Finnish experts' perceptions of digital healthcare forms in 2035 and the anticipated healthcare workforce impacts: A Delphi study

ABSTRACT

Purpose: To explore Finnish experts' perceptions of the forms of digital healthcare that are anticipated to be the most utilised in healthcare in the medium-term future (year 2035) and anticipated healthcare workforce impacts those forms will have.

Design/methodology/approach: A total of 17 experts representing relevant interest groups participated in a biphasic online Delphi study. The results for each round were analysed using descriptive statistical methods and inductive content analysis.

Findings: The forms of digital healthcare that the experts perceived as most likely to be utilised were those enabling patient participation, efficient organisation of services and automated data collection and analysis. The main impacts on the healthcare workforce were seen as being the redirection of workforce needs within the healthcare sector and need for new skills and new professions. The decrease in the need for a healthcare workforce was seen as less likely. The impacts were perceived as being constructed through three means: impacts within healthcare organisations, impacts on healthcare professions and impacts via patients.

Research limitations: The results are not necessarily transferable to other contexts because the experts anticipated local futures. Patients' views were also excluded from the study.

Originality/value: Healthcare organisations function in complex systems where drivers, such as regional demographics, legislation and financial constraints, dictate how digital healthcare is utilised. Anticipating the workforce effects of digital healthcare utilisation has received limited attention; the study adds to this discussion.

Keywords: digital health, healthcare, health workforce, Delphi, future

Original Article

Introduction

Healthcare systems worldwide are searching for ways to adapt to drivers, such as the need for sustainable, equal healthcare systems, demographic changes, and emerging technologies (Braithwaite *et al.*, 2018). One of the key problems has been the availability of a healthcare workforce, which can be broken down into retention problems, difficulties in attracting healthcare professionals, skills mismatches, and inefficient organisation of work, to name a few main issues (WHO, 2022). The utilisation of digitalisation and technology in healthcare has been seen as a potential way of responding to those challenges by providing effective, timely healthcare services through increasing automatisation and patient participation and improving the flow of information and efficacy of time usage (European Commission, 2018; Lapão *et al*., 2019; Topol, 2019). Because of the relative freshness of the phenomena, there are no established terms to describe it but for example, the term 'eHealth' has been proposed (Shaw *et al.*, 2017). The term 'digital healthcare' has also been suggested to describe the forms of healthcare that operate within the framework created by technology (Topol, 2019; Vähäkainu and Neittaanmäki, 2018; Zarif, 2022) and will be used in the present article to describe the phenomenon.

Impacts on the healthcare workforce are not an explicit part of healthcare technology assessments (Fattore *et al.*, 2011; Haverinen *et al.*, 2019), despite the hopes of reduced workforce needs placed on the increased utilisation of digital healthcare. The utilisation of digital healthcare is guided by regional and national strategies, national and international legislation, financial constraints and the technological skills of both staff and patients. The position of digital healthcare as a part of the international, national, and regional healthcare systems—here with multiple factors influencing its introduction and utilisation—supports viewing healthcare as a part of a complex system (Braithwaite *et al.*, 2018; Lipsitz, 2012; Rouse, 2008). In a complex system, understanding the functioning of individual parts is not sufficient for comprehending the whole system because it is more than the sum of its parts (Puustinen and Jalonen, 2020). It has been suggested that the practice of anticipation is useful when there is a desire to shape the future of complex systems (Pernaa, 2020). Here, anticipation can be described as viewing the future as building on the actions and decisions taken in the present (Miller *et al.*, 2018, p. 53) and as a way in which the future is expressed in the present (Miller, 2018). As the images of the future guide

decision-making processes (Linturi and Kuusi, 2022), it is essential to be aware of what those images are. This is what the present study aims to offer because this can provide an additional perspective for digital healthcare utilisation against the backdrop of the decreasing availability of the healthcare workforce.

Digital healthcare can be used to monitor health, enable communications and collect, manage and utilise health data (Shaw *et al.*, 2017), and it has been studied from various perspectives, such as ethics and acceptability (Busse *et al.*, 2021; Zarif, 2022), efficacy (Granja *et al.*, 2018), economical aspects (Tenhunen *et al.*, 2018), equal access (Kaihlanen *et al.*, 2022; Kwiatkowska and Skórzewska-Amberg, 2019) and future prospects (Immonen *et al.*, 2019; Topol, 2019). The impacts of digital healthcare on the workforce skill needs (Bollinger *et al.*, 2013; Radnia, 2018) and the workforce itself have also been discussed. The interview study by Lapão (2016) indicated that increasing the utilisation of digital healthcare will have two main implications: it will reduce the need for healthcare staff by increasing the efficacy, but it will also increase workforce needs as new forms of healthcare services are created. Digital healthcare has also been seen as diverting both service and workforce needs into the primary healthcare sector (Bronsoler *et al.*, 2020). In earlier publications, digital healthcare has been thought as changing the way healthcare staff do their work, rather than changing the actual workforce needs (Meskó *et al.*, 2018).

Previous works that have explored the possible, probable, and desirable futures of technology utilisation in healthcare systems have identified the development of artificial intelligence (AI), the Internet of Things (IoT) and robotics, improvements in sensor technologies, digital architecture and information management as essential aspects (Jauhiainen *et al*., 2017; Topol, 2019). However, because technological development in the healthcare sector often follows the technological development of other industries and is utilised in various ways within different parts of the healthcare sector, it is challenging to navigate this complexity to anticipate which forms of digital healthcare will be utilised in the future and what the implications for the healthcare workforce needs will be.

The purpose of the present study was to explore Finnish experts' perceptions of the forms of digital healthcare that are anticipated to be the most utilised in the medium-term future (year 2035) and the likely healthcare workforce impacts those forms of digital healthcare will have. This was done by utilising the Argumentative Delphi method. In an anonymous, biphasic Delphi process, the panel consisting of experts representing healthcare organisations (HCO), healthcare technology organisations (HTO) and healthcare education institutions (HEI) evaluated the likelihood and desirability of different scenarios. The Delphi method can be useful when the studied phenomenon has various possible futures and no specific interest group has certain information about its future developments or even a complete overview of the phenomenon (Linturi and Kuusi, 2022) but there is a need to create preferences between several possible futures (Keeney *et al.*, 2001). As such, it is suitable for studying complex issues in complex systems (Miller *et al.*, 2018, p. 59).

Methods

Study design and setting

The study was conducted utilising the Delphi method, which has been described as a way of having a controlled debate about forecasting future developments when future development is not known and cannot be calculated statistically (Gordon, 2009). The Argumentative Delphi method was seen as an appropriate variation of the Delphi for the purposes of this study, as one of the aims of the study was to explore the potential differences between the anticipated workforce impacts of digital healthcare amongst the different stakeholders. The study setting was a Finnish province known as a healthcare technology hub. In Finland, both the healthcare sector and society in general are seen as especially prepared to embrace new forms of digital healthcare, partly because of the swift transition of services created by the Covid-19 pandemic, vast healthcare databanks and high-quality education system paired with good digital skills at the population level (Hendolin and Hämäläinen, 2022; Finnish Government 2020). These qualities made the particular Finnish province a suitable setting to study the phenomena of digital healthcare.

The selection and recruitment of the expert panel

For selecting and recruiting the experts, four main interest groups were identified through stakeholder analysis in co-operation with the municipal authorities: HCO, HTO, HEI and patients. After consideration, the view of the patient-expert was excluded because the expertise of the patient could not be easily identified, a problem shared by health technology assessment initiatives in general (Wortley *et al.*, 2016). For defining expertise, the definition by McPherson *et al.* (2018) was adopted, in which expertise can be understood as having special knowledge derived from training or experience. Six organisations representing relevant interest groups (HCO, HTO and HEI) within the province were chosen. The recruitment of experts was done by snowballing within those organisations to ensure the coverage of the panel (Stubin *et al.*, 2020). For this, key informants were identified based on their expertise and position within the organisation in relation to the topic and the snowballing was done through them. Participating experts were asked to identify their expertise from five predefined areas: technological development, service provision, ethics, service planning and development and legal expertise. The completed expert matrix (Table I) shows that the coverage of the panel was sufficient for the purposes of the study.

(Insert Table I)

The experts were contacted by email and received two reminders during each round, here according to a separate communications plan. Initially, 19 experts agreed to participate, but 17 (13 females, 4 males) took part in the first round and 12 (9 females, 3 males) in the second. In a qualitative Delphi study, the size of the panel is not seen as an essential criterion (Stubin *et al.*, 2020), and the saturation of comments can be taken as a sign of a sufficient number of experts (Tapio *et al.*, 2011). In general, a panel of 12–15 experts can be viewed as sufficient (Salkind, 2013). The experts' position in their respective organisations varied between senior management and operative level.

Ethical considerations

The study was conducted according to the principles of the Helsinki Declaration (The World Medical Association, 2013). Research permits were gained from the participating organisations. The experts received an information letter stating that participation was voluntary and could be withdrawn at any time; they then gave informed consent by registering for the study. According to the principles of the Delphi method (Gordon, 2009), the experts remained anonymous during the study, and scientific rigour was followed to protect their anonymity during data analysis.

Data collection

The eDelphi application (www.edelphi.org) was used in data collection. The application also served as a way of managing data during the study by creating automated statistics of the responses and displaying both the statistics and anonymous open comments to the experts during the rounds. The experts were therefore able to both read the comments of others and to respond to them or to adjust their own respond if they wished. The first Delphi round was open online for two weeks, and the second round opened a week later and was also open for two weeks. The opening time of each round was extended by two days because of requests from experts. The first Delphi round focused on experts' perceptions of digital healthcare utilisation in 2035. The experts were first asked to evaluate the likelihood and preferability of three scenarios modelling the development of digital healthcare by the year 2035 using a 7-point Likert scale ranging from extremely unlikely/undesirable (---) to extremely likely/desirable (+++). This served as way to introduce the experts to the general topic before the next part, in which they were asked to anticipate the percentual increase or decrease (on a scale of +100% to -100%) of the utilisation of 13 specific forms of digital healthcare in three time points (2025, 2030 and 2035) compared with their understanding of the utilisation of the specific form of digital healthcare in the year 2020.

The forms of digital healthcare under evaluation in the first round were selected using previous research (Jauhiainen *et al.*, 2017; Radnia, 2018; Topol, 2019). Additional data highlighting the current utilisation of the form of digital healthcare were attached to each question. Another option for selecting the forms of digital healthcare to be included would have been to utilise

statistical projections on the current forms of digital healthcare and extrapolate their known workforce impacts. Two main problems were identified with this option. First, despite the sizeable Finnish healthcare data pools, there were no comprehensive, reliable and up-to-date recordings of the current levels of digital healthcare utilisation that could have been used to set the baseline. Second, including only those forms of digital healthcare currently utilised would have excluded those forms of digital healthcare not currently in mainstream use. Each individual question received 10–15 answers, and 103 open comments were given in round one.

The second Delphi round consisted of six scenarios set in 2035, in which the forms of digital healthcare that surpassed the limit of inclusion were incorporated. Originally, the limit of inclusion was set to ≥50%, but because only one form of digital technology surpassed it, the limit was reduced to ≥40%. The experts were asked to evaluate the likelihood of each scenario on a 5-point Likert scale ranging from very unlikely (--) to very likely (++), here from the perspective of three workforce outcomes:

1) Whether the scenario will reduce the need for healthcare workforce
2) Whether the scenario will redirect the healthcare workforce needs within the workforce
3) Whether the scenario will create the need for new professions within the healthcare workforce

These perspectives were formulated based on earlier studies (Bollinger *et al.*, 2013; Bronsoler *et al.*, 2020; Lapão, 2016; Lapão *et al.*, 2019; Lapão and Dussault, 2017; WHO, 2016). A total of 49 comments were provided during the second round.

Data analysis

The data were exported into Microsoft Excel and analysed quantitatively and qualitatively. The means and standard deviations were calculated for the data from the first round to select the forms of digital healthcare that can form the scenarios for round two. Inductive content analysis (Kyngäs, 2019) was utilised in analysing the comments from round one for identifying any essential forms of digital healthcare that might have not been included and those factors that were seen as impacting the utilisation of digital healthcare. In round two inductive content

analysis was used for identifying in which ways the anticipated impacts on workforce needs were viewed as constructing. The unit of analysis was defined as a sentence, which was then turned into open codes and grouped to form subcategories, categories and main categories (Kyngäs, 2019).

Findings

Round one

As presented in Figure 1, the experts perceived digital healthcare in general as being a likely and desirable part of the healthcare systems in 2035, with structural barriers being the most potential barriers to this development.

(Insert Figure 1)

The experts' estimations of the percentual increase or decrease of the utilisation of 13 specific forms of digital healthcare in the 2035 time point are presented in Table II in increasing order based on the experts' view of their utilisation. The forms of digital healthcare that were seen as most likely to be utilised were the ones that enabled patient participation, the efficient organisation of services and automated data collection and analysis.

(Insert Table II)

During the inductive content analysis of round one, 48 open codes derived from the comments were formed into 21 subcategories, eight categories and three main categories (Table III) of the factors impacting the forms of digital healthcare that were anticipated to be the most utilised regionally in 2035. The three main categories were organisations, humans and technology. One new form of digital healthcare emerged from the comments and was included in round two: digital care paths.

(Insert Table III)

‘Difficulties in transferring information across organisational limits will continue to be a problem’. (Expert 3, healthcare organisation)

Within organisations, different levels of healthcare and the limits between them and the surrounding structures were seen as the key factors for digital healthcare utilisation. The movement of information and coordination of care between primary- and secondary-level healthcare was also seen as an important factor, while the division between the public and private healthcare sectors was seen as a potential threat. Structural factors, such as information security and the requirement for equal access to services, were perceived as impacting digital healthcare utilisation. Some experts commented that digital healthcare may result in unequal access to healthcare services to some demographic groups, such as the elderly and immigrants.

‘Technology gets outdated fast and might get too expensive’. (Expert 9, healthcare organisation)

The availability and accessibility of technology were seen as important requirements for the integration of digital healthcare. Expenses and the fast rate of technological development were identified as potential problems for technology utilisation for organisations making large investments in technology and digital systems. The absence of support services and introduction of unfinished systems were also perceived as potential obstacles, as well as unexpected events such as changes in geopolitics and counter-reactions to ‘digital hype’.

‘It is most important to introduce functions that benefit the patient’. (Expert 4, healthcare technology organisation)

The impact of the human factor was perceived as being displayed through both the professionals and patients. Technology and digitalisation were seen as working best in unison with the professional to ensure the best available treatment for the patient. The experts expressed concerns for situations where care processes are centred around digitalisation and technology rather than the patient. Some experts estimated that both patients and professionals will possess

sufficient technological skills by 2035, while others perceived insufficient skills as a potential obstacle.

Round two

The scenarios from the second round and likelihoods of their perceived healthcare workforce impacts are presented in Figure 2. The potential of digital healthcare to redirect healthcare workforce needs was seen as mostly likely, and this redirection was seen as happening from one profession to another, but also from the secondary level of healthcare to the primary level of healthcare. The impact that was seen as the most likely was the need for new healthcare professions, especially in developing and maintaining technologies and digital services, as well as data analysts and technical support personnel. The potential of digital healthcare to reduce the need for a healthcare workforce was viewed mostly as unlikely or very unlikely; in contrast, some experts viewed a potential need to increase healthcare workforce because of rising service needs. Some potential to reduce workforce needs was identified in those forms of digital healthcare aimed at assisting in diagnostics or organising and redirecting resources.

(Insert Figure 2)

In the inductive content analysis process, the replies to each scenario were first analysed individually. During the process, the same subcategories were repeated, and towards the final scenario, saturation of the data became apparent because no new categories emerged and the final analysis was performed by combining the comments from all scenarios. There were 76 open codes divided into 31 subcategories, eight categories and three main categories (Table IV). The three main categories through which the workforce impacts of digital healthcare were viewed as occurring were those for healthcare organisations, the impacts on healthcare professions and impacts via patients.

(Insert Table IV)

‘There will be an increased need for primary-level healthcare workers, as patients will be increasingly directed to the primary-level clinics …’. (Expert 8, healthcare organisation)

The impacts for healthcare organisations and subsequent impacts on healthcare workforce needs were divided into three subcategories: care processes, resource management and changing needs. The care processes were seen as being impacted by digital healthcare in that they could be more individual and efficient, which was seen as redirecting workforce needs by, for example, reducing the time spent assessing care needs so that it could be spent on delivering care. Digital healthcare was seen as having the potential to enable smarter, flexible resourcing and creating priorities, which could impact healthcare workforce needs in specific units and parts of the care process. This, this was seen as changing the need for workforce within different levels of healthcare, focusing the need more firmly on primary-level healthcare. It was also anticipated to enable the division of work differently, such as the transmission of tasks from radiologists to professionals preparing radiological procedures. Digital healthcare was perceived as potentially increasing the demand for services and creating the need for new kinds of services.
‘… we will need people with multicompetences, people that know how to implement technical solutions to be part of the services, that know how to develop digital services …’. (Expert 6, healthcare organisation)

The impacts on healthcare professions were divided into new professions and new skills. Current healthcare professions were not perceived as having the required skillsets for the future. The experts estimated that healthcare professionals’ skill requirements would be expanded as the need for in-depth technological understanding increased, but also that completely new professions focused on implementing, improving and developing digital health services would be required by the healthcare organisations.

‘… patients will be more aware of their health status; this will probably reduce the number of unnecessary controls and visits to healthcare “just to make sure” …’ (Expert 7, healthcare technology organisation)

Impacts via patients included the ways in which digital healthcare's impacts on patients were seen as influencing healthcare workforce needs. Digital healthcare was seen as impacting access to healthcare services by improving availability; on the other hand, it was deemed important that patients should also have access to in-clinic visits and could choose the method of contact. Some experts expressed worries that technology would create distance in the relationship between the patient and healthcare professional, even producing negative health outcomes for the patient, which could lead to an increase in the need for healthcare services and, therefore, workforce needs. Digital healthcare was also viewed as potentially increasing the awareness of health-related issues that could empower and motivate patients to improve self-care, thus reducing the need for healthcare services. On the other hand, the increasing amount of health data produced by patients was seen as potentially increasing the workload of the healthcare systems. An essential aspect was also the capability of the patients to utilise digital healthcare; individual capabilities needed to be recognised and sufficient support services should be available to ensure equal access.

Discussion

The present study contributes to the discussion of the impacts of digital healthcare on the healthcare workforce, producing new knowledge about the forms of digital healthcare experts anticipate being utilised in 2035 and anticipated impacts on the healthcare workforce. The value of utilising anticipatory practices in healthcare service planning is that they can bring additional perspectives into situations where the cost of real-life tests can be high (Miller *et al.*, 2018, p. 54). In addition, being aware of the underlying anticipatory assumptions can empower people to understand how and why the images of the future influence their decisions in the present and to ask new questions concerning the future (Ehresmann *et al.*, 2018, pp. 66–67). The need for healthcare workers is predicted to rise globally because of demographic changes, increases in noncommunicable diseases and an ageing workforce (WHO, 2018), so it is critical to assess the impacts of workforce needs when designing strategies for digital healthcare integration.

According to our results, the integration of digital healthcare into all areas of healthcare by 2035 is a likely and desirable development. The forms of digital healthcare that are perceived as the

most likely to be utilised were the ones enabling patient participation, the efficient organisation of services and automated data collection and analysis. This was consistent with earlier studies (Jauhiainen *et al.*, 2017; Topol, 2019) but with some exceptions; the utilisation of technologies such as robotics, virtual reality and augmented reality and applications of genome technology was perceived as less likely, possibly because of the regional drivers for development that the experts were taking into consideration. Previous studies (Habran *et al.*, 2018) have discussed the impact of the driver of development on the forms of digital healthcare. When the driver is technological advancement, development often overlooks existing, similar forms of digital healthcare while ignoring the cost effectiveness of further development of current technologies versus developing new technologies. On the other hand, when the focus has been on the needs of healthcare professionals, the development has leaned on utilising current technologies in new ways or with different patient groups, hence solving specific health problems (Habran *et al.*, 2018). Other studies have also recorded this difference between professionals with different types of expertise (Fruehwirt and Duckworth, 2021).

In the present study, the experts perceived both organisational needs and technological possibilities as the main drivers for the implementation of digital healthcare as problematic, similar to previous findings (Fruehwirt and Duckworth, 2021). The human drivers, especially the patient-centred view and empowering the patients, were seen as being important. The agency of the patient has been recognised as a factor influencing, for example, future hospital management needs (Pihlainen *et al.*, 2019), and the results of the present study have indicated that the patient view is also essential when assessing the drivers of digital healthcare utilisation.

The results suggest that digital healthcare utilisation might not have the desired impacts on healthcare workforce needs because the potential of digital healthcare to reduce the need for healthcare workforce has been perceived as unlikely. Earlier studies have also found digital healthcare as being perceived as changing the way work in the healthcare sector is done (Bronsoler *et al.*, 2020; Meskó *et al.*, 2018). In our study, digital healthcare was perceived to redirect healthcare workforce needs from one profession to another, but also from the secondary to primary level of healthcare. The most likely impact of digital healthcare on the healthcare workforce was perceived as need for new healthcare professions. This has been supported by

earlier studies (Lapão, 2016), bringing in the question of how the healthcare sector, which is already struggling to maintain a sufficient workforce, will manage to attract those professionals needed in digital and technological services.

The results suggest that the technical and digital skills of the healthcare workforce are quintessential when following the anticipated integration of digital healthcare. Previous studies have suggested that the digital health training initiatives of healthcare workers should focus on competencies relevant to a particular healthcare setting (Nazeha *et al.*, 2020), such as on nursing documentation and the principles of nursing informatics for nurses (Egbert *et al.*, 2019). Contrary to this, the results support the view that it is important that healthcare workers also have a core set of transferrable digital and technical skills enabling them to work in unison with the professionals developing technological and digital aids and, most importantly, the patients (Li *et al.*, 2019; Risling, 2017). Healthcare workers' digital competencies have also been found to be linked to psychological and organisational factors (Bronsoler *et al.*, 2020; Konttila *et al.*, 2019), highlighting the complexity of developing suitable skillsets for future healthcare workers.

Study limitations

One of the main challenges of the Delphi method is the conflicting expectations for evaluating the reliability of the method and results (Hasson and Keeney, 2011; Tapio *et al.*, 2011). The essential qualities for successful application specifically for healthcare research have been suggested as the identification of the problem area of research, concise definition of expertise and selection of the panel, data management and controlled feedback, hence maintaining suspense during the iterative Delphi rounds, analysis, closing criteria and stability of the results (McPherson *et al.*, 2018; Nasa *et al.*, 2021; Trevelyan and Robinson, 2015). The present study has aimed to address each of these areas, but as in any qualitative study, it is possible that the qualities of the researcher have guided the interpretation of the data and that further study would be required to ensure the transferability of the results. It is also notable that the response rate of the second round fell below 70%. However, as Tapio *et al.* (2011) have argued, the main goal of a Delphi study is not to produce statistically representative data but to solicitate the opinions of a

selected group of experts because any results concerning the future—and the future itself—cannot be known.

The current study has several limitations, most of which deal with the broad view on the issue adopted, which has resulted in the superficial treatment of certain important issues that would have warranted more attention to detail. These include, but are not limited to, the specific forms of digital healthcare and the details of their implementation. The Topol Review (Topol, 2019) identifies and classifies the forms of digital healthcare that are seen as the most essential for the NHS in the United Kingdom by the year 2040 and has used this as a basis for making recommendations for patients, professionals and healthcare systems. Such a comprehensive study was not available for the Finnish healthcare system, and as such, the current study does not necessarily competently reflect the current trends of digital healthcare within Finland. The WHO suggests literature reviews and opinion surveys of key informants as information sources to inform the planning of technological changes in healthcare (WHO, 2022), and the latter is what the present study aims to offer. To be used as background information in policy making, the study would need to be more representative of the healthcare sector. Because this study was limited in its focus to one province of Finland, the topic would also require further study to explore whether these findings are applicable to other regions nationally and internationally.

Conclusion

Healthcare organisations operate as parts of complex systems, and anticipating the impacts of interactions is not simple, nor are the outcomes necessarily straightforward. However, the increasing lack of a healthcare workforce suggests that the impacts of digital healthcare on healthcare workforce needs is an important issue that should be taken into consideration when regional, national and international healthcare strategies are formed. The findings suggest that the technologies that hold the most potential for reducing workforce needs are those focused on enabling patient participation, the efficient organisation of services and automated data collection and analysis. The study also highlighted both the need for new skillsets for healthcare professionals and for new professions that would support both clinical workers and patients in utilising digital healthcare.

The present study confirmed the position of digital healthcare as part of complex systems, and further study is suggested to better identify the future developments of digital healthcare and clarify the key components shaping the workforce impact of digital healthcare. The Delphi method was found to be a relatively inexpensive and fast method of gauging expert opinions, and the use of Delphi as a tool for policy making in healthcare is also a suggested area of further study.

References

Bollinger, R., Chang, L., Jafari, R., O'Callaghan, T., Ngatia, P., Settle, D., McKenzie-White, J., Patel, K., Dossal, A. and Al Shorbaji, N. (2013), "Leveraging information technology to bridge the health workforce gap", *Bulletin of the World Health Organization*, Vol. 91 No. 11, pp.890-892. DOI:10.2471/BLT.13.118737.

Braithwaite J., Mannion R., Matsuyama Y., Shekelle P., Whittaker S., Al-Adawi S., Ludlow K., James W., Ting H., Herkes J., Mcpherson E., Churruca K., Lamprell G., Ellis L., Boyling C., Warwick M., Pomare C., Nicklin W. and Hughes C. (2018) "The future of health systems to 2030: a roadmap for global progress and sustainability", *International Journal for Quality in Health Care*, Vol. 30 No. 10, pp.823-831. DOI:10.1093/intqhc/mzy242.

Bronsoler, A., Doyle, J., and van Reenen, J. (2020) "The Impact of New Technology on the Healthcare Workforce", research brief, Massachusetts Institute of Technology, Massachusetts, 26 October.

Busse, T.S., Kernebeck, S., Nef, L., Rebacz, P., Kickbusch, I. and Ehlers, J.P. (2021), "Views on Using Social Robots in Professional Caregiving: Content Analysis of a Scenario Method Workshop", *Journal of Medical Internet Research*, Vol. 23 No. 11. DOI:10.2196/20046.

Egbert, N., Thye, J., Hackl, W.O., Müller-Staub, M., Ammenwerth, E. and Hübner, U. (2019), "Competencies for nursing in a digital world. Methodology, results, and use of the DACH-recommendations for nursing informatics core competency areas in Austria, Germany, and Switzerland", *Informatics for Health and Social Care*, Vol. 44 No. 4, pp.351-375. DOI:10.1080/17538157.2018.1497635.

Ehresmann, A., Tuomi, I., Miller, R., Béjean, M. and Vanbremeersch, J.-P. (2018), "Towards a formal framework for describing collective intelligence knowledge creation processes that 'use-the-future'", Miller, R. (Ed.), *Transforming the Future: Anticipation in the 21st Century*, Routledge, London, pp.66-92.

European Comission (2018), *Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the*

Committee of the Regions on enabling the digital transformation of health and care in the Digital Single Market; empowering citizens and building a healthier society, Brussels. Available at: https://digital-strategy.ec.europa.eu/en/library/communication-enabling-digital-transformation-health-and-care-digital-single-market-empowering (Accessed 4 April 2022)

Fattore, G., Maniadakis, N., Mantovani, L.G. and Boriani, G. (2011), "Health technology assessment: what is it? Current status and perspectives in the field of electrophysiology", *Europace,* Vol. 13 No. 2, pp.ii49-ii53. DOI:093/europace/eur083.

Finnish Government (2020), *Terveysalan tutkimus- ja innovaatiotoiminnan kasvustrategia. Tiekartta 2020-2023 -kestävää kasvua ja hyvinvointia.* Helsinki: Publications of the Finnish Government 2020:33, availabe at http://urn.fi/URN:ISBN:978-952-383-520-7 (accessed 28 March 2022).

Fruehwirt, W. and Duckworth, P. (2021), "Towards better healthcare: What could and should be automated?", *Technological Forecasting and Social Change,* Vol. 172, p.120967. DOI:10.1016/J.TECHFORE.2021.120967.

Gordon, T.J. (2009), "The Delphi Method", Glenn, J.C. and Gordon, T.J. (Ed.s), *Futures Research Methodology - V3.0,* The Millennium Project; 3.0 edition.

Granja, C., Janssen, W. and Johansen, M.A. (2018), "Factors Determining the Success and Failure of eHealth Interventions: Systematic Review of the Literature", *Journal of Medical Internet Research,* Vol. 20 No. 5, p.e10235. DOI:10.2196/10235.

Habran, E., Saulpic, O. and Zarlowski, P. (2018), "Digitalisation in healthcare: An analysis of projects proposed by practitioners", *British Journal of Health Care Management,* Vol. 24 No. 3, pp.150-155. DOI:10.12968/bjhc.2018.24.3.150.

Hasson, F. and Keeney, S. (2011), "Enhancing rigour in the Delphi technique research", *Technological Forecasting and Social Change,* Vol. 78 No. 9, pp. 1695-1704, DOI:10.1016/J.TECHFORE.2011.04.005.

Haverinen, J., Keränen, N., Falkenbach, P., Maijala, A., Kolehmainen, T. and Reponen, J. (2019), "Digi-HTA: Health technology assessment framework for digital healthcare services", *Finnish Journal of EHealth and EWelfare,* Vol. 11 No. 4, pp.326-341. DOI:10.23996/fjhw.82538.

Hendolin, M. and Hämäläinen, H. (2022). “Terveysdatan sujuva ja turvallinen käyttö- viisi askelta kohti reilua datataloutta 2030”, working paper, The Finnish Innovation Fund Sitra, Helsinki, 29 March 2022.

Immonen, M.S., Similä, H., Lindholm, M., Korpelainen, R. and Jämsä, T. (2019), “Technologies for fall risk assessment and conceptual design in personal health record system”, *Finnish Journal of EHealth and EWelfare,* Vol. 11 No. 1-2, pp.53-67. DOI:10.23996/FJHW.73258.

Jauhiainen, A., Sihvo, P., Jääskeläinen, H., Ojasalo, J. and Hämäläinen, S. (2017), “Skenaariotyöskentelyllä tietoa tulevaisuuden sosiaali- ja terveyspalveluista ja osaamistarpeista”, *Finnish Journal of EHealth and EWelfare,* Vol. 9 No. 2-3, pp.136-147. DOI:10.23996/FJHW.61002.

Kaihlanen, A-M., Virtanen, L., Buchert, U., Safarov, N., Valkonen, P., Hietapakka, L., Hörhammer, I., Kujala S., Kouvonen A. and Heponiemi T. (2022), “Towards digital health equity - a qualitative study of the challenges experienced by vulnerable groups in using digital health services in the COVID-19 era”, *BMC Health Services Research,* Vol. 22 No. 188. DOI:10.1186/s12913-022-07584-4.

Keeney S, Hasson F, and McKenna HP (2001) “A critical review of the Delphi technique as a research methodology for nursing” *International Journal of Nursing Studies,* Vol 38 No. 2 pp.95-200. DOI: 10.1016/S0020-7489(00)00044-4

Konttila, J., Siira, H., Kyngäs, H., Lahtinen, M., Elo, S., Kääriäinen, M., Kaakinen, P., Oikarinen A., Yamakawa M., Fukui, S., Utsumi M., Higami Y., Higuchi A., Mikkonen K. (2019), “Healthcare professionals’ competence in digitalisation: A systematic review”, *Journal of Clinical Nursing,* Vol. 28 No. 5-6, pp.745-761. DOI:10.1111/JOCN.14710.

Kwiatkowska, E.M. and Skórzewska-Amberg, M. (2019), “Digitalisation of Healthcare and the Problem of Digital Exclusion”, *Journal of Management and Business Administration,* Vol. 27 No. 2, pp.48-63. DOI:10.7206/JMBA.CE.2450-7814.252.

Kyngäs, H. (2019), “Inductive Content Analysis”, Kyngäs, H., Mikkonen, K. and Kääriäinen, M. (Ed.s), *The Application of Content Analysis in Nursing Science Research,* Springer International Publishing AG, pp.13-21.

Lapão, L.V. (2016), “The Future Impact of Healthcare Services Digitalization on Health Workforce: The Increasing Role of Medical Informatics”, *Studies in Health Technology and Informatics*, Vol. 228, pp.675–679. DOI:10.3233/978-1-61499-678-1-675.

Lapão, L.V., Dussault, G. and World Health Organization (2017), “The contribution of eHealth and mHealth to improving the performance of the health workforce: a review”, *Public Health Panorama*, Vol. 3 No. 3. pp.463-472.

Lapão, L.V., Maia, M. and Dussault, G. (2019), “eHealth solutions to regional shortages in the health workforce”, *European Journal of Public Health*, Vol. 29 Issue Supplement_4. DOI:10.1093/EURPUB/CKZ185.411.

Li, S., Bamidis, P.D., Konstantinidis, S.T., Traver, V., Car, J. and Zary, N. (2019), “Setting priorities for EU healthcare workforce IT skills competence improvement”, *Health Informatics Journal*, Vol. 25 No. 1, pp.174-185. DOI:10.1177/1460458217704257

Linturi, H. and Kuusi, O. (2022), “Tulevaisuuksia ennakoiva Delfoi-menetelmä”, Aalto, H.-K., Heikkilä, K., Keski-Pukkila, P., Mäki, M. and Pöllänen, M. (Ed.s), *Tulevaisuudentutkimus Tutuksi - perusteita ja menetelmiä*, Tulevaisuudentutkimuksen Verkostoakatemia, Tulevaisuuden tutkimuskeskus, Turun yliopisto, Turku, pp.178-198.

Lipsitz, L.A. (2012), “Understanding Health Care as a Complex System: The Foundation for Unintended Consequences”, *JAMA*, Vol. 308 No. 3, pp.243-244. DOI:10.1001/JAMA.2012.7551.

McPherson, S., Reese, C. and Wendler, M.C. (2018), “Methodology update: Delphi studies”, *Nursing Research*, Vol. 67 No. 5, pp. 404-410. DOI:10.1097/NNR.0000000000000297.

Meskó, B., Hetényi, G. and Gyorffy, Z. (2018), “Will artificial intelligence solve the human resource crisis in healthcare?”, *BMC Health Services Research*, Vol. 18 No. 1. DOI:10.1186/S12913-018-3359-4.

Miller, R. (2018), “Sensing and making-sense of Futures Literacy: Towards a Futures Literacy Framework (FLF)”, Miller, R. (Ed.), *Transforming the Future: Anticipation in the 21st Century*, Routledge, London, pp.15–50.

Miller, R., Poli, R. and Rossel, P. (2018), “The Discipline of Anticipation - Foundations for Futures Literacy”, in Miller, R. (Ed.), *Transforming the Future: Anticipation in the 21st Century*, Routledge, London, pp.51–65.

Nasa, P., Jain, R. and Juneja, D. (2021), “Delphi methodology in healthcare research: How to decide its appropriateness”, *World Journal of Methodology*, Vol. 11 No. 4, pp.116-129. DOI:10.5662/WJM.V11.I4.116.

Nazeha, N., Pavagadhi, D., Kyaw, B.M., Car, J., Jimenez, G. and Car, L.T. (2020), “A Digitally Competent Health Workforce: Scoping Review of Educational Frameworks”, *Journal of Medical Internet Research*, Vol. 22 No. 11. DOI:10.2196/22706.

Pernaa, H.-K. (2020), *Hyvinvoinnin toivottu tulevaisuus: tarkastelussa kompleksisuus, antisipaatio ja osallisuus*, Vaasan yliopisto, Vaasa, 24 March.

Pihlainen, V., Kivinen, T. and Lammintakanen, J. (2019), “Perceptions of future hospital management in Finland”, *Journal of Health Organization and Management*, Vol. 33 No. 5, pp.530–546. DOI:10.1108/JHOM-02-2018-0045.

Puustinen, A. and Jalonen, H. (2020), “Kompleksisuusajattelu: ymmärtämistä edistävä uusi lähestymistapa vai vanhaa viiniä uudessa pullossa?”, Vartiainen, P. and Raisio, H. (Ed.s), *Johtaminen kompleksisessa maailmassa: viisautta pirullisten ongelmien kohtaamiseen*, Gaudeamus, Helsinki.

Radnia, R. (2018), *Työllisyyden ja osaamisen muutoksia. Osaamisen ennakointifoorumin skenaariotyön tuloksia. Sosiaali-, terveys- ja hyvinvointialan ennakointiryhmän III-vaiheen raportointi*. Opetushallitus, Helsinki.

Risling, T. (2017), “Educating the nurses of 2025: Technology trends of the next decade”, *Nurse Education in Practice*, Vol. 22, pp.89-92. DOI:10.1016/J.NEPR.2016.12.007.

Rouse, W.B. (2008), “Health Care as a Complex Adaptive System: Implications for Design and Management”, *Bridge*, Vol. 38 No. 1.

Salkind, N. (2013), “Delphi Technique”, in Salkind, N. (Ed.), *Encyclopedia of Measurement and Statistics*, Sage Publications, Inc., DOI:10.4135/9781412952644.N128.

Shaw, T., McGregor, D., Brunner, M., Keep, M., Janssen, A. and Barnet, S. (2017), "What is eHealth? Development of a Conceptual Model for eHealth: Qualitative Study with Key Informants", *Journal of Medical Internet Research*, Vol. 19 No. 10, p.e8106, DOI:10.2196/JMIR.8106.

Stubin, T., Tikkanen, J. and Linturi, H. (2020), "4. Delfoi-paneeli", *METODIX*, available at: https://metodix.fi/2020/10/16/4-delfoi-paneeli/ (accessed 12 April 2022).

Tapio, P., Paloniemi, R., Varho, V. and Vinnari, M. (2011), "The unholy marriage? Integrating qualitative and quantitative information in Delphi processes", *Technological Forecasting and Social Change*, Vol. 78 No. 9, pp.1616-1628. DOI:10.1016/J.TECHFORE.2011.03.016.

Tenhunen, H., Hirvonen, P., Linna, M., Halminen, O. and Hörhammer, I. (2018), "Intelligent Patient Flow Management System at a Primary Healthcare Center - The Effect on Service Use and Costs", *Studies in Health Technology and Informatics*, Vol. 255, pp.142-146. DOI:10.3233/978-1-61499-921-8-142.

The World Medical Association (2013), "WMA Declaration of Helsinki – Ethical principles for medical research involving human subjects", The World Medical Association, Fortaleza.

Topol, E. (2019), *The Topol Review. Preparing the Healthcare Workforce to Deliver the Digital Future. An Independent Report on Behalf of the Secretary of State for Health and Social Care*, available at: https://topol.hee.nhs.uk/wp-content/uploads/HEE-Topol-Review-2019.pdf (accessed 12 April 2022)

Trevelyan, E.G. and Robinson, N. (2015), "Delphi methodology in health research: How to do it?", *European Journal of Integrative Medicine*, Vol. 7 No. 4, pp.423-428. DOI:10.1016/J.EUJIM.2015.07.002.

Vähäkainu, P. and Neittaanmäki, P. (2018), *Digitaalinen terveys ja älykäs terveydenhuollon teknologia.* Jyväskylän yliopisto, Jyväskylä.

WHO (2016), *Global strategy on human resources for health: Workforce 2030*. World Health Organization, Geneva, available at: https://apps.who.int/iris/bitstream/handle/10665/250368/9789241511131-eng.pdf (accessed 30 May 2022)

WHO (2022), *Health and Care Workforce in Europe: Time to Act*, World Health Organization Regional Office for Europe, Geneva, available at: https://www.who.int/europe/publications/i/item/9789289058339 (accessed 2 December 2022)

WHO (2018), *Building the Primary Health Care Workforce of the 21st Century*, World Health Organization, Geneva, available at: https://apps.who.int/iris/handle/10665/328072 (accessed 12 May 2022)

Wortley, S., Street, J., Lipworth, W. and Howard, K. (2016), "What factors determine the choice of public engagement undertaken by health technology assessment decision-making organizations?", *Journal of Health Organization and Management*, Vol. 30 No. 6, pp.872-890. DOI: 10.1108/JHOM-08-2015-0119.

Zarif, A. (2022), "The ethical challenges facing the widespread adoption of digital healthcare technology", *Health and Technology*, Vol. 12 No. 1, pp.175–179. DOI: 10.1007/s12553-021-00596-w.

Table I. Matrix displaying self-assessed expertise of the participating experts.

Expertise / Interest group	Technological development	Providing services	Ethics	Service planning and development	Legal expertise
HCO 2				x	
HCO 1		x			
HCO 2	x	x		x	
HCO 2	x	x	x	x	x
HCO 2	x				
HCO 2	x	x	x	x	
HCO 1		x		x	
HCO 2		x	x	x	
HCO 1		x			
HTO/HCO 2	x	x	x	x	x
HCO/HEI 1		x			
HEI 1				x	
HEI 2	x	x	x	x	x
HTO 2	x				
HTO 2				x	
HTO 2	x				
HTO 2	x	x			x

Abbreviations: HCO=Healthcare organisation, HTO=Healthcare technology organisation, HEI=Healthcare education institution, 1= participated in first round only, 2=participated in both rounds

(Source: Authors' own work)

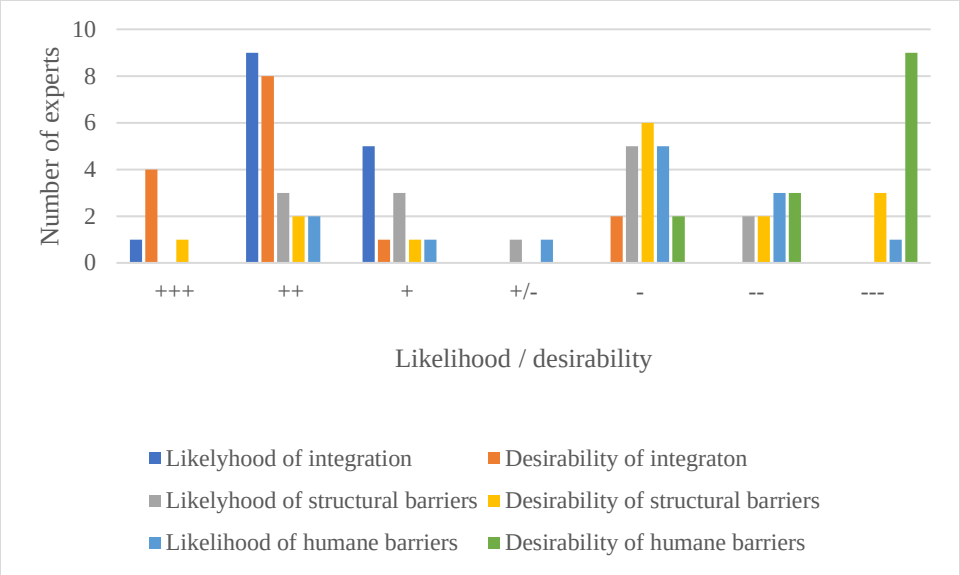


Figure 1. Digital healthcare is an integral part of all forms of healthcare in 2035 on a scale of extremely unlikely/undesirable (---) to extremely likely/desirable (+++).
(Source: Authors' own work)

Table II. Time point questions from the first Delphi round.

Utilisation of digital healthcare compared with 2020	Number of answers	2035 mean *	Standard deviation
1. Utilising mobile games in self-care guidance	12	+51,2%	18,9
2. The portion of contacts to healthcare that are handled without physical visit to a healthcare facility	13	+49,6%	25,2
3. Utilising AI in personal health data analysis	11	+46,8%	25,3
4. Utilising at home sensors and wearables for diagnostics and remote monitoring	13	+46,3%	16,5
5. Utilising AI for automated image interpretation	12	+45,4%	17,5
6. The portion of visits related to chronic conditions being replaced by telehealth contacts and remote monitoring	13	+44,2%	19,1
7. Utilising AI in healthcare systems data analysis	12	+44%	26,1
8. eVisits utilising VR and AR	12	+42,7%	25,8
9. The portion of homecare visits replaced by eVisits and remote monitoring	12	+34,6%	17,9
10. Utilising robotics in homecare	12	+32,9%	14,3
11. Utilising AI-based therapy apps	10	+30,8%	15,7
12. Utilising VR and AR for rehabilitation at home	12	+24,2%	18,3
13. Utilising genome reading for tailored medicine	12	+23,4%	16,6

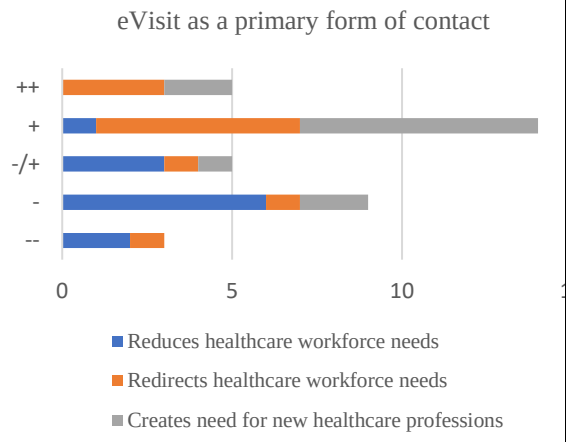
* The range for answers was -100% to 100%.
Abbreviations: AI=Artificial intelligence, VR=Virtual reality, AR=Augmented reality
(Source: Authors' own work)

Table III. Experts' perceptions of factors impacting the forms of digital healthcare anticipated to be the most utilised regionally in 2035.

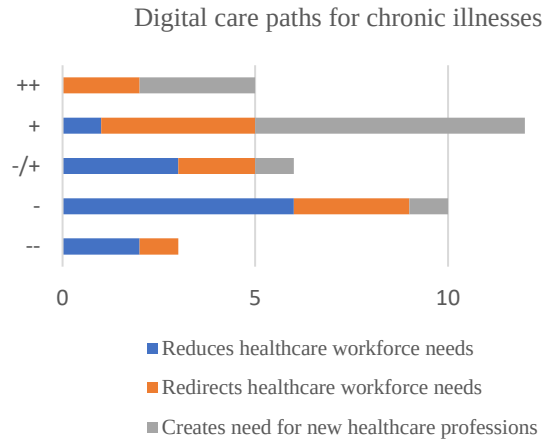
Subcategories (n=21)	**Categories (n=8)**	**Main categories (n=3)**
Secondary-level healthcare Primary-level healthcare Private healthcare	Levels of healthcare	Organisations
Crossing organisational limits Fading organisational limits	Organisational limits	
Laws Information Equality	Structural barriers	
Patient-centred care Significance of human contact Technological skills	Patients	Humans
Professionals and technology working together The presence of a professional	Professionals	
Resistance Unpredictable events Outdated technology Unfinished systems	Problems with technology utilisation	Technology
Cost Support services Meeting needs	Accessibility	
Affordable equipment Equipment for loan/lease	Availability	

(Source: Authors' own work)

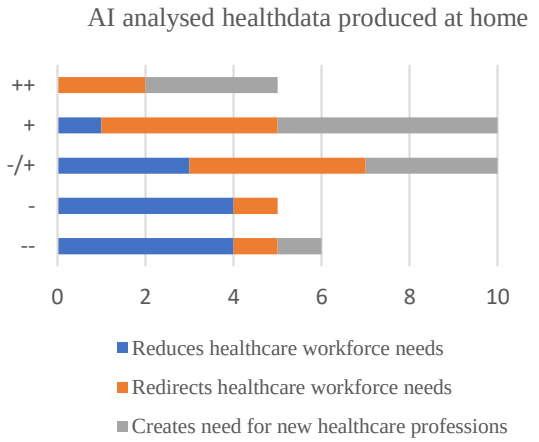
Scenario 1:
In 2035, eVisit is the primary form of contact for all patients with a novel health problem, excluding emergency patients. Patients will be directed to different healthcare professionals based on data from automatically processed questionnaires and remote monitoring. eVisits utilise affordable and high-quality mobile phone apps, such as stethoscope and otoscope apps and VR glasses.



Scenario 2:
When diagnosed with a chronic illness in 2035, the patient is directed to a tailored digital care path. Digital care paths help identify potential health issues related to the illness, maintain health, prepare them for possible changes and manage the results of home-based monitoring. The frequency of in-clinic controls is based on progress in the digital care path.



Scenario 3:
In 2035, the amount of health data produced at home has increased significantly because measuring devices are integrated in smartphones, watches, rings, home appliances and clothes. The data are transferred into the healthcare data system, where the data are subjected to AI-based analytics and viewed by a healthcare professional, if needed.



Scenario 4:
In 2035, AI will be utilised in analysing health data produced in healthcare settings. In, for example, radiology and dermatology, this means that initial analysis of images is done by AI and that only images flagged by the AI will be analysed by a specialist.

Scenario 5:
In 2035, healthcare organisations will plan their services mainly by utilising AI in analysing healthcare usage data. The analysis is used in planning, for example, the location, equipment and opening times of healthcare units.

Scenario 6:
In 2035, healthcare organisations will plan their services partially by utilising AI in analysing healthcare usage data. Important criteria alongside the data analysis are regional accessibility and equality, legal limitations and local political decision making.

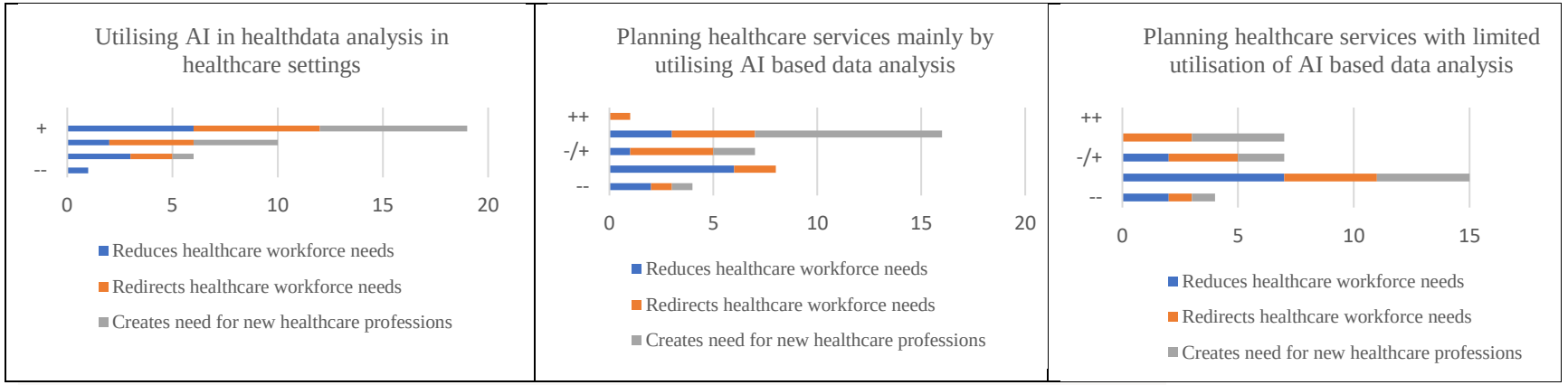


Figure 2. The scenarios of the second Delphi round and likelihoods of their perceived workforce impact on a scale of very unlikely (--) to very likely (++).
Abbreviations: AI=Artificial intelligence, VR=Virtual reality, AR=Augmented reality
(Source: Authors' own work)

Table IV. Experts' perceptions of factors influencing the impact of digital healthcare on healthcare workforce needs.

Subcategories (n=31)	Categories (n=8)	Main categories (n=3)
Beginning of the care process Enhancing assessments	Care process	Impacts within healthcare organisations
Resources for following alerts Resources for tracking information Smarter resourcing Flexible resourcing Organising resources Enabling needs-based use of resources	Resource management	
Decreasing needs in time Decreases need in specialty areas Increased need for services Need for primary-level healthcare workers Needs between professions will shift Needs will change within a specialty	Changing needs	
Professions that will understand technology and content New professions for maintaining systems Digital care path developers Digi mentors Digital solution developers	New professions	Impacts on healthcare professions
Multiskilled people Data analysis skills Technical skills and ability to notice mistakes Using information for management	New skills	
Access to care Access to healthcare professionals Speed of access	Access	Impacts via patients
Awareness of health status Awareness of methods Increasing self-care because of awareness	Awareness	
Capability to use digital healthcare Capability for individual access to information	Capabilities	

(Source: Authors' own work)