Master thesis

The necessary competences that nurses need to work with artificial intelligence from lifestyle monitoring in smart homes: Scoping review and Delphi study

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Abstract

Background: Continuous lifestyle monitoring of elderly aging in place can play a vital role in reducing risks and ensuring their well-being and safety. This monitoring can be facilitated through smart homes, utilizing artificial intelligence (AI) to collect and analyze data from wearable devices and sensors. Despite the potential benefits of AI in healthcare, many nurses are not fully prepared to embrace AI technology due to a lack of skills and knowledge about AI. Therefore, this study aims to identify and establish comprehensive list of competences for nurses to work with AI in lifestyle monitoring for long-term care in smart homes.

Method: The study methodology consists of two main components: a scoping review and a Delphi study. The scoping review systematically identified and summarized existing literature to gather insights on AI competences for nurses. Complementing this, the Delphi study engages a panel of 48 experts. The two-round Delphi process collects expert feedback, refining a list of 64 competences. Through statistical analysis and consensus criteria, the study derives a final list of AI competences essential for nurses. The experts were asked to rate the relevance and clarity of the competences, and consensus was achieved by an agreement of >80%.

Results: The scoping review resulted in 7 included articles that comprised the initial list of competences, totaling 64 competences across 10 domains. In the first Delphi round, 46 competences achieved consensus on both relevance and clarity. In the second round, 9 out of 19 competences achieved consensus on relevance and clarity.

Conclusion: This study highlights 55 AI competences in nursing, emphasizing the importance of ethical considerations, practical feasibility, ongoing development, and the need for further consensus-building efforts of 10 AI competences for nurses. The ethical aspects play a significant role in the development and integration of AI in nursing practice, these considerations are crucial for ensuring responsible use of AI technologies in healthcare. Furthermore, the practical feasibility of implementing these competences need to be carefully assessed.

Keywords: Artificial Intelligence; Nursing Competences; Lifestyle Monitoring; Education; Smart Home.

1. Introduction

The global challenge of an aging population in social and healthcare is enormous (Turjamaa et al., 2014). According to epidemiological studies, 11% of the world's population is over 65 years old, with a projected increase to 22% by 2050 (Kanasi et al., 2016). On 1 January 2022, the Netherlands counted 3.525.453 inhabitants aged 65 or older, this is 20% of the whole population (Centraal Bureau voor Statistiek, n.d.).

The challenges arising from an aging population are numerous and can have social, economic, and healthcare implications. A key challenge is the need for increased healthcare services and long-term care support. This puts pressure on healthcare systems to meet the growing demand for medical professionals, specialized facilities, and affordable care options (Schulz et al., 2020). In many countries, the emphasis of care for elderly has shifted away from institutional care towards a home care model to cope with the challenges arising from an aging population (Vanleerberghe et al., 2017). There has been a significant shift in healthcare towards prioritizing the maximization of resources available to the elderly population and facilitating their ability to age in place (Vanleerberghe et al., 2017). Aging in place refers to older adults remaining in their own homes and communities as they age, this has gained attention as a preferable alternative to institutional care (Turjamaa et al., 2014).

Aging in place has several advantages over placement in a care facility. Placement in a care facility, particularly when it occurs against an individual's wishes, has been recognized as a significant concern within the field of elderly care (Cutchin, 2003). Liu et al. (2016) have highlighted the negative outcomes associated with involuntary institutionalization, such as social isolation, depression, and increased reliance on others to complete self-care tasks. These adverse effects can impact the well-being and quality of life of elderly (Liu et al., 2016). However, aging in place is not without its disadvantages, particularly in terms of safety and healthcare support. Elderly individuals who choose to age in place frequently rely on informal caregivers, typically their family members. However, informal caregivers often face a burden that is quite high, which may lead to challenges in providing care they need. This can lead to caregivers not being able to cope, and the elderly being placed in a care facility. As a result, the objective of aging in place will be lost (Mihailidis et al., 2004). To help informal caregivers, nurses could monitor lifestyle changes of the individual elderly, to decrease the chance of healthcare problems. Monitoring elderly can play a crucial role in

reducing risks and potentially dangerous situations, promoting their overall well-being and safety (Liu et al., 2019). Continuous monitoring of vital signs, activity levels, and environmental factors can provide valuable insights into an individual's well-being. Changes in vital signs, such as heart rate, blood pressure, or oxygen saturation, can be identified, alerting nurses to potential health concerns. This early detection allows preventing the escalation of health issues and potentially reducing the risk of life-threatening situations (Udupa & Yellampalli, 2018). Monitoring elderly who are aging in place, can be done through a smart home. A smart home is a residential space equipped with various devices, sensors and systems that are interconnected and can be controlled remotely or automated to enhance convenience, energy efficiency, security, and overall quality of life. The smart home system consists of three primary technological components: physical components, the control system, and the communication system (P. Liu et al., 2019; Majumder et al., 2017; Udupa & Yellampalli, 2018).

While safety is a crucial aspect of aging in place, it is equally important to recognize lifestyle changes, to early detect healthcare problems. In recent years, there has been an increasing focus on the role of lifestyle factors in health outcomes (Sharma et al., 2016). Lifestyle choices, such as diet, exercise, and sleep patterns, can have a significant impact on an individual's health and well-being. With the rise of chronic diseases and the aging population, it is becoming increasingly important to monitor and manage lifestyle factors in home care (Kim et al., 2022). Artificial intelligence (AI) has the potential to revolutionize the way lifestyle factors are monitored and managed in home care settings through data from smart homes. AI refers to computer software algorithms that can perform tasks that would normally necessitate human intelligence (Fritz & Dermody, 2019). AI-powered home care solutions can provide real-time insights into lifestyle factors by analyzing data from wearable devices and other sensors by tracking factors, such as physical activity, sleep patterns and dietary habits. Furthermore, AI can provide personalized recommendations to patients and caregivers and be used to identify potential health risks based on lifestyle factors, allowing for early intervention and preventive measures (Sapci & Sapci, 2019). One of the key advantages of AI-powered lifestyle monitoring from smart homes in home care is the ability to provide continuous, 24/7 monitoring. This can help to identify changes in lifestyle patterns that may be indicative of underlying health issues, allowing for early intervention and timely treatment (Fritz & Dermody, 2019).

Research indicates that 63% of nurses are not eagerly embracing AI technology (Sheela, 2022). Many of them feel unprepared for AI implementation, primarily due to a lack of the necessary skills and knowledge. Enhancing AI skills and knowledge could potentially make nurses more willing and better equipped to embrace AI. However, to achieve this, it is crucial for them to understand precisely what these skills entail. This underscores the importance of conducting research into competences in this area (Labrague et al., 2023).

In the professional profile of nurses in the Netherlands, only digital competences, such as Information and Communication Technology (ICT), and e-health are mentioned to enhance personal contact with the care recipient. Nurses should be capable of applying the latest information and communication technologies and providing remote care (e-health) as a complement to personal contact with the care recipient. The professional profile specifies that nurses should have knowledge of the latest ICT applications aimed at improving and supporting communication in healthcare. Additionally, as a skill, nurses should be able to employ digital skills and available ICT capabilities to support professional and patient-centered communication (V&VN, 2020). However, this is not a comprehensive list of competences that nurses need to possess to feel prepared to work with AI. Given the increasing relevance of AI in healthcare, there is a pressing need to identify and define the specific AI competences e that nurses should possess to effectively leverage AI technologies in long-term care.

Research has already been conducted to determine which computer competences nurses should possess. In a study performed by Jiang et al. (2004), seven domains for competences were central: Concepts of hardware, software, and network; Principles of computer applications; Skills in computer usage; Program design; Limitations of the computer; and lastly, Personal and social issues related to attitudes toward the computer. The domain concerning attitudes toward the computer was considered the most important. However, these competences do not extend to encompass the unique skills and knowledge required to work effectively with AI-driven healthcare applications. For example, Nurses should know the basic usage of a computer, login/logout a computer and use a mouse (Jiang et al., 2004).

Addressing this knowledge gap is essential to ensure that nurses are adequately prepared and equipped to embrace AI as an integral part of their professional practice.

In the literature there is a lack of information and articles that provides a comprehensive overview or establishes the expected knowledge, skills, and attitudes, referred to as competences, specifically for nurses in the context to work with AI in lifestyle monitoring. This absence of a comprehensive overview of AI competences creates a significant challenge as it leaves nurses and other healthcare professionals without clear guidance on how to effectively utilize AI in their practice.

This Delphi study aims to gain a comprehensive list of competences for nurses to work with AI in lifestyle monitoring for home care. The following research questions will be addressed:

Main question
"Which competences do nurses need to work with artificial intelligence through lifestyle monitoring in smart homes?"

Sub questions
"Which competences according to the literature do nurses need to work with artificial intelligence through lifestyle monitoring in smart homes?"

"Which competences according to experts from this Delphi study, do nurses need to work with artificial intelligence through lifestyle monitoring in smart homes?"

2. Methods

2.1 Study design

The study design of this study combines the methodologies of a scoping review and the Delphi method. A scoping review was necessary to identify competences that were previously established in literature, forming the initial list for the questionnaire of the Delphi study. The Delphi method was employed to gather opinions, insights, and consensus of a panel of experts regarding these identified competences. This study is a part of a larger study with another researcher, wherein a focus group and an interview with a nurse had already been conducted. The outcomes and insights obtained from the focus group, interview, and literature reviews were incorporated into this study to generate competence list 1, shown in figure 1.

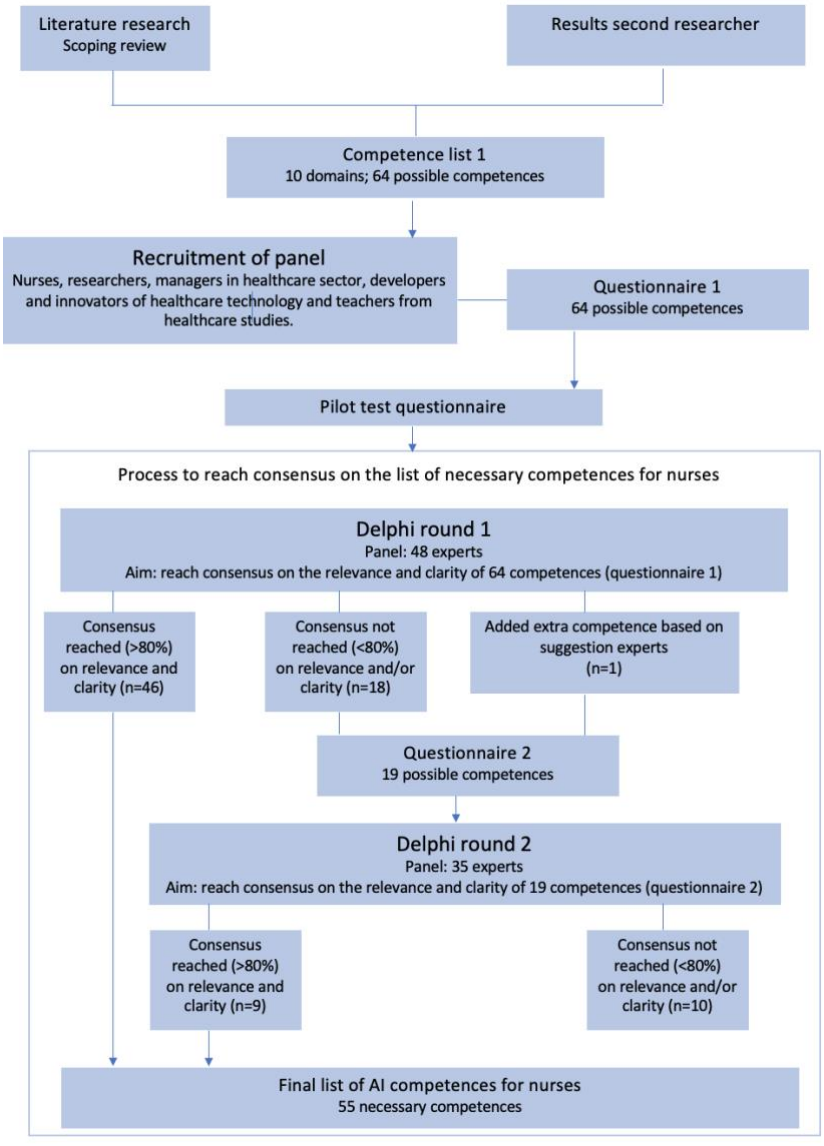

Figure 1: flow diagram study design of the development of necessary nursing competences for AI.

2.2 Scoping review

In an article of Munn et al. (2018), suggestions when to use a scoping review were highlighted. Following the suggestion, a scoping review was conducted to identify the various types of evidence available in a specific field. A scoping review is a type of research synthesis that aims to map and summarize the existing literature on a particular topic. The main goal of a scoping review is to identify the key concepts, types of evidence and gaps in research related to a specific topic (McKinstry et al., 2013). The topic of this study is a very new and specific, and therefore very relevant to use in this study.

The review adhered to the methodology outlined in the guidance document provided by the Joanna Briggs Institute for conducting a scoping review, while also incorporating the framework developed by Arksey and O'Malley (Peters et al., 2015; Arksey & O'Malley, 2005). To ensure comprehensive reporting of the findings, the review followed the 'Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews' checklist (Tricco et al., 2018).

2.2.1 Sources and Search strategy

In March and April of 2023, searches were conducted on PubMed. The search string was formulated with guidance from an Information Specialist working for the faculty department Library, ICT Services & Archive (LISA) at the University of Twente. The search string used was as follows: (AI OR "artificial intelligence" OR “big data” OR "deep learning" OR “machine learning” OR “healthcare technologies”) AND (nurs* OR “medical students” OR “healthcare providers”) AND (“medical curriculum” OR education OR learning OR “technology competencies” OR “nursing informatics”) AND (medicine OR “patient care” OR “home care”). In addition, a single round of snowballing was performed on the primary sources to identify other relevant titles.

2.2.2 Eligibility criteria and Selection process

Different inclusion and exclusion criteria were employed at the title, abstract, and full-text screening phases to narrow down the focus. In the screening process the following criteria were applied:

1. Title screening: During the title screening phase, titles that included AI, topics related to nurses and healthcare professionals, education, or competences were considered, regardless of their target group or setting.

2. Abstract screening: During the abstract screening phase, the primary focus was on determining the relevance of the study. This involved examining the study's background and purpose to determine its alignment with the research focus. Studies were included if their abstracts contained information about the skills and knowledge required by healthcare professionals for using AI or other health technologies, the challenges these professionals encountered with this sort of technologies, or the steps involved in using AI or health technologies in practice. Not only were competences for AI considered, but also other health technologies, such as telehealth. Studies that discussed how to use AI in educating for healthcare students were excluded from consideration.

3. Full-text screening: During the full-text screening phase, several criteria were utilized. Firstly, only studies addressing AI topics or health technologies were considered for inclusion (e.g., the same criteria as step 2). Secondly, studies for which the full-text article could not be obtained, even after contacting the corresponding author, were excluded. Thirdly, studies focusing on target groups other than healthcare professionals or students were excluded. Lastly, only studies published within the past 10 years were included, due to the relatively recent emergence of AI in the healthcare field.

   Given the exploratory nature of the scoping review, the eligibility criterion that was utilized was that the publications should be peer reviewed. No quality appraisals were conducted. Since, scoping reviews do not aim to produce quality appraisals, their primary objective is to provide an overview or map of the available evidence (Munn et al., 2018; Research Guides: Knowledge Synthesis: Systematic, Scoping &Amp; Other Reviews: Quality Assessment and Data Extraction, n.d.).

2.2.3 Scoping review analysis

All search results were uploaded to an online systematic review management platform known as 'Covidence.' This platform improves evidence synthesis by enhancing the efficiency and

experience of creating and maintaining systematic reviews (Kellermeyer et al., 2018). One of its valuable features is the automatic removal of duplicate entries.

Data collection and extraction from the scoping review were conducted by a single researcher from this study. Data was extracted according to a structured data extraction form, to describe to whom and in which setting the identified competences might be relevant, study aim, and setting were extracted. Also, to determine whether distinctions existed in competences based on various categories of health technology and AI. Additionally, information was extracted on type technology, target group, and design methodology used. Finally, all competences mentioned in the paper were extracted.

Through the analysis of the scoping review, competences and domains were identified. To create an initial list of competences without overlap (from different studies), several iterative discussions took place with the research team. Also, during these discussions' decisions were made regarding the categorization of competences into domains, and which domains should be used.

2.3 Delphi study

A Delphi study is a research method that involves a structured and iterative process of gathering and analyzing feedback from a panel of experts. The goal of a Delphi study is to reach a consensus or convergence of opinions from experts on a topic or issue. Delphi studies are often used in areas where there is significant uncertainty or disagreement among experts (Jünger et al., 2017). Van Houwelingen et al. (2016) conducted a similar study focusing on the essential competences for telehealth activities in nursing, utilizing the Delphi method. This indicates that the Delphi method is also suitable for application in this study. In this study, there were two rounds of questionnaires conducted: Delphi round 1 and 2. In both rounds the experts were asked to rate 64 competences on relevance and clarity.

2.3.1 Ethical Approval

Ethical approval for the Delphi study was granted by the ethics committee of the BMS faculty, domain Humanities and Social Sciences, at the University of Twente in the Netherlands (#230212).

2.3.2 Participants and Setting

The process started by selecting a panel of experts who have knowledge and experience with artificial intelligence or other lifestyle monitoring technology. The experts were recruited through convenience sampling within the networks Linked-In, personal contacts and snowball sampling as the experts were asked to further distribute the “sign-up to participate” link among relevant members of their network. The inclusion criteria for this study comprised individuals who met the following requirements: minimum age of 18 years, working in healthcare as a nurse, innovator, developer, researcher, manager, or teacher, and having experience with remote lifestyle monitoring, AI in healthcare, or the utilization of sensors. The sign-up page provided the experts an overview of inclusion criteria’s so they could see if they met the requirements to participate in this study, see Appendix I. Participation in the study was not bound by strict criteria, instead, experts could participate if they believed they met the requirements. However, in the questionnaire, experts were asked to specify their age, work experience and with what kind of technology they had experience. Therefore, it was possible to determine whether the participants had sufficient knowledge and experience to be regarded as "experts."

During the recruitment phase, a total of 78 individuals expressed their interest in participating in this study. However, only 48 experts successfully completed the first questionnaire, and 35 experts completed the second questionnaire. In the second Delphi round, only the 48 participants of the first round were asked to complete the second questionnaire. The panel of experts comprises nurses, researchers, managers in healthcare sector, developers and innovators of healthcare technology and teachers from healthcare studies, see table 1 Sociodemographic characteristics. These experts were asked to complete two series of questionnaires that are designed to elicit their opinions about relevance and clarity on 64 AI competences for nurses within 10 domains. The responses of the first questionnaire were analyzed, and a summary report was generated that provides an overview of the expert’s opinions.

2.3.3 Materials and Procedures

The web-based questionnaire was administered through Qualtrics. The experts got a link in their mailbox if they had signed the “I would like to participate in this study” link. The first round of questions was conducted during May of 2023 and the second round during June of 2023. Participants had two weeks to complete the questionnaires. A reminder email was sent

after the first week, followed by another reminder during the last two days of the allowed time frame. The first questionnaire started with an introduction page that explained the aim of this study and some difficult concepts, followed by informed consent. Second, experts were presented with a set of background questions (i.e., age, gender, level of education, experience technology, experience technology months, work experience, work experience years). Third, the experts had to go through 10 domains, all the domains had several competences, and they had to rate (not – somewhat – quite - very) the competences based on relevance and clarity. Enhancing clarity was a necessary step, because in cases where an item did not achieved consensus, it could be attributed to the experts' potential lack of clarity regarding the intended competences. Consequently, there was a risk of overlooking a critical competence. In the questionnaire, the experts could move for- and backwards. Within the questionnaire's comments section, experts were provided the opportunity to propose additional competences that might have been overlooked in the initial list.

In the second round, only the 48 experts included in the first round received the second questionnaire. The second questionnaire started with a smaller introduction, where the participants could follow a link for the results of the first questionnaire. Followed by the adjusted competences which did not reach consensus in the first Delphi round. Again, the experts rated the competences based on relevance and clarity and they could leave comments.

2.3.4 Analysis

The gathered results underwent analysis utilizing Microsoft Excel software. Statistical measures such as the mean and standard deviation were computed, with additional insights drawn from the accompanying comments. These comments were only used to help (if necessary) reformulating a competence. Consensus was reached when a competence scored >80% of agreement among experts. This could be positive and negative* consensus, if the items scored >80% positive, it meant that the experts agreed that the item was relevant/clear. If the item scored >80% negative, it meant that the experts agreed that the item was not relevant/clear. There were four options that could appear in the results. Firstly, positive consensus on both relevance and clarity, in this case the item would directly be added to the final list of competences. Secondly, positive consensus only reached on relevance. In this case, the item is not clear and understandable formulated. Therefore, the item should be reformulated and asked again in the second Delphi round. Thirdly, positive consensus only reached on clarity, and negative consensus on relevance. When this appeared, the competence

should be removed from the list of competences and should not be asked again in the second Delphi round. However, if negative consensus was not reached, the competence should be asked again, because there are some experts that found it relevant. Fourthly, there is no consensus reached on relevance and clarity. Then, the item should be reformulated and asked again in the second round. The analysis was the same for the first and second Delphi round.

This analysis framework aligns with the methodology employed by Jünger et al. (2017) and Van Houwelingen et al. (2016) in their Delphi studies, wherein the identical rating scale was utilized. In instances where consensus was not attained (scoring <80%) on competence relevance and clarity, these comments were used to refine the formulation of competences for the second questionnaire.

*Negative consensus did not occur in this study.

3. Results

3.1 Summary of included literature

The identification of records resulted in 2469 hits. After the removal of duplicates, 2457 studies remained for the screening process. After the application of the inclusion- and exclusion criteria, a final selection of seven studies from the years 2013 to 2023 were included. Figure 2 shows the study selection process.

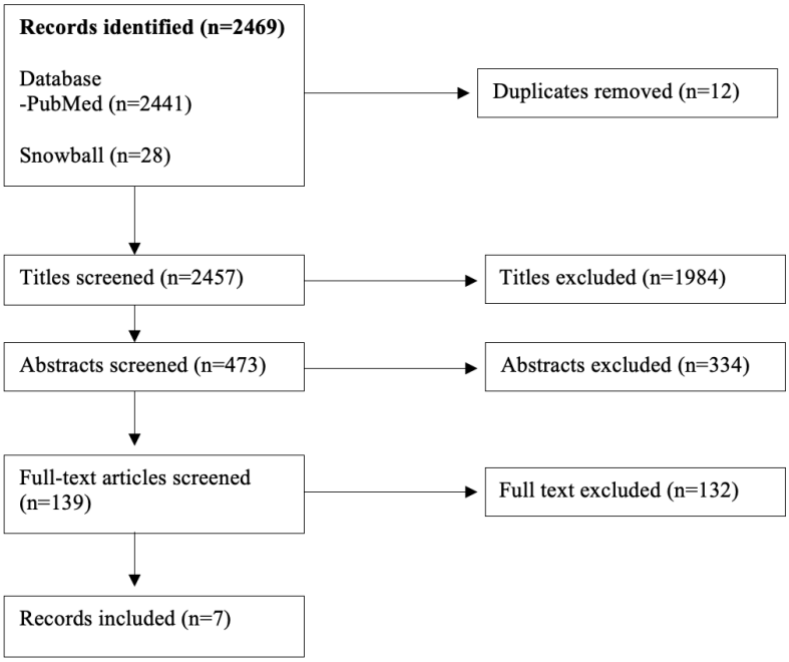

Figure 2 PRISMA flow diagram of scoping review

In table 1 the study characteristics of the included articles from the scoping review are shown. Most of the included articles that aimed to identify nursing competences for telehealth were conducting the Delphi method and were used in a clinical and healthcare setting. Furthermore, other included studies discussed what needed to be adjusted in the education program to prepare medical students for the use of AI, these articles were conducting a literature review.

Table 1
Study characteristics of the included articles

Author (year), country	Technology	Study design	Setting	Competences
Rutledge et al. (2021), United States of America Study aim: The study seeks to develop and describe the development of telehealth competences for nursing education and practice.	Type technology: Telehealth Target group: Nurses	**Methods** (objective) Delphi method was conducted, with use of the four P's of Telehealth framework (planning, preparing, providing, and performance evaluation).	Clinical and Healthcare	Competences created in domain: 1 Basis 2 Produce 3 Indicate 4 Personalize 7 Intergrade 9 Implement

				10 Evaluate
Author (year), country	**Technology**	**Study design**	**Setting**	**Competences**
Charow et al. (2021), Canada Study aim: This scoping review aims to provide an overview of the types of current or past AI education programs that pertains to the programs' curricular content, modes of delivery, critical implementation factors for education delivery, and outcomes used to assess the programs' effectiveness.	Type technology: Artificial Intelligence Target group: Physicians, nurses, and radiology technologist.	**Methods** (objective) Scoping Review: Stage 1 Search Strategy The widespread use of terms relating to health professions and education in health sciences literature, the decision was made to focus the searches on health professions education concepts. Stage 2 Study Selection The 2-stage screening process consisted of (1) title and abstract scan and (2) full-text review. Stage 3 Data Collection The following domains where captured: article details, study details, education program details, and implementation factors. Stage 4 Synthesizing and Reporting the results To report on the included studies, a narrative synthesis approach was used. This included a numeric summary using descriptive statistics to report each domain. For program curriculum under education program details, curriculum topics were inductively coded.	Clinical and Healthcare	Competences created in domain: 1 Basis 2 Produce 5 Register 7 Intergrade 8 Communicate 9 Implement 10 Evaluate
Author (year), country	**Technology**	**Study design**	**Setting**	**Competences**
Van Houwelingen et al. (2016), The Netherlands Study aim: The article presents essential Nursing Telehealth Entrustable Professional Activities (NT-EPAs) and corresponding competences for nurses.	Type technology: Telehealth Target group: Nurses	**Methods** (objective) Delphi method Four round Delphi study: Rate competencies (Collect expert ratings on 52 competences' importance) Feedback (Provide experts with feedback for rating revisions) Revise (Allow experts to refine ratings based on feedback) Consensus (Aim for consensus by setting a 80% agreement threshold on competencies) Results and discussion (Identify 14 Nursing Telehealth Entrustable Professional Activities (NT-EPAs) and a total of 52 essential competencies for telehealth nursing.	Clinical Nursing Healthcare	Competences created in domain: 1 Basis 3 Indicate 4 Personalize 5 Register 6 Interpret 7 Intergrade 8 Communicate 9 Implement 10 Evaluate
Author (year), country	**Technology**	**Study design**	**Setting**	**Competences**
Park et al. (2019), Korea Study aim: The purpose of this study is to provide a succinct summary of the current state of AI from a medical	Type technology: Artificial Intelligence Target group: Medical students	**Methods** (objective) Literature review	Chronic illnesses or primary healthcare	Competences created in domain: 1 Basis 2 Produce 3 Indicate 4 Personalize

viewpoint and suggest what medical students should do to prepare for the era of AI in medicine.				6 Interpret 10 Evaluate

Author (year), country	Technology	Study design	Setting	Competences
Civaner et al. (2022), Turkey Study aim: This study examined the perceptions of future physicians on the possible influences of artificial intelligence on medicine, and to determine the needs that might be helpful for curriculum restructuring.	Type technology: Artificial Intelligence Target group: Future physicians	**Methods** (objective) A cross-sectional multi-centre study: In this study a literature review and survey were conducted.	Medical education	Competences created in domain: 1 Basis 6 Interpret 8 Communicate 10 Evaluate

Author (year), country	Technology	Study design	Setting	Competences
Han et al. (2019), Korea Study aim: The aim is to identify and synthesize the values that medical educators need to implement in the curricula and to introduce representative educational programs for students to work with advanced technology and artificial intelligence.	Type technology: Advanced technology and Artificial Intelligence Target group: Future physicians	**Methods** (objective) An integrative review: Literature research existing of various experimental and non-experimental research.	Clinical Healthcare	Competences created in domain: 1 Basis 2 Produce 7 Integrate 8 Communicate 10 Evaluate

Author (year), country	Technology	Study design	Setting	Competences
Jeong. (2020), Korea Study aim: The aim is to find out if it is necessary to introduce education on AI into the nursing curriculum.	Type technology: Artificial Intelligence Target group: Nurses	**Methods** (objective) Literature review	Women's health nursing	Competences created in domain: 1 Basis 3 Indicate 6 Interpret 7 Intergrade

After the scoping review the competences, shown in table 2, were divided into 10 domains. Domain 1 Basis is a broad domain, it is about having a basic level of knowledge, skills, and attitude regarding AI in healthcare. Nurses should also have insight into the validity and reliability of AI. Furthermore, nurses should be aware of the ethical risks and feel responsible for correct handling patients' data. An example, the study of Civaner et al. (2022) implies that the ethical and legal implications of AI systems are essential in ensuring safe and informed use of AI systems, and specific learning objectives should include frameworks to approach AI ethics and facilitating discussions of important AI ethics topics like liability and data privacy. Additionally, Jeong (2020) suggested the following content for an AI curriculum in nursing

education: big data, the concept of AI, algorithms, models of machine learning, and the model of deep learning. Also, the curriculum should include coding practice with Python.

Domain 2 Produce is about the development of Lifestyle Monitoring with Artificial Intelligence (LMAI). Nurses need to be open to participating in the development process, leveraging their expertise to enhance and refine LMAI technologies. Additionally, the nurse stays engaged with and critically assesses new developments in the LMAI domain. They play a role in identifying the preferences and requirements of patients, informal caregivers, and colleagues concerning LMAI utilization. The nurse should be able to improve, test, validate and develop LMAI application, ensuring their functionality and effectiveness. For example, both Charow et al. (2021) and Park et al. (2019) described that a nurse should have the skills to develop, test and validate AI algorithms.

Domain 3 Indicate is about assessing whether an LMAI application is suitable in a given situation. In this domain it is important that nurses can set goals for patients to use LMAI and decide if it is suitable for a specific patient, knowing the advantages and disadvantages of using LMAI. According to Van Houwelingen et al. (2016), it is essential for nurses to be able to assess whether telehealth (or in this case LMAI) technology is convenient for a patient using established criteria, like cognitive ability.

Domain 4 Personalize is about configuring the LMAI application to align with a patients' situation. It is important that the nurse plays a central role in the effective utilization of LMAI in healthcare. This involves establishing agreements with the patient and informal caregivers regarding LMAI use, configuring the technology to match patient goals and preferences, providing training on its usage, strategically placing sensors for data collection, and collaborating with technical experts. Van Houwelingen et al. (2016) wrote that nurses should be able to provide training to patients in the use of technology.

Domain 5 Register is about reporting measurements and data from the patient in accordance with the workflow of the LMAI application. The nurse should be able to demonstrate an understanding of the significance of accurate and thorough reporting of patient measurements and data related to LMAI. This includes the ability to report this information in a format compatible with LMAI, recognizing the link between patient input data and its utilization by LMAI. The nurse can also identify the specific measurements and data required to derive

meaningful insights from LMAI. Furthermore, the nurse possesses knowledge of the relevant laws and regulations governing the protection and exchange of medical data, ensuring compliance with legal standards. Van Houwelingen et al. (2016) emphasized the importance of nurses possessing knowledge regarding laws and regulations concerning the protections and exchange of medical data, e.g., data protection and confidentiality.

Domain 6 Interpret is about reading, processing, and analyzing the output of LMAI application. The nurse possesses a range of competences related to interpreting and utilizing the outcomes produced by the LMAI. This includes a deep understanding of the application's output, the ability to link LMAI results to the patient's clinical condition, and an awareness of the reliability and potential limitations of LMAI data. A quote from Park et al. (2019, p4) "Medical students should try to develop abilities to distinguish correct information from hype and spin and even capabilities to create thorough- ly validated, trustworthy information for patients and the public." To interpret data accurately, it is crucial to distinguish between accurate data generated by the AI system and any potentially biased information it might produce. Therefore, nurses would need skills to interpret the AI generated data, to assess its reliability to a patient's case.

Domain 7 Intergrade is about effectively applying the output of an LMAI application in practice. Nurses are receptive to incorporating technology advice into their decision-making processes, recognizing the potential of LMAI in early detection of patient health and behavioral changes. Nurses should understand responsibilities regarding the utilization of LMAI outcomes and can proficiently monitor a patient's health condition using this technology. They integrate LMAI outcomes into their patient-centered approach, adhering to relevant protocols for its integration. Importantly, nurses possess the capability to make autonomous decisions and, when necessary, consciously deviate from LMAI recommendations. According to, Han et al. (2019) healthcare professionals should prioritize a humanistic approach by integrating AI technology, to deal with the complexity of patients that are not easily accessible with technology.

Domain 8 Communicate is about communicating with patients, informal caregivers, colleagues, and technical experts about the use of LMAI. Nurses need to have good communication skills to explain to patients and informal caregivers the role of LMAI outcomes in healthcare decision-making, ensuring transparency and comprehension.

Additionally, the nurse actively engages in collaboration with patients, informal caregivers, and formal healthcare providers, facilitating
discussions and consensus-building related to LMAI outcomes and their practical application. According to, Charow et al. (2021) healthcare professionals should know how to communicate results with patients in a personalized and meaningful way and discuss the use of AI in the medical decision-making process.

Domain 9 Implement is about guiding the implementation of an LMAI application in a structured manner. During the implementation, nurses serve as guides for patients, colleagues and other healthcare providers, imparting knowledge, and expertise on LMAI implementation. Furthermore, the nurse is well-versed in the organization's policies, procedures, and protocols concerning LMAI deployment. They possess an understanding of the associated costs, encompassing both organizational and patient perspectives. Implementation of AI in health care settings: healthcare professionals need to understand how to embed AI tools into clinical settings and workflows. Specifically, this implementation of AI in health care settings includes requirements for clinical translation and interpretation of model outputs (Charow et al., 2021).

Domain 10 Evaluate is about evaluating the use of LMAI with patients, informal caregivers, and colleagues. Nurses should also possess evaluation skills. It is important that they can effectively assess the effectiveness of interventions informed by LMAI outcomes, determining whether the intended goals have been met. Additionally, maintaining a critical perspective, ensuring transparency in both LMAI outcomes and any unintended consequences that may arise. According to Van Houwelingen et al. (2016) nurses should know how to evaluate and adjust the patient care plan. Nurses actively involve patients and family caregivers to their patient care plan. Therefore, nurses evaluate the patient care plan in consultation with the patient. When patients use telehealth services, ‘the use of telehealth’ is part of the evaluation because the use of telehealth is a part of their patient care plan (Van Houwelingen et al., 2016).

Table 2
Identified competences with source [Competence list 1]

	Domain 1 Basis	**Source**
1.1	The nurse has a clear understanding of the (im)possibilities of AI technology.	Charow et al. (2021);

1.2	The nurse maintains a positive-critical attitude towards AI technology.	Delphi
1.3	The nurse understands relevant AI concepts such as algorithms, analysis, big data, machine learning, and deep learning.	Charow et al. (2021); Rutledge et al. (2021); Civaner et al. (2022); Park et al. (2019); Jeong (2020);
1.4	The nurse can provide examples of AI applications used in healthcare.	Charow et al. (2021); Van Houwelingen et al. (2016); Jeong (2020);
1.5	The nurse possesses the digital skills required to work with AI technology.	Charow et al. (2021); Rutledge et al. (2021); Van Houwelingen et al. (2016); Civaner et al. (2022); Park et al. (2019); Jeong (2020); Han et al. (2019)
1.6	The nurse is aware of and takes into account the ethical risks associated with the use of AI technology, such as privacy, fairness, and security.	Charow et al. (2021); Rutledge et al. (2021); Van Houwelingen et al. (2016); Civaner et al. (2022); Park et al. (2019); Jeong (2020); Han et al. (2019);
1.7	The nurse has insight into the validity and reliability of AI concerning the target audience.	Charow et al. (2021); Van Houwelingen et al. (2016);
1.8	The nurse feels responsible for handling patient data correctly when using AI applications.	Charow et al. (2021); Rutledge et al. (2021); Van Houwelingen et al. (2016);
1.9	The nurse is willing to invest time in working with AI technology, both for themselves and for patients and caregivers.	Delphi
1.10	The nurse can code (at a basic level) in various programming languages, such as Python.	Civaner et al. (2022); Jeong (2020);
	Domain 2 Produce	
2.1	The nurse is open to playing a role in the development of LMAI applications.	Delphi
2.2	The nurse contributes from their expertise to improve and develop LMAI.	Charow et al. (2021);
2.3	The nurse actively engages in and critically examines new developments related to LMAI.	Delphi
2.4	The nurse identifies the wishes and needs of patients, informal caregivers, and colleagues regarding the use of LMAI.	Charow et al. (2021); Rutledge et al. (2021); Han et al. (2019)
2.5	The nurse can connect various stakeholders, including IT professionals, innovators, and developers, to advocate for practical needs in LMAI development.	Van Houwelingen et al. (2016);
2.6	The nurse can test and validate an LMAI application prototype using real-world data.	Charow et al. (2021); Park et al. (2019);
	Domain 3 Indicate	

3.1	The nurse can assess whether LMAI is suitable for a given situation, taking into account the patient and informal caregivers.	Van Houwelingen et al. (2016);
3.2	The nurse can identify the wishes and needs of a patient and their informal caregivers in terms of LMAI support.	Van Houwelingen et al. (2016); Rutledge et al. (2021);
3.3	The nurse has knowledge of the potential advantages and disadvantages of using LMAI and can relate this to a patient's situation.	Van Houwelingen et al. (2016); Park et al. (2019); Jeong (2020);
3.4	The nurse can collaboratively set goals with the patient to be pursued with the help of LMAI.	Delphi
3.5	The nurse can choose from available sensors and determine which ones best match the patient's wishes, needs, and skills.	Delphi
	Domain 4 Personalize	
4.1	The nurse can make agreements with the patient and caregivers regarding the use of LMAI.	Van Houwelingen et al. (2016); Rutledge et al. (2021);
4.2	The nurse can configure LMAI to align with the goals and preferences of the patient, including configuring functionalities and alerts.	Van Houwelingen et al. (2016); Park et al. (2019);
4.3	The nurse can train the patient and caregivers in using the technology.	Van Houwelingen et al. (2016);
4.4	The nurse can strategically position sensors in the environment to reliably collect data.	Delphi
4.5	The nurse can collaborate with a technical team to resolve issues with LMAI during technical malfunctions.	Delphi
	Domain 5 Register	
5.1	The nurse is aware of the importance of accurately and comprehensively reporting patient measurements and data in relation to LMAI.	Delphi
5.2	The nurse can report patient measurements and data in a suitable manner for LMAI use.	Van Houwelingen et al. (2016);
5.3	The nurse understands the relationship between the patient's input data and how LMAI utilizes it.	Van Houwelingen et al. (2016);
5.4	The nurse can specify which patient measurements and data are necessary to obtain meaningful results from LMAI.	Delphi
5.5	The nurse promotes the importance of a uniform reporting approach among colleagues to ensure data and care quality.	Delphi
5.6	The nurse has knowledge of the laws and regulations regarding medical data protection and exchange.	Charow et al. (2021); Van Houwelingen et al. (2016);
	Domain 6 Interpret	
6.1	The nurse can interpret the outcomes generated by the LMAI application.	Civaner et al. (2022); Van Houwelingen et al. (2016);
6.2	The nurse understands the output of LMAI.	Civaner et al. (2022); Van Houwelingen et al. (2016);
6.3	The nurse can relate the relevance of LMAI output to the patient's clinical situation.	Delphi
6.4	The nurse has insight into the reliability of LMAI output.	Van Houwelingen et al. (2016); Civaner et al. (2022); Jeong (2020);
6.5	The nurse is aware of the (clinical) limitations of LMAI.	Charow et al. (2021);

6.6	The nurse can assess whether the LMAI output is alarming.	Delphi
6.7	The nurse is aware of factors that can make the output of an LMAI application less reliable for specific patient groups.	Park et al. (2019); Jeong (2020);
	Domain 7 Intergrade	
7.1	The nurse is open to using technology advice in clinical decision-making.	Charow et al. (2021); Civaner et al. (2022);
7.2	The nurse is aware of the role that LMAI can play in early detection of patient health and behavioral changes.	Van Houwelingen et al. (2016);
7.3	The nurse is aware of their responsibilities regarding the use of LMAI outcomes.	Van Houwelingen et al. (2016); Jeong (2020);
7.4	The nurse can monitor a patient's health condition using LMAI.	Van Houwelingen et al. (2016);
7.5	The nurse can compare LMAI outcomes with expectations based on clinical experience.	Charow et al. (2021); Civaner et al. (2022);
7.6	The nurse can use LMAI outcomes, supplemented with clinical experience, to make care decisions and implement interventions.	Delphi
7.7	The nurse can incorporate LMAI outcomes into their work in a patient-centered manner.	Van Houwelingen et al. (2016); Han et al. (2019)
7.8	The nurse has knowledge of relevant protocols for integrating LMAI into clinical decision-making.	Rutledge et al. (2021); Han et al. (2019)
7.9	The nurse is capable of making independent choices and can consciously deviate from LMAI recommendations when necessary.	Delphi
7.10	The nurse knows the rights and responsibilities of the nurse in collaboration with LMAI.	Van Houwelingen et al. (2016);
	Domain 8 Communicate	
8.1	The nurse communicates in an understandable manner to build trust in LMAI among patients and informal caregivers.	Charow et al. (2021); Van Houwelingen et al. (2016); Civaner et al. (2022);
8.2	The nurse can explain to patients and informal caregivers how LMAI outcomes are used to make healthcare decisions.	Charow et al. (2021); Van Houwelingen et al. (2016); Civaner et al. (2022); Han et al. (2019)
8.3	The nurse collaborates with patients, informal caregivers, and formal healthcare providers on LMAI outcomes and implementation.	Van Houwelingen et al. (2016);
8.4	The nurse can communicate with IT professionals and other technical experts about LMAI deployment, including any necessary adjustments.	Van Houwelingen et al. (2016);
	Domain 9 Implement	
9.1	The nurse coordinates the patient's care process using LMAI.	Van Houwelingen et al. (2016); Rutledge et al. (2021);
9.2	The nurse guides (new) colleagues and other healthcare providers in working with LMAI.	Van Houwelingen et al. (2016);
9.3	The nurse has knowledge of the organization's policies, procedures, and protocols regarding LMAI deployment.	Van Houwelingen et al. (2016);
9.4	The nurse understands the costs of LMAI deployment, both for the organization and the patient.	Charow et al. (2021); Rutledge et al. (2021);
9.5	The nurse comprehends how LMAI can be integrated into clinical environments and existing workflows.	Charow et al. (2021);

9.6	The nurse can deploy and adapt LMAI to align with the organization's existing processes and the patient's needs.	Delphi
9.7	The nurse can provide information about LMAI to other healthcare professionals.	Van Houwelingen et al. (2016);
	Domain 10 Evaluate	
10.1	The nurse can evaluate the effectiveness of interventions based on LMAI outcomes by assessing whether the intended goals have been achieved.	Van Houwelingen et al. (2016); Rutledge et al. (2021); Park et al. (2019);
10.2	The nurse maintains a critical perspective to make LMAI outcomes and unintended consequences transparent.	Delphi
10.3	The nurse can think critically based on experiences to better align LMAI with clinical questions.	Charow et al. (2021);
10.4	The nurse can understand and report system errors.	Van Houwelingen et al. (2016); Civaner et al. (2022); Han et al. (2019)

3.2 Results Delphi round 1

In the first round, a total of 48 experts completed the questionnaire which consists of 64 competences across 10 domains. All the competences that were presented in the first questionnaire are shown in table 2, competence list 1.

3.2.1 Sociodemographic Characteristics

In this study participated a diverse group of experts with varying sociodemographic characteristics and technology-related experiences, all the results are shown in table 3. The participants' age distribution shows a broad range, most participants age is between 31-40 years old (33%) and held WO-master’s degrees (52%).

Experts had experience within several fields of technology, like remotely lifestyle monitoring, AI and different sensors. Experts provided additional instances such as smart floors (a type of intelligent floor technology that is equipped with sensors to collect data and monitor environmental conditions (Tošić et al., 2021)), eHealth solutions, and demotics (same concept as smart home technology (Simonet & Noyce, 2021)). Most of the experts have over 24 months of experience with health technologies. Some experts indicated that they lacked practical experience with these kinds of technology but possessed substantial theoretical knowledge.

Regarding work experience, the sample comprises individuals from a wide array of professions, including nursing, teaching, research, healthcare management, and technology development. Additionally, there are experts who serve as vitality coaches or consultants for

health technologies. The majority have less than 10 years of work experience, contributing to a diverse mix of expertise levels.

Table 3
Sociodemographic characteristics

Sociodemographic characteristics	**Frequency, n (%)**
Age	
20-30	11 (22.9)
31-40	16 (33.3)
41-50	6 (12.5)
50+	15 (31.3)
Gender	
Male	20 (41.7)
Woman	28 (58.3)
Level of education	
MBO	1 (2.1)
HBO	14 (29.2)
WO Bachelor	3 (6.2)
WO Master	25 (52.1)
PHD*	5 (10.4)
Technology experience	
Artificial intelligence in healthcare	24 (17.8)
Fall and motion sensors	32 (23.7)
Body sensors	34 (25.2)
Lifestyle monitoring at distance	28 (20.7)
No experience	2 (1.5)
Other	15 (11.1)
Technology experience in months	
<6	8 (16.7)
6-12	4 (8.3)

12-24	4 (8.3)
>24	26 (54.2)
Other	6 (12.5)
Work experience	
MBO nursing	1 (1.5)
HBO nursing	12 (17.6)
MBO teacher	2 (2.9)
HBO teacher	8 (11.8)
WO teacher	0 (0.0)
Researcher	17 (25.0)
Manager in healthcare	5 (7.4)
Innovator in healthcare	14 (20.6)
Developer of technology	3 (4.4)
Other	6 (8.8)
Work experience in years	
<5	17 (35.4)
5-10	19 (39.6)
11-15	2 (4.2)
>15	10 (20.8)

*This section was “other”, however all the 5 experts filled in PHD.

3.2.2 Competences

In table 4 the results of Delphi round 1 are summarized. In this round, 46 competences reached positive consensus on both relevance and clarity. There were four items that achieved consensus on relevance but not on clarity. Consensus on clarity alone was reached for nine competences. However, they did not reach negative consensus, therefore the competences were reformulated and asked again in Delphi round 2. There were five competences that did not reach consensus on relevance and clarity. The competences that did not reach consensus regarding their relevance and/or clarity (n=18) were reformulated and presented again in the second questionnaire of Delphi round 2. Meanwhile, the competences that achieved positive consensus on both relevance and clarity (n=46) were directly integrated into the final list of AI competences for nurses. All the results are shown in Appendix II. In domain 10, one

competence was added based on recommendations of experts. It is noticeable that in Domain 4, four out of five competences did not reach consensus on relevance only. However, the 4 competences scored higher than 70%, with the exception of competence 4.4, which scored 56% on relevance. It is also noticeable that the most disagreement among the experts occurs in Domains 1 and 2. The standard deviation often hovers around 0.9 (see Appendix II). Furthermore, concerning the competences in Domains 3, 5, 6, 7, 8, 9, and 10, they are clear and relevant. From these domains, only 5 items need to be reformulated.

Table 4
Summary results Delphi round 1

Domain	Number of competences	Mean relevance	Mean clarity
1. Basis	10	3.08	3.06
2. Produce	6	2.87	3.21
3. Indicate	5	3.45	3.43
4. Personalize	5	3.16	3.42
5. Register	6	3.25	3.27
6. Interpret	7	3.38	3.34
7. Integrate	10	3.46	3.33
8. Communicate	4	3.50	3.52
9. Implement	7	3.13	3.41
10. Evaluate	4	3.39	3.42

3.3 Results Delphi round 2

During this stage, 18 +1 competences were refined and subsequently re-evaluated for their relevance and clarity in the second questionnaire. Table 6 represents the competences that were asked in the second questionnaire. A summary of the results is shown in Table 5. An example of a competence that have been reformulated is competence 7.7. This item was formulated from “The nurse can incorporate LMAI outcomes into their work in a patient-centered manner.” to “The nurse can use the outcomes of LMAI to provide person-centered care.”. In the second round, the item achieved consensus on both relevance and clarity. During the analysis of Domain 10 - Evaluating, several experts recommended the inclusion of a competence related to self-reflection in the context of working with LMAI. Consequently, this suggested competence was integrated into domain 10 as competence 10.5: The nurse can assess what the personal contribution has been in the process of working with LMAI and

whether any changes are needed in this regard. However, in the second round, the competence scored 74% on relevance and 59% on clarity. Therefore, competence 10.5 is excluded of the final list of competences. The complete collection of results of Delphi round 2 can be found in Appendix III.

Table 5
Summary results Delphi round 2

Domain	Number of competences	Mean relevance	Mean clarity
1. Basis	6	2.99	3.09
2. Produce	4	2.99	3.17
4. Personalize	4	3.22	3.27
5. Register	1	3.29	3.26
6. Interpret	1	3.03	3.14
7. Integrate	1	3.57	3.51
9. Implement	1	2.46	3.14
10. Evaluate	1	2.97	2.57

Table 6
Competences asked in Delphi round 2

Domain	**Competence**
1.1	The nurse has knowledge of how AI technology can be used in healthcare.
1.3	The nurse understands relevant AI concepts (algorithms, analytics, big data, machine learning, and deep learning) in relation to the nursing domain.
1.5	The nurse possesses skills to work with AI technology in healthcare.
1.7	The nurse understands how the data on which an AI system is trained can impact the system's output.
1.9	The nurse is willing to invest time in learning to work with AI technology.
1.10	The nurse has basic coding skills.
2.3	The nurse is aware of new developments in LMAI.
2.4	The nurse assesses the preferences and needs of patients, caregivers, and colleagues regarding LMAI.
2.5	The nurse can connect various disciplines (such as IT professionals, innovators, developers) to raise awareness of nursing practice needs in the development of LMAI.
2.6	The nurse can test a prototype LMAI application for suitability in practice.
4.2	The nurse can configure LMAI to align with the goals and the patient's needs.
4.3	The nurse practices with patients and caregivers on how to use LMAI.

4.4	The nurse properly places sensors to reliably collect data.
4.5	The nurse can identify issues in case of a malfunction, allowing the technical department to resolve them.
5.4	The nurse can determine the necessary measurements and data to obtain meaningful results from LMAI.
6.4	The nurse can assess the reliability of LMAI output.
7.7	The nurse can use the outcomes of LMAI to provide person-centered care.
9.4	The nurse understands the costs associated with the use of LMAI, both for patients, the organization, and society.
10.5	The nurse can evaluate their personal contribution to the process of working with LMAI and determine if changes are necessary.

The second questionnaire, comprising 19 competences (one added based on an expert's recommendation), was completed by 35 professionals. Following an analysis of the results, the competences that garnered positive consensus in terms of both relevance and clarity (n=9) were incorporated into the final list of competences.

3.4 Final list

The final list, as presented in table 7, encompasses all 55 AI competences for nurses that received positive consensus among the experts.

Table 7

Final list of AI competences for nurses

DOMAIN	COMPETENCE
BASIS	
1.1	The nurse has knowledge of how AI technology can be used in healthcare.
1.2	The nurse maintains a positive-critical attitude towards AI technology.
1.4	The nurse can provide examples of AI applications used in healthcare.
1.6	The nurse is aware of and takes into account the ethical risks associated with the use of AI technology, such as privacy, justice, and security.
1.8	The nurse feels responsible for handling patient data correctly while using AI applications.
1.9	The nurse is willing to invest time in learning how to work with AI technology.
PRODUCE	
2.1	The nurse is open to playing a role in the development of LMAI applications.
2.2	The nurse contributes expertise to improve and develop LMAI.
2.4	The nurse identifies the needs and preferences of patients, caregivers, and colleagues regarding the use of LMAI.
INDICATE	

3.1	The nurse assesses whether LMAI is suitable for the situation, taking into account the patient and caregivers.
3.2	The nurse is capable of identifying the needs and preferences of patients and caregivers concerning LMAI support.
3.3	The nurse has knowledge of the possible advantages and disadvantages of using LMAI and can relate this to a patient's situation.
3.4	The nurse, together with the patient, can set goals to be pursued with the use of LMAI.
3.5	The nurse can select from available sensors and determine which ones best align with the patient's needs, preferences, and abilities.
PERSONALIZE	
4.1	The nurse makes agreements with the patient and caregivers regarding the use of LMAI.
4.2	The nurse can specify how LMAI should be configured to align with the goals and the patient.
4.3	The nurse practices with the patient and caregivers how they can use LMAI.
4.4	The nurse positions the sensors in a suitable manner to collect data reliably.
REGISTER	
5.1	The nurse is aware of the importance of accurately and completely reporting patient measurements and data in relation to LMAI.
5.2	The nurse can report patient measurements and data in a suitable manner for use in LMAI.
5.3	The nurse understands the relationship between the entered patient measurements and data and how LMAI utilizes them.
5.4	The nurse can specify which measurements and data are needed to obtain meaningful results from LMAI.
5.5	The nurse promotes the importance of a uniform reporting method among colleagues to ensure data quality and care quality.
5.6	The nurse has knowledge of the laws and regulations regarding the protection and exchange of medical data.
INTERPRET	
6.1	The nurse can interpret the outcomes from the LMAI application.
6.2	The nurse understands the output of LMAI.
6.3	The nurse can relate the relevance of LMAI output to the patient's clinical situation.
6.4	The nurse can determine whether the output of LMAI is reliable.
6.5	The nurse is aware of the (clinical) limitations of LMAI.
6.6	The nurse assesses whether the output is alarming.
6.7	The nurse is aware of factors that can make the output of an LMAI application less reliable for specific patient groups.
INTEGRATE	
7.1	The nurse is open to using technology's advice in clinical decision-making.
7.2	The nurse is aware of the role LMAI can play in early detection of patient health and behavior changes.
7.3	The nurse understands responsibilities regarding what to do with LMAI outcomes.
7.4	The nurse can monitor a patient's health using LMAI.
7.5	The nurse can compare LMAI outcomes with expectations based on clinical experience.
7.6	The nurse can use LMAI outcomes, supplemented with clinical experience, to make care decisions and implement interventions.

7.7	The nurse can use the outcomes of LMAI to provide person-centered care.
7.8	The nurse has knowledge of relevant protocols related to integrating LMAI in clinical decision-making.
7.9	The nurse is capable of making independent decisions and consciously deviating from LMAI advice when necessary.
7.10	The nurse is aware of the rights and responsibilities of nurses in collaboration with LMAI, such as situations in which the nurse deviates from the advice.
COMMUNICATE	
8.1	The nurse communicates in an understandable manner to build trust in LMAI among patients and caregivers.
8.2	The nurse can explain to patients and caregivers how LMAI outcomes are used to make care decisions.
8.3	The nurse collaborates with patients, caregivers, and formal healthcare providers regarding LMAI outcomes and usage.
8.4	The nurse can communicate with IT professionals and other technical experts about the use of LMAI, including any necessary adjustments.
IMPLEMENT	
9.1	The nurse coordinates the care process for a patient using LMAI.
9.2	The nurse assists (new) colleagues and other healthcare providers in working with LMAI.
9.3	The nurse has knowledge of the organization's policies, procedures, and protocols regarding the use of LMAI.
9.5	The nurse understands how LMAI can be integrated into clinical environments and existing workflows.
9.6	The nurse can deploy and adapt LMAI to align with the organization's and patient's existing processes.
9.7	The nurse can provide information about LMAI to other healthcare providers.
EVALUATE	
10.1	The nurse can evaluate the impact of interventions based on LMAI outcomes by assessing whether the intended goals have been achieved.
10.2	The nurse maintains a critical perspective to reveal the outcomes and unintended consequences of LMAI.
10.3	The nurse can think critically, based on experience, to better align LMAI with clinical needs.
10.4	The nurse is capable of understanding system errors and reporting them.

4. Discussion

4.1. Principle Findings and Summary

This study set out to identify the competences nurses need to work with artificial intelligence through lifestyle monitoring in smart homes. A framework composed of 55 competences across 10 domains was constructed based on the input of 7 articles and the involvement of 48 experts.

4.2 Implications

While previous research focused on telehealth competences, AI competences tailored for physicians or the broader scope of medical education in general. However, these results bringing into focus AI competences designed explicitly for nurses. Analyzing the results, a connection emerges between the findings in this study and what is already been written in previous studies. Both acknowledge the paramount importance of nurses being well-versed in the ethical considerations that accompany AI's integration into healthcare. It is a shared refrain that underscores the ethical dimensions of AI competences. Yet, there is some discussion about AI knowledge and skills of nurses. Jeong (2020) and Civaner et al. (2022) suggests that nurses should possess coding skills, allied to programming in languages like Python, a notion encapsulated in competence 1.10. However, this tune faces resistance from the panel of experts, creating a dissonance between academic recommendations and practical consensus. Notably, this contention is not unique to this study; other literature sources omit mention of this coding skill. Even Park et al. (2019, p.4) said “Preparing for AI does not merely mean learning information technology such as computer programming”. Not only is there discussion about the relevance of coding among researchers in literature, also in this Delphi study. In both Delphi rounds is competence 1.10 hard to agree on among the experts (no consensus was reached). In the first round the standard deviation was 0.81 and the second round 1.00, which means that some experts find it relevant and others not.

Continuing, there is another area found where there is disagreement. Charow et al. (2021) implicated that healthcare professionals should be able to develop, test, and validate AI algorithms with real medical data, as denoted by competence 2.6. However, this proposal meets with disagreement among the expert panel, raising questions about the extent of nurses' involvement in the intricacies of algorithm development. A third dissonance emerges the financial aspects of AI integration. Charow et al. (2021) suggest that healthcare professionals

should have knowledge of the costs associated with integrating AI technologies into healthcare, embodied in competence 9.4. However, this competence fails to find consensus among the experts, prompting contemplation about the extent to which nurses should be engaged in budgetary considerations.

4.3 Strengths and Limitations

4.3.1 Strengths

The study's methodological strength lies in its well-structured and executed Delphi design. Van Houwelingen et al. (2016) conducted a comparable study concentrating on competences required for telehealth tasks in nursing, employing the Delphi method. The Delphi method is particularly appropriate for this purpose, because it allows for the collection of opinions and insights form a diverse group of experts, ensuring that the identified competences are well-informed and based on a broad range of expertise. Furthermore, it is an iterative process. The Delphi method involves multiple rounds of data collection and feedback, which enables experts to revise their opinions. This iterative process helps in refining and reaching a consensus on the competence (Nasa et al., 2021). At last, the Delphi method provides a structured and systematic approach to gather experts' opinions. The approach included an initial phase of two literature reviews, a focus group, and interviews, which laid a strong foundation for the competence identification process. Including experts from diverse healthcare fields, like teachers, nurses or innovators and various levels of education is a strength because it ensures a broader and more comprehensive perspective on AI competences in nursing. Experts with different level of education and from different healthcare fields bring unique insights and experiences related to AI applications in their specific domains. This diversity allows for a richer understanding of what necessarily is for nurses to work with AI.

Lastly, another strength of this study is the collaborative effort of two researchers who contributed their expertise to the research process. When two researchers work together, they can bring different perspectives, skills, and knowledge to the study. This collaboration often leads to a more comprehensive and well-rounded research process, as they can complement each other's strengths and help overcome each other's weaknesses (Hartley&Cabanac, 2016). The inclusion of a researcher with a nursing background enriched the design of the study, formulating and ensuring a holistic perspective on the development of AI competences for nurses.

4.3.2 Limitations

Despite the strengths of the study, there are several limitations that need consideration. One limitation is the decline in response rate during the second Delphi round. While the first round garnered responses from 48 participants, the second round experienced a reduction to 35 respondents. Factors such as participant availability and questionnaire fatigue could have contributed to this decline. It is possible that the originally interested individual encountered scheduling conflicts or other commitments that affected their ability to complete the questionnaire. Furthermore, questionnaire fatigue might have played a role, given that the questionnaire took approximately 30 minutes to complete. It is possible that participants lost motivation to complete the questionnaire. The decrease in response rate during the second round of the Delphi study may have had consequences for the results. The drop in number of participants between rounds could introduce selection bias (Hohmann et al., 2018), if the participants who dropped out had different perspectives or expertise compared to those who remained. It is a challenge to conform this possibility as demographic information was not asked in the second questionnaire.

Another limitation pertains to the direct applicability of the identified competences. Not all competences were formulated as clear and distinct statements, and there was some overlap between them, like competence 1.1 and 1.4. This lack of clarity could potentially hinder the practical implementation of the competences within nursing education and practice. This limitation concerning the clarity and distinctiveness of the identified competences could potentially hinder their implementation within nursing education and practice. When competences are not clearly and distinctly formulated, it becomes challenging for the experts to understand precisely what is expected of them. This lack of clarity can lead to confusion, making it difficult to use the competences in education, practice or evaluate the performance of nursing professionals. Also, the study remains incomplete as consensus was not achieved for 10 of the identified competences.

Lastly, the rapidly evolving landscape of AI necessitates a dynamic approach to competences. As AI technologies continue to advance at an unprecedented pace, the required competences for individuals in various fields, including nursing, are also subject to continuous change (Briganti & Moine, 2020). Therefore, it is worth considering that the competences identified in this study may not necessarily remain representative in the coming years.

4.4 Practical Recommendations

The first recommendation is the integration of the identified AI competences into nursing curricula. Collaborative efforts between nursing educators, curriculum developers, and AI experts are essential to ensure that these competences are effectively woven into the fabric of nursing education. This integration will equip future nurses with the necessary skills and knowledge to use AI technologies in their practice. Considering the findings from the literature research and expert opinions, it becomes evident that ethical considerations should receive heightened attention during the integration of AI competences into the nursing curriculum.

Secondly, the nursing profession is undergoing significant transformation due to technological advancements, such as AI. Therefore, it is imperative to update nursing professional profiles to reflect the evolving role of nurses in utilizing AI and healthcare technologies. Nursing organizations and educators could collaborate to revise the nursing professional profile to include the identified AI competences. The roles currently defined in the nursing professional profile are caregiver, communicator, collaborator, reflective Evidence-Based Practice professional, health promoter, organizer, and lastly, the professional and quality improver. Only in the communicator role is there a mention of digital skills, where the nurse can utilize digital skills, information, and communication technology to support professional and person-centered communication (V&VN, 2020). Therefore, the recommendation is to add an additional role, such as a technologist, to the profile where the competences from this study can be used for.

Thirdly, the field of AI is rapidly evolving, and nursing practice is continually influenced by technological advancements. To ensure the ongoing relevance of the identified AI competences, a mechanism for continuous evaluation and adaptation should be established. Regular reviews and updates will allow the competences to remain aligned with emerging AI technologies and evolving healthcare needs. Lastly, investigating potential overlap between competences is essential to avoid redundancy and ambiguity. An education expert should assess the extent of overlap between competences, aiming to streamline the list and enhance its clarity. Such an analysis would further refine the competence framework and improve its usability. Furthermore, the education expert should focus on an examination of each

competence and redefine or rephrase certain items to meet the criteria of a well-defined competence. As, in the comment section some experts suggested that not all competences were defined as a competence, to ensure the competence can be used in practice.

4.5 Future Research

In the context of this study, several suggestions for future research can further enhance the understanding and application of these competences within nursing education and practice. In nursing there are different levels of education and practice, understanding potential variations in competence levels among different categories of nurses is crucial. Future research could examine whether there are variations in AI competences based on nursing roles, experience levels, or specialization areas. This investigation would inform tailored educational approaches and professional development paths for nurses seeking to specialize in AI-related healthcare. To address the 10 competences that did not reach consensus in this Delphi study, a future research direction could involve a third round of the Delphi method followed by a focus group discussion with experts. This collaborative process would provide an opportunity to elicit diverse perspectives and reach agreement on the final formulation of those competences.

5. Conclusion

This study highlights 55 AI competences in nursing, emphasizing the importance of ethical considerations, practical feasibility, ongoing development, and the need for further consensus-building efforts of 10 AI competences for nurses. The ethical aspects play a significant role in the development and integration of AI in nursing practice, these considerations are crucial for ensuring responsible use of AI technologies in healthcare. Therefore, the competences related to ethics are most important, according to the literature research and experts. All the included articles wrote that ethical considerations are really important and 92% of the experts find it relevant. Furthermore, the practical feasibility of implementing these competences need to be carefully assessed. Understanding the feasibility of integrating AI competences is essential for healthcare institutions. While this study has identified a list of AI competences for nurses, it is important to recognize that this list is a starting point. Further development and refinement of these competences are needed to align them with evolving healthcare and technological landscapes. Lastly, consensus was not reached on 10 of the identified competences. This signifies the need for additional Delphi round to discuss and refine these competences to achieve a clearer and more comprehensive list of competences.

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7. Appendix

Appendix I

Aanmeldformulier

We zijn halverwege mei gestart met de dataverzameling in ronde 1. Mocht je nog een bijdrage willen leveren aan deze studie dan nodigen we je uit om contact op te nemen via onderstaande gegevens.

Sjors Groeneveld en Noelle Pot, via s.w.m.groeneveld@saxion.nl

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Onderstaand vind je meer informatie over de studie 'Competenties van verpleegkundigen in het (samen)werken met leefstijlmonitoring op basis van AI'. Onderaan kun je je emailadres achterlaten om je aan te melden voor deelname aan de studie.

Het gebruik van datagedreven technologieën in de zorg neemt in rap tempo toe. Verschillende toepassingen zoals datagedreven leefstijlmonitoring op basis van kunstmatige intelligentie (AI) kunnen personen ondersteunen om zelfstandig te blijven wonen, kunnen bijdragen aan het inzichtelijk maken van de gezondheid van een persoon en bijdragen aan een oplossing voor het tekort aan zorgprofessionals.

Het is van belang dat verpleegkundigen, als de grootste groep zorgprofessionals, betrokken zijn bij de ontwikkelingen rondom dit type technologieën. Verpleegkundigen kunnen de uitkomsten van leefstijlmonitoring op basis van AI gebruiken en integreren in hun zorgverlening. Dit vraagt echter wel om specifieke competenties.

Op dit moment is er onvoldoende kennis over wat deze verpleegkundige competenties zijn om samen te werken met leefstijlmonitoring op basis van AI. Dit is een probleem omdat de inzet van dit type technologie toeneemt en daarmee ook de vraag naar zorgprofessionals die ermee kunnen werken. Bovendien moeten we ook in de curricula van onze zorgopleidingen aandacht hebben voor deze ontwikkelingen.

<u>Criteria</u>
We zijn op zoek naar de volgende deelnemers:

- Verpleegkundigen, innovatoren en managers/teamleiders in de zorg, die ervaring hebben met
    - Leefstijlmonitoring op afstand
    - AI in de zorg
    - Het gebruik van sensoren in de zorg
- Docenten, onderzoekers of ontwikkelaars die ervaring hebben met
    - Leefstijlmonitoring op afstand
    - AI in de zorg
    - Het gebruik van sensoren in onderwijs, onderzoek, ontwikkeling

Als jij aan bovenstaande criteria voldoet, dan zouden we jou graag uitnodigen om deel te nemen aan deze studie. Concreet betekent dat twee keer een online vragenlijst invullen. De eerste vragenlijst ontvang je in mei, de tweede vragenlijst in juni. Per vragenlijst ben je ongeveer 20-30 minuten bezig. Als je twijfelt of je aan bovenstaande criteria voldoet, dan nodigen we jou toch uit om je aan te melden, tijdens de eerste vragenlijst komen we daar dan op terug.

Meld je aan!
Hieronder kun je je gegevens achterlaten. Je ontvangt dan vanzelf in mei op dit emailadres een uitnodiging voor de eerste vragenlijst.

Meer informatie
Voor meer informatie kun je contact opnemen met:
Sjors Groeneveld en Noelle Pot, via s.w.m.groeneveld@saxion.nl

Dit onderzoek maakt deel uit van het project 'Artificial Intelligence: slimme hulp óf help!?' dat wordt uitgevoerd in samenwerking tussen Hogeschool Saxion en Universiteit Twente en is (mede) gefinancierd door de Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO).

Vereist
Emailadres

Verzenden

Appendix II

Results domain 1 Basic

Domain	No.	Statement		Scores	%	n	Mean	SD	Consensus >80% (Yes/No)
Basis Een basisniveau van kennis, vaardigheden en attitude rondom artificial intelligence (AI).	1.1	De verpleegkundige heeft een duidelijk beeld van de (on-)mogelijkheden van AI technologie.	Relevance	Not relevant	2.08%	1	3.38	0.75	Yes
				Somewhat relevant	10.42%	5			
				Quite relevant	35.42%	17			
				Very relevant	52.08%	25			
			Clarity	Not clear	4.17%	2	2.81	0.73	No
				Somewhat clear	25.00%	12			
				Quite clear	56.25%	27			
				Very clear	14.58%	7			
	1.2	De verpleegkundige heeft een positief-kritische houding ten opzichte van AI technologie.	Relevance	Not relevant	6.25%	3	3.29	0.84	Yes
				Somewhat relevant	6.25%	3			
				Quite relevant	39.58%	19			
				Very relevant	47.92%	23			
			Clarity	Not clear	0.00%	0	3.21	0.61	Yes
				Somewhat clear	10.42%	5			
				Quite clear	58.33%	28			
				Very clear	31.25%	15			
	1.3	De verpleegkundige begrijpt wat relevante AI begrippen, zoals algoritmen, analyse, big data, machine learning en deep learning zijn.	Relevance	Not relevant	8.33%	4	2.71	0.89	No
				Somewhat relevant	33.33%	16			
				Quite relevant	37.50%	18			
				Very relevant	20.83%	10			
			Clarity	Not clear	4.17%	4.17%	2.98	0.78	No
				Somewhat clear	18.75%	18.75%			
				Quite clear	52.08%	52.08%			
				Very clear	25.00%	25.00%			
	1.4	De verpleegkundige kan voorbeelden geven van AI toepassingen die in	Relevance	Not relevant	2.08%	1	3.17	0.66	Yes
				Somewhat relevant	8.33%	4			
				Quite relevant	60.42%	29			

		de zorg ingezet worden.		Very relevant	29.17%	14			
			Clarity	Not clear	0.00%	0	3.38	0.56	Yes
				Somewhat clear	4.17%	2			
				Quite clear	54.17%	26			
				Very clear	41.67%	20			
	1.5	De verpleegkundige bezit de digitale vaardigheden om met AI technologie te werken.	Relevance	Not relevant	4.17%	2	3.29	0.79	Yes
				Somewhat relevant	8.33%	4			
				Quite relevant	41.67%	20			
				Very relevant	45.83%	22			
			Clarity	Not clear	8.33%	4	2.92	0.93	No
				Somewhat clear	22.92%	11			
				Quite clear	37.50%	18			
				Very clear	31.25%	15			
	1.6	De verpleegkundige kent en houdt rekening met de ethische risico's bij het inzetten van AI technologie, zoals privacy, rechtvaardigheid en veiligheid.	Relevance	Not relevant	2.08%	1	3.50	0.71	Yes
				Somewhat relevant	6.25%	3			
				Quite relevant	31.25%	15			
				Very relevant	60.42%	29			
			Clarity	Not clear	4.17%	2	3.21	0.79	Yes
				Somewhat clear	10.42%	5			
				Quite clear	45.83%	22			
				Very clear	39.58%	19			
	1.7	De verpleegkundige heeft inzicht in de validiteit en betrouwbaarheid van AI in relatie tot de doelgroep.	Relevance	Not relevant	6.25%	3	3.13	0.81	Yes
				Somewhat relevant	8.33%	4			
				Quite relevant	52.08%	25			
				Very relevant	33.33%	16			
			Clarity	Not clear	4.17%	2	3.00	0.79	No
				Somewhat clear	18.75%	9			
				Quite clear	50.00%	24			
				Very clear	27.08%	13			
	1.8		Relevance	Not relevant	2.08%	1	3.38	0.78	Yes

		De verpleegkundige voelt zich verantwoordelijk voor het correct omgaan met patiëntgegevens tijdens het gebruik van AI toepassingen.		Somewhat relevant	12.50%	6			
				Quite relevant	31.25%	15			
				Very relevant	54.17%	26			
			Clarity	Not clear	0.00%	0	3.42	0.64	Yes
				Somewhat clear	8.33%	4			
				Quite clear	41.67%	20			
				Very clear	50.00%	24			
	1.9	De verpleegkundige is bereid de tijd te nemen rondom het werken met AI technologie, zowel voor zichzelf als voor zorgvragers en mantelzorgers.	Relevance	Not relevant	4.17%	2	3.08	0.84	No
				Somewhat relevant	18.75%	9			
				Quite relevant	41.67%	20			
				Very relevant	35.42%	17			
			Clarity	Not clear	8.33%	4	3.10	0.90	Yes
				Somewhat clear	10.42%	5			
				Quite clear	43.75%	21			
				Very clear	37.50%	18			
	1.10	De verpleegkundige kan coderen (basisniveau) in verschillende programmeertalen, zoals Python.	Relevance	Not relevant	58.33%	28	1.60	0.81	No*
				Somewhat relevant	25.00%	12			
				Quite relevant	14.58%	7			
				Very relevant	2.08%	1			
			Clarity	Not clear	16.67%	8	2.71	1.02	No
				Somewhat clear	20.83%	10			
				Quite clear	37.50%	18			
				Very clear	25.00%	12			

Appendix III

Results Delphi Round 2

No.	Statement		Scores	%	n	Mean	SD	Consensus >80% (Yes/No)
1.1	De verpleegkundige heeft kennis van de mogelijkheden hoe AI technologie ingezet kan worden in de zorg.	Relevance	Not relevant	0.00%	0	3.40	0.60	Yes
			Somewhat relevant	5.71%	2			
			Quite relevant	48.57%	17			
			Very relevant	45.71%	16			
		Clarity	Not clear	2.86%	1	3.09	0.77	Yes
			Somewhat clear	17.14%	6			
			Quite clear	48.57%	17			
			Very clear	31.43%	11			
1.3	De verpleegkundige begrijpt wat relevante AI begrippen, (algoritmen, analyse, big data, machine learning en deep learning) zijn in relatie tot het verpleegkundig domein.	Relevance	Not relevant	2.86%	1	2.86	0.87	No
			Somewhat relevant	37.14%	13			
			Quite relevant	31.43%	11			
			Very relevant	28.57%	10			
		Clarity	Not clear	2.86%	1	3.14	0.72	Yes
			Somewhat clear	11.43%	4			
			Quite clear	54.29%	19			
			Very clear	31.43%	11			
1.5	De verpleegkundige bezit vaardigheden om met AI technologie in de zorg te werken.	Relevance	Not relevant	0.00%	0	3.40	0.60	Yes
			Somewhat relevant	5.71%	2			
			Quite relevant	48.57%	17			
			Very relevant	45.71%	16			
		Clarity	Not clear	2.86%	1	2.89	0.75	No
			Somewhat clear	25.71%	9			
			Quite clear	51.43%	18			
			Very clear	20.00%	7			
1.7		Relevance	Not relevant	2.86%	1	3.00	0.76	No

	De verpleegkundige begrijpt hoe de data waarop een AI systeem getraind is, van invloed is op de output van het systeem.		Somewhat relevant	20.00%	7			
			Quite relevant	51.43%	18			
			Very relevant	25.71%	9			
		Clarity	Not clear	0.00%	0	3.20	0.58	Yes
			Somewhat clear	8.57%	3			
			Quite clear	62.86%	22			
			Very clear	28.57%	10			
1.9	De verpleegkundige is bereid tijd te investeren om te leren werken met AI technologie.	Relevance	Not relevant	0.00%	0	3.17	0.70	Yes
			Somewhat relevant	17.14%	6			
			Quite relevant	48.57%	17			
			Very relevant	34.29%	12			
		Clarity	Not clear	0.00%	0	3.23	0.68	Yes
			Somewhat clear	14.29%	5			
			Quite clear	48.57%	17			
			Very clear	37.14%	13			
1.10	De verpleegkundige kan op basisniveau coderen	Relevance	Not relevant	37.14%	13	2.09	1.00	No
			Somewhat relevant	25.71%	9			
			Quite relevant	28.57%	10			
			Very relevant	8.57%	3			
		Clarity	Not clear	2.86%	1	2.97	0.81	No
			Somewhat clear	25.71%	9			
			Quite clear	42.86%	15			
			Very clear	28.57%	10			
2.3	De verpleegkundige is op de hoogte van nieuwe ontwikkelingen rondom LMAI	Relevance	Not relevant	0.00%	0	2.80	0.75	No
			Somewhat relevant	40.00%	14			
			Quite relevant	40.00%	14			
			Very relevant	20.00%	7			
		Clarity	Not clear	2.86%	1	3.06	0.71	Yes

			Somewhat clear	14.29%	5			
			Quite clear	57.14%	20			
			Very clear	25.71%	9			
2.4	De verpleegkundige stelt de wensen en behoeften rondom LMAI vast met zorgvragers, mantelzorgers en collega's.	Relevance	Not relevant	5.71%	2	3.31	0.78	Yes
			Somewhat relevant	2.86%	1			
			Quite relevant	45.71%	16			
			Very relevant	45.71%	16			
		Clarity	Not clear	2.86%	1	3.20	0.75	Yes
			Somewhat clear	11.43%	4			
			Quite clear	48.57%	17			
			Very clear	37.14%	13			
2.5	De verpleegkundige kan diverse disciplines (zoals ICT'ers, innovatoren, ontwikkelaars) met elkaar verbinden om de wensen vanuit de verpleegkundige praktijk onder de aandacht te brengen rondom de ontwikkeling van LMAI.	Relevance	Not relevant	2.86%	1	2.89	0.82	No
			Somewhat relevant	31.43%	11			
			Quite relevant	40.00%	14			
			Very relevant	25.71%	9			
		Clarity	Not clear	0.00%	0	3.14	0.64	Yes
			Somewhat clear	14.29%	5			
			Quite clear	57.14%	20			
			Very clear	28.57%	10			
2.6	De verpleegkundige kan een prototype LMAI toepassing testen op geschiktheid voor de praktijk.	Relevance	Not relevant	2.86%	1	2.94	0.75	No
			Somewhat relevant	22.86%	8			
			Quite relevant	51.43%	18			
			Very relevant	22.86%	8			
		Clarity	Not clear	0.00%	0	3.26	0.60	Yes
			Somewhat clear	8.57%	3			
			Quite clear	57.14%	20			
			Very clear	34.29%	12			

4.2	De verpleegkundige kan aangeven hoe LMAI ingesteld moet worden zodat het is afgestemd op de doelen en de zorgvrager.	Relevance	Not relevant	0.00%	0	3.29	0.61	Yes
			Somewhat relevant	8.57%	3			
			Quite relevant	54.29%	19			
			Very relevant	37.14%	13			
		Clarity	Not clear	2.86%	1	3.23	0.64	Yes
			Somewhat clear	2.86%	1			
			Quite clear	62.86%	22			
			Very clear	31.43%	11			
4.3	De verpleegkundige oefent met de zorgvrager en mantelzorgers hoe zij LMAI kunnen gebruiken.	Relevance	Not relevant	0.00%	0	3.34	0.63	Yes
			Somewhat relevant	8.57%	3			
			Quite relevant	48.57%	17			
			Very relevant	42.86%	15			
		Clarity	Not clear	5.71%	2	3.23	0.80	Yes
			Somewhat clear	5.71%	2			
			Quite clear	48.57%	17			
			Very clear	40.00%	14			
4.4	De verpleegkundige plaatst de sensoren op een geschikte wijze om op een betrouwbare manier data te verzamelen.	Relevance	Not relevant	2.86%	1	3.23	0.80	Yes
			Somewhat relevant	14.29%	5			
			Quite relevant	40.00%	14			
			Very relevant	42.86%	15			
		Clarity	Not clear	0.00%	0	3.49	0.55	Yes
			Somewhat clear	2.86%	1			
			Quite clear	45.71%	16			
			Very clear	51.43%	18			
4.5	De verpleegkundige kan bij een storing aangeven wat het probleem is zodat de technische dienst het kan oplossen.	Relevance	Not relevant	0.00%	0	3.03	0.70	No
			Somewhat relevant	22.86%	8			
			Quite relevant	51.43%	18			
			Very relevant	25.71%	9			

		Clarity	Not clear	0.00%	0	3.14	0.76	No
			Somewhat clear	22.86%	8			
			Quite clear	40.00%	14			
			Very clear	37.14%	13			
5.4	De verpleegkundige kan aangeven welke metingen en gegevens nodig zijn om zinvolle resultaten te krijgen vanuit LMAI.	Relevance	Not relevant	0.00%	0	3.29	0.61	Yes
			Somewhat relevant	8.57%	3			
			Quite relevant	54.29%	19			
			Very relevant	37.14%	13			
		Clarity	Not clear	2.86%	1	3.26	0.77	Yes
			Somewhat clear	11.43%	4			
			Quite clear	42.86%	15			
			Very clear	42.86%	15			
6.4	De verpleegkundige kan bepalen of de output van LMAI betrouwbaar is.	Relevance	Not relevant	2.86%	1	3.03	0.70	Yes
			Somewhat relevant	14.29%	5			
			Quite relevant	60.00%	21			
			Very relevant	22.86%	8			
		Clarity	Not clear	0.00%	0	3.14	0.59	Yes
			Somewhat clear	11.43%	4			
			Quite clear	62.86%	22			
			Very clear	25.71%	9			
7.7	De verpleegkundige kan bepalen of de output van LMAI betrouwbaar is.	Relevance	Not relevant	0.00%	0	3.57	0.49	Yes
			Somewhat relevant	0.00%	0			
			Quite relevant	42.86%	15			
			Very relevant	57.14%	20			
		Clarity	Not clear	0.00%	0	3.51	0.55	Yes
			Somewhat clear	2.86%	1			
			Quite clear	42.86%	15			
			Very clear	54.29%	19			

9.4	De verpleegkundige heeft inzicht in de kosten van de inzet van LMAI, zowel voor de zorgvrager, de organisatie als de maatschappij.	Relevance	Not relevant	14.29%	5	2.46	0.84	No
			Somewhat relevant	34.29%	12			
			Quite relevant	42.86%	15			
			Very relevant	8.57%	3			
		Clarity	Not clear	2.86%	1	3.14	0.76	Yes
			Somewhat clear	14.29%	5			
			Quite clear	48.57%	17			
			Very clear	34.29%	12			
10.5	De verpleegkundige kan evalueren wat de persoonlijke bijdrage is geweest in het proces rondom het werken met LMAI en of verandering hierin nodig is.	Relevance	Not relevant	5.71%	2	2.97	0.84	No
			Somewhat relevant	20.00%	7			
			Quite relevant	45.71%	16			
			Very relevant	28.57%	10			
		Clarity	Not clear	20.00%	7	2.57	0.99	No
			Somewhat clear	20.00%	7			
			Quite clear	42.86%	15			
			Very clear	17.14%	6			