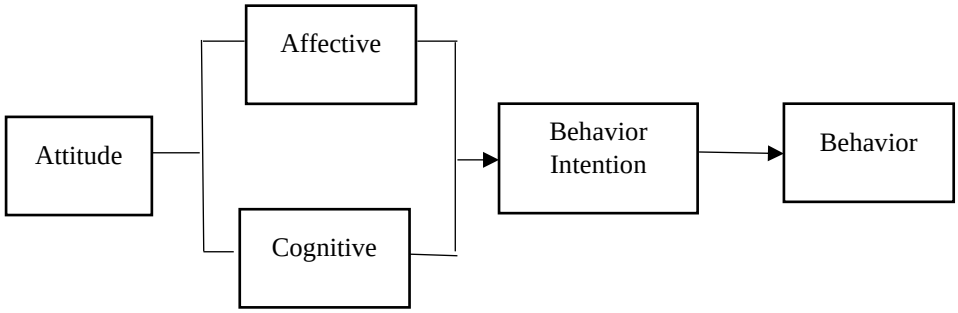

Figure 2: The 2-Component Model of Attitude

Patient Technology Acceptance Model

The patient technology acceptance model (PTAM) developed by Onyeachu and Clarke (2022) can identify that acceptance of technology by patients depends on age (real and perceived) and the illness from which they suffer. Age and illness (i.e., demographic factors) influence the behaviours of the patient and the relationship between the patient and doctors and healthcare service providers.

Figure 3 shows the patient construct consists of six themes (i.e., personality, attitude, support, personal meaning, self-efficacy control, coping strategy adopted) that determine the areas in the life of a patient over which the patient influences to accept or reject the technology.

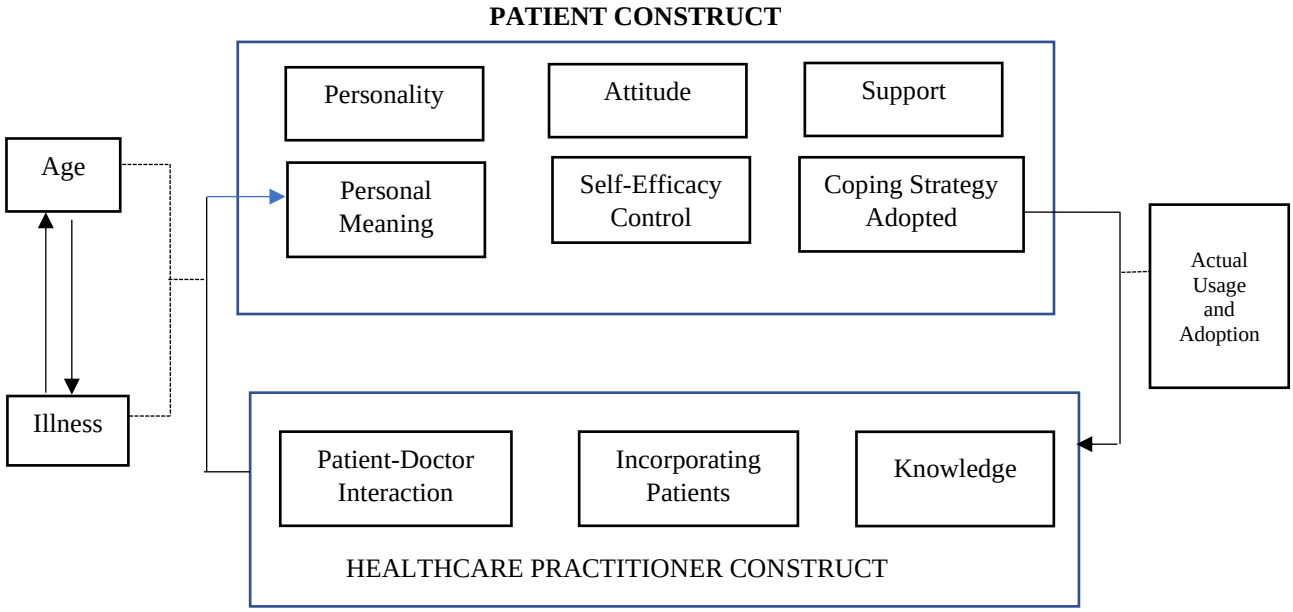

Figure 3: Patient Technology Acceptance Model

Meanwhile, the healthcare practitioner construct in Figure 3 shows how the doctor can influence the acceptance of technology by the patients (Onyeachu and Clarke, 2022). At the same time, age and illness influence the patient and doctor constructs.

A framework for understanding patient attitudes and beliefs about healthcare AI

The framework proposed by Richardson et al. (2022) as shown in Figure 4 reflects multiple interactions among patients' experiences and beliefs related to healthcare technologies, highlighting the role of patients' experiences with medical care, health technologies, nonmedical digital technologies, and their broader social context.

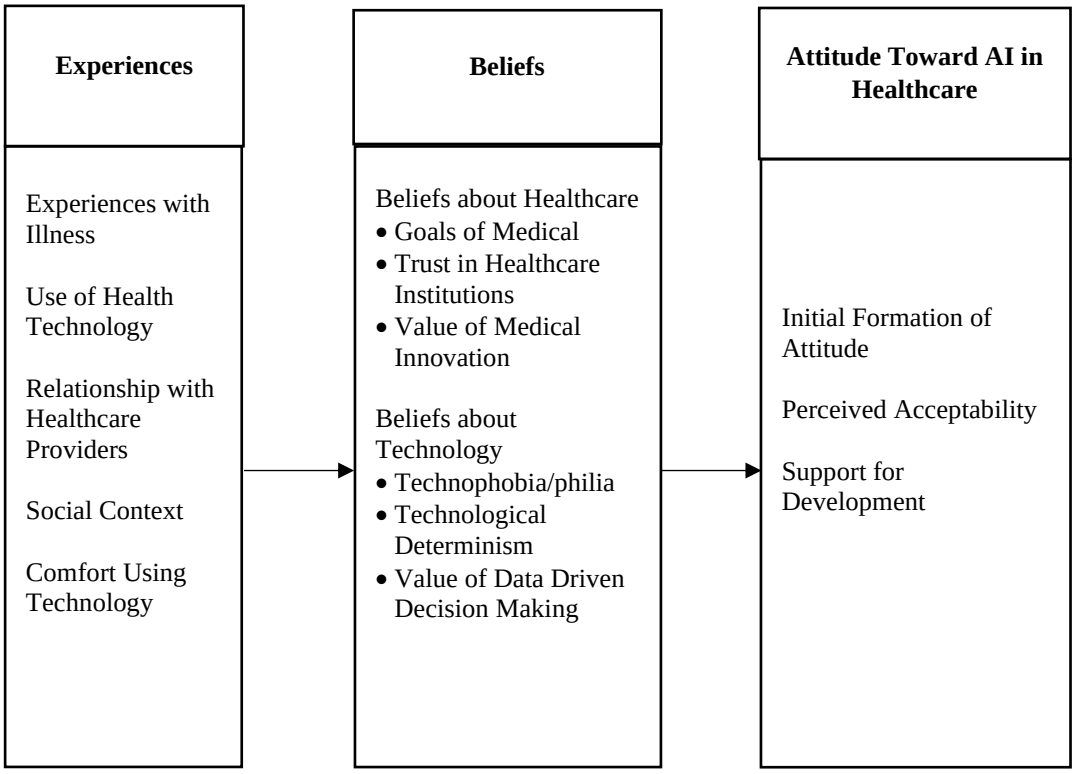

Figure 4: A framework for understanding patients' attitudes and beliefs about healthcare AI

The Research Gap / The Missing Parameter

Research on the attitudes and perspectives of diabetic patients is the basis for the implementation of AI applications. Although the role of AI in diabetes care is anticipated to increase in the future, this technology should also be embraced by patients, who are important but still neglected stakeholders. Currently, it is still unknown how patients view the development of AI in diabetes care in terms of awareness, uncertainties, and expectations. This knowledge is important to define pre-conditions for the development of AI systems for clinical purposes. By identifying the attitudes and perspectives on AI implementation, possible actions could be considered and thought about. Thus, a study that explores the patients' attitudes and perspectives is needed because they might have opinions that are not known by healthcare practitioners or AI developers.

Conceptual Framework

The conceptual framework of this study was based on the review of the extant literature. This framework will be used for the empirical investigation to answer the research questions. The framework below (Figure 5) merged two models (PTAM and Richardson *et al*. framework) to explore the attitudes and perspectives amongst diabetic patients in previous communities.

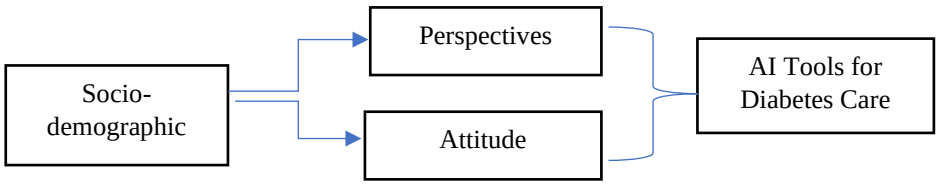

Figure 5: The Conceptual framework

Qualitative Method

Qualitative research is not done for generalisation but rather to produce evidence based on the exploration of specific contexts and particular individuals. The purpose of qualitative research has, thus, been directed toward providing in-depth explanations and meanings rather than generalizing findings. This study aimed to explore patient attitudes and perceptions of the use of AI tools for diabetic care.

For this observational study, in-depth semi-structured interviews will be the data collection method. Purposive sampling will be used to identify participants who are current patients within a government tertiary hospital located in the south of the royal town of Klang, Selangor, Malaysia. The inclusion theory will be that they are Malaysian adults in the age range of 18 - 65 years old and they are categorised under the governmental B40, those whose net income is below RM4,850 per month, and the M40 whose net income is between RM4,852 and RM20,960 per month. In addition, the participants have been living with type 2 diabetes mellitus (DM) with a duration of more than a year and can describe their situation in Malaysia. The expected number of participants will be twenty (20) or until saturation data sets in. Participant recruitment will be stopped once data saturation is achieved. This will be determined when no new or relevant data seems to arise regarding the theme, the theme is well-developed and reveals variation, and the relationships among themes are well-established (Strauss and Corbin, 1998).

All the interviews will be audio-recorded and then transcribed verbatim. Since Malaysia is a country that is made up of Malays, Chinese, and Indians, the language used during the interviews will be that which the participants are comfortable with. The transcribed data will then be translated into English and verified by the language experts from the university. Each interview session will not be more than forty-five (45) minutes long as the participants who are patients in a hospital might tire easily.

The data obtained will then be thematically analysed. Thematic analysis is a method for analysing qualitative data to identify, analyse, and report repeated patterns (Braun & Clarke, 2006; Tong, Sainsbury & Craig, 2007; Sundler, 2019; Kiger & Varpio, 2020). It could describe and interpret data in the process of selecting codes and constructing themes. Figure 6 illustrates the process of thematic analysis.

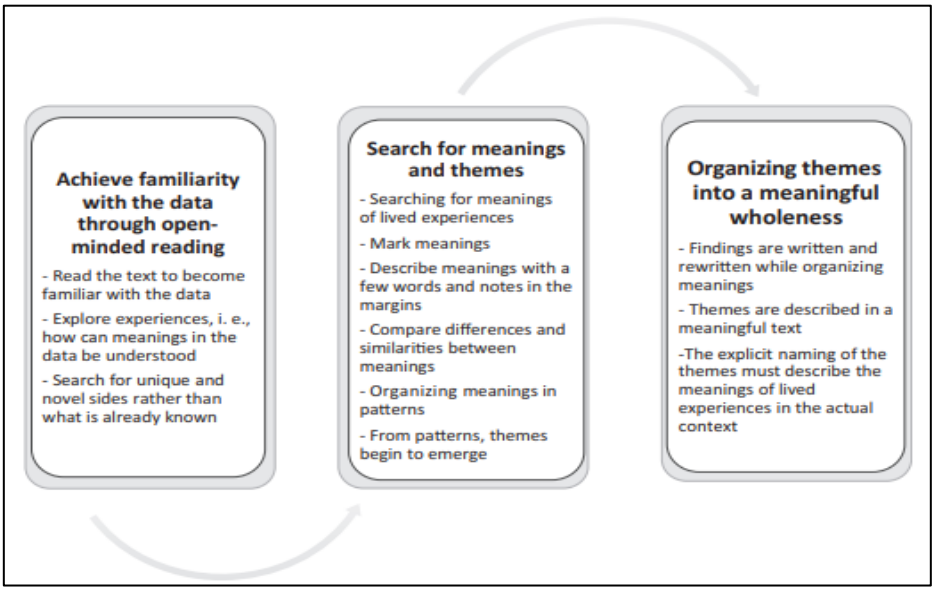

Figure 6: The process of thematic analysis

In this study, a deductive approach to theme identification will be used to improve on a particular aspect of the data that could best understood in the context of a pre-existing framework (Braun & Clarke, 2006). The Braun and Clarke's thematic analysis consists of six steps, namely:

i) Familiarising yourself with the data
ii) Generating initial codes
iii) Searching for themes
iv) Reviewing themes
v) Defining and naming themes
vi) Producing the report/manuscript

This method of analysis is designed to be a recursive, rather than linear process in which subsequent steps may prompt the researcher to circle back to earlier steps in light of new data or newly emerging themes that merit further investigation (Clarke & Braun, 2017).

CONCLUSION AND RECOMMENDATIONS

Artificial intelligence (AI) holds the potential to transform diabetic patient healthcare. The greatest challenge to AI in these healthcare domains is not whether the technologies will be capable enough to be useful, but rather ensuring their adoption in daily clinical practice. The evidence to support whether or not diabetic patients will accept the clinical use of AI is still scarce. In this regard, further research is required to explore the attitudes of Malaysian diabetic patients toward the clinical use of AI and examine the possible influencing factors. Further research investigating patients' attitudes and perceptions is required to assist in designing a sustainable service delivery framework. Thus, the expected outcome of this research will be a new framework that would enable a deeper understanding of patients' attitudes about AI applications and further help to understand the patients' attitudes and perceptions in terms of accepting AI diabetes care applications.

DECLARATION OF STATEMENT

The lead author attests to the manuscript's integrity, declaring that it presents a truthful, accurate, and open picture of the study that was described. There have been no significant omissions from the study, and any differences from the planned (and, if applicable, registered) study have been suitably justified.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest. All co-authors have reviewed and approved the manuscript, and there are no financial interests to disclose.

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