Achieving digital transformation in cancer care across Europe: Practical recommendations from the TRANSiTION project

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A B S T R A C T

Background: Digital transformation in cancer care requires a comprehensive integration of digital technologies, data analytics, and innovative processes to enhance the delivery of healthcare services. Achieving digital transition relies on the appropriate preparation of the oncology workforce through adequate education and training in digital solutions. The aim of the current paper was to develop a recommendations scheme for digital transition in oncology through healthcare professionals' and health managers' digital training.
Methods: A mixed methods approach including a rapid literature review on relevant articles, guideline papers and statements of European organisations that was incorporated in expert's panel survey was performed. This paper is part of the EU funded project entitled "TRANSiTION" - Digital TRANSition and dIgiTal resiIlience in Oncology.
Results: Four levels of recommendations arisen from the current study and include actions in the following areas: (i.) policy, (ii.) education (iii.) clinical practice and (iv.) research. These recommendations are interrelated and collaboration between all relevant stakeholders is crucial on a national, transnational and European level.
Conclusions: The recommendations proposed in this paper could have an impact on the digital transformation in cancer care across Europe. Strong leadership on a policy level, coordination and cooperation among the relevant stakeholders is the stepping stone to a successful and swift digital transition in healthcare systems.
Policy summary: The recommendations aims to impact several key policies and policy improvements in Europe, including regulatory frameworks on digital health technologies; data sharing and interoperability; digital literacy among both patients and healthcare professionals and health managers and the use of digital tools for patient-centered care, to harness the full potential of digital transformation in cancer care, ultimately leading to better patient outcomes and more efficient healthcare systems.

1. Introduction

Digital technology is an inevitable part of the future of healthcare systems in Europe [1]. The digitization of health has long been on the European agenda to modernize and improve care in all settings across member states. This has been reflected on the Digital Targets for 2030 set out by Europe's Digital Decade across 4 areas of interest: skills,

infrastructure, business and government [2].

As part of the Digital Decade policy programme, the focus has recently shifted from developing the technology to implementation of digital solutions and to train or familiarize the healthcare workforce, patients and the general public in the use of technology [3]. This has been identified as a priority in an effort to better prepare the health workforce to efficiently be able to respond to the rapid infiltration of

technology in an increasing number of areas within healthcare across the disease continuum [4]. From a patient and general public perspective, the shifting towards the implementation of digital solutions has also contributed to cultivating a digital culture that facilitates acceptance as well as adherence to the systematic use of technology.

The world is undergoing an unprecedented digital change, and in health sector people are increasingly demanding better quality of care delivery. The shifting of care from the hospital to closer to home and the community, with the support of technology, has become the daily practice in many cases. This has been particularly evident in the management of chronic diseases, such as cancer. Patients constantly seek to becoming more autonomous and empowered to manage their own health. In particular, the COVID-19 pandemic has accelerated this change in many areas of life in a very short period of time [5].

Within the healthcare context, the health workforce has to daily use digital applications and other forms of technology to provide person-center and remote care. Moreover, cross-border healthcare will oblige healthcare professionals (HCPs) to rely on health data from other countries, interpreting the data to determine how to best treat the patient [6]. Recent developments such as the European Health Data Space (EHDS), is anticipated to empower individuals to take control of their health data and facilitate the exchange of data for the delivery of healthcare across the European Union (EU) [7]. At the same time, healthcare professionals will be required to be digitally competent to work within a genuine single market for electronic health record systems.

This need for digital transition is acknowledged also at EU level, and several initiatives take it into account. Explicitly, in the field of oncology and in cancer care, one of the flagships of the Europe's Beating Cancer Plan is referred to modernize the approach to cancer by introducing new technologies, research and innovation at the service of patient-centered care and to digitalization in cancer prevention and care [8]. Moreover, the vision of the EU4Health programme 2021–2027 is for a healthier EU by providing financial support in the health area with a special focus on strengthening the health systems by reinforcing health data, digital tools and services, and digital transformation of healthcare. These challenges will also have to be met by academic institutions and professional associations for healthcare professionals [9].

These new era in health creates a special demand for digital transformation in health across all the health systems in Europe due to the growing need of technology use. We are almost on a changing healthcare sector due to the increasing use of digital solutions. The rapid change to a digitalized healthcare and the associated requirements is inextricably linked and depends on health care personnel's skills in the use and sustainability of digital technologies, both in training and in the clinical workplace [10]. Thus, the transition in digital world in health care presupposes a well-trained workforce. However, the preparedness of the healthcare workforce is not without challenges. A policy brief driven by the TRANSiTION consortium has identified the specific challenges of developing structured, accessible, and comprehensive digital training programme, that incorporate specific and clearly defined attributes [11].

In order to address the requirements of the digital transition via HCPs and health managers training, in health sector generally and in the oncology field specifically, as well to improve the digital preparedness and resilience in European countries, an expert panel study was conducted with the aim to build a recommendation scheme.

These recommendations form part of the European project "TRANSiTION - Digital Transition and Digital Resilience in Oncology" (project reference: 101101261), which aims to develop a European education and training programme for HCPs and health managers in EU member states that will enable the acquisition of digital skills and competencies for current and future needs that the integration of digital solutions generates [12]. Working towards the better preparedness and readiness of the health workforce, such a training programme cultivates a pathway that leads to the digital transition and digital resilience.

2. Methods

The recommendations proposed in this document come of an online survey that included open-ended questions and was conducted during May – July 2023.

2.1. Participants

Participants in the survey were experts in digital solutions in health with or without an oncology background who were purposively selected and voluntarily completed the online survey. Those experts were clinicians, researchers, academics and industry representatives. Participants were recruited through the consortium of the TRANSiTION project, 18 persons in total, at least one from every participating country in the project i.e. Belgium, Bulgaria, Croatia, Cyprus, France, Germany, Greece, Italy, Lithuania, Poland, Portugal, Romania, Spain, and Slovenia, that reported on the data for each of the items included in the online survey. Inclusion criteria included being experts on national level on digital health technology, that means they had knowledge and experience in the field of digital health within their country, were involved in developing, implementing, promoting digital health solutions and / or be involved in shaping national policies and strategies to integrate digital health technologies into the healthcare system to improve patient care, accessibility, and efficiency. All the participants were informed in advance about the aim of the survey, explanations were provided on the online form and how to fill it in, as well as ongoing support when a question was raised.

2.2. Survey design

The online survey was designed to collect data on good practices, challenges, barriers, enablers and support needed on a digital transformation in oncology / healthcare. The survey consisted of five open-ended questions that were developed based on the literature and a panel discussion with the consortium during the kick-off meeting of the TRANSiTION project to ensure relevance and clarity. Participants reflected on the following questions: "describe good practices undertaken in your country for digital transformation"; "describe challenges for digital solutions / tools implementation in your national healthcare system"; "describe the barriers for digital transformation in your country"; "describe the health workforce and health systems enablers for digital solutions / tools implementation in oncology \ healthcare system"; and "what support might needed for implementation digital solutions in health".

2.3. Data collection procedure

The survey was distributed via email and hosted on Google Forms. The survey was available for two months, during which participants could access the survey link and complete it at their convenience.

2.4. Ethical considerations

This study adhered to ethical standards for research involving human participants. All data were collected anonymously, and no personally identifiable information was requested. Participants were informed that participation was voluntary, and they could withdraw at any time without consequence. The survey data was stored securely, and the results are reported in aggregate format to protect participants' privacy. Ethical approvals have been obtained accordingly from the Cyprus Bioethics Committee (ΕΕΒΚ ΕΠ 2023 01.184).

2.5. Data analysis

Data collected from the survey responses were analysed using thematic analysis of the results. Thematic analysis is a type of qualitative

analysis used to analyze classifications and present themes (patterns) that relate to the data. Thematic analysis identifies core themes, in this case, recommendations or strategies, via the careful reading, and rereading, of the data [13]. This approach offers a detailed capture of diverse themes and interpretations of them. Following the guidelines by Javadi and Zarea [14], an inductive thematic analysis was undertaken, where the findings were not predetermined towards any particular theory, but were instead grounded entirely in the data.

3. Findings

3.1. Respondents characteristics

The following Table 1 presents an overview of the experts' background. In total 8 male and 10 female experts provided data regarding the digital health recommendations.

4. Recommendations for digital transformation in cancer care

Several contributors have endeavored to establish explicit positions that reflect literature, experience and knowledge in the field of digital transition in cancer care across Europe. These recommendations are designed to be considered as a basis for reflection and work practices for all those involved in cancer care and digital health. These recommendations do not pretend to respond to every conceivable situation. Additionally, in order to create a positive impact on cancer care across Europe, these recommendations follow the theories of change as a way to be a powerful and helpful tool for policy makers [15].

Four levels of recommendations were proposed and include actions in the following levels (i.) policy, (ii.) education, (iii.) clinical practice and (iv.) research (Fig. 1). The recommendations are interrelated and collaboration between all relevant stakeholders is crucial.

On a policy level, the development of a comprehensive national/ European strategy for digital skills training in health, and partnerships for knowledge exchange, are required, along with a regulatory and quality assurance framework to ensure safety, efficacy, and privacy of digital health technologies through regulatory guidelines. It is crucial to establish standards to protect patient information and to provide equal access to digital training and resources for all healthcare professionals and health managers, by fostering a culture of lifelong learning and adaptability to digital trends. Additionally, collaboration between public and private sectors to develop and implement digital skills training programs, and among healthcare and educational institutions to integrate them into practice, with a continuous monitoring and evaluation of the training programs will ensure effective digital transformation in health. At the same time, allocation of funding to support the above strategy is important and public awareness on the benefits and responsible use of digital health technologies in oncology will assure the sustainability of the transformation.

Based on the experts' input, it is crucial countries to incorporate digital skills training in health into early stage of education for healthcare professionals and health managers and to develop programs focused on digital skills in oncology. At the same time, continuing education opportunities for healthcare professionals to update their knowledge with accessible and affordable digital skills courses, including hands-on training through internships, clinical rotations, and simulation exercises is of great significance. Professional associations could assist to develop guidelines and recommendations, and to promote interdisciplinary collaboration.

The role of research for the digital transformation in cancer care, such as funding opportunities for the development of innovative digital solutions in oncology, creation and evaluation of digital tools, and the identification of digital skills gaps among cancer professionals, were also stated. Research projects have a lot to provide by assessing the effectiveness of existing digital skills training programs, explore innovative training approaches, and study the correlation between digital skills and

Table 1
Respondents characteristics.

Country	Region	Gender	Expert's background	Organisation
Belgium	Flamish	M	Cancer Nurse, Researcher, Manager	European Oncology Nursing Society (EONS)
Bulgaria	National	F	Physician, Researcher, Academic	Bulgarian General Practice Society for Research and Education (BGPSRE)
Croatia	Osijek-Baranja County	F	Physician, Researcher, Academic	Faculty of Medicine Osijek
Cyprus	National	F	Researcher, Academic	Cyprus University of Technology
France	Brittany	M	Physician	Universite De Bretagne Occidentale - Univeriste De Brest (UBO)
Germany	National	M	Researcher, Digital Solutions Expert	Padagogische Hochschule Heidelberg (PHHD)
Germany	National	M	Physician, Researcher	University Medical Center Freiburg
Greece	National	M	Researcher, Cancer Nurse, Scientific & Policy Advisor	Hellenic Ministry of Health
Italy	National	M	Physician, Researcher in Cancer & Digital Health	Istituto Europeo Di Oncologia (IEO)
Lithuania	National	F	Digital Solutions Expert	Smart Health Digital Innovation HUB
Poland	Central (Masovian District)	F	Researcher in Cancer & Digital Health	PCG Polska
Portugal	Porto	F	Medical Oncologist	Associacao de Investigacao de Cuidados de Suporte em Oncologia (AICSO)
Romania	National	F	Physician, Researcher in Cancer & Digital Health	The Oncology Institute, Cluj-Napoca
Romania	National	F	Physician, Researcher in Cancer & Digital Health	Carol Davila University of Medicine and Pharmacy (UMFCD)
Slovenia	National	F	Nurse, Academic, Researcher	University of Maribor Faculty of Health Sciences
Spain	Andalusia	F	Researcher in Cancer & Digital Health	Escuela Técnica Superior de Ingeniería Informática de la Universidad de Sevilla
Spain	Galicia	M	Researcher in Cancer & Digital Health	Servicio Gallego de Salud (SERGAS)
Spain	Catalonia	M	Academic, Researcher in Cancer & Digital Health	Universitat Oberta de Catalunya (UOC)

M: male, **F:** female

research quality, efficiency, and innovation. Obviously, ethical considerations such as issues related to data privacy, security, and artificial intelligence in digital skills training should be considered, and evaluation of the impact of data sharing on digital skills development and research outcomes to be included.

Furthermore, the participating experts mentioned the value of upskilling and reskilling the existing workforce. To that direction actions
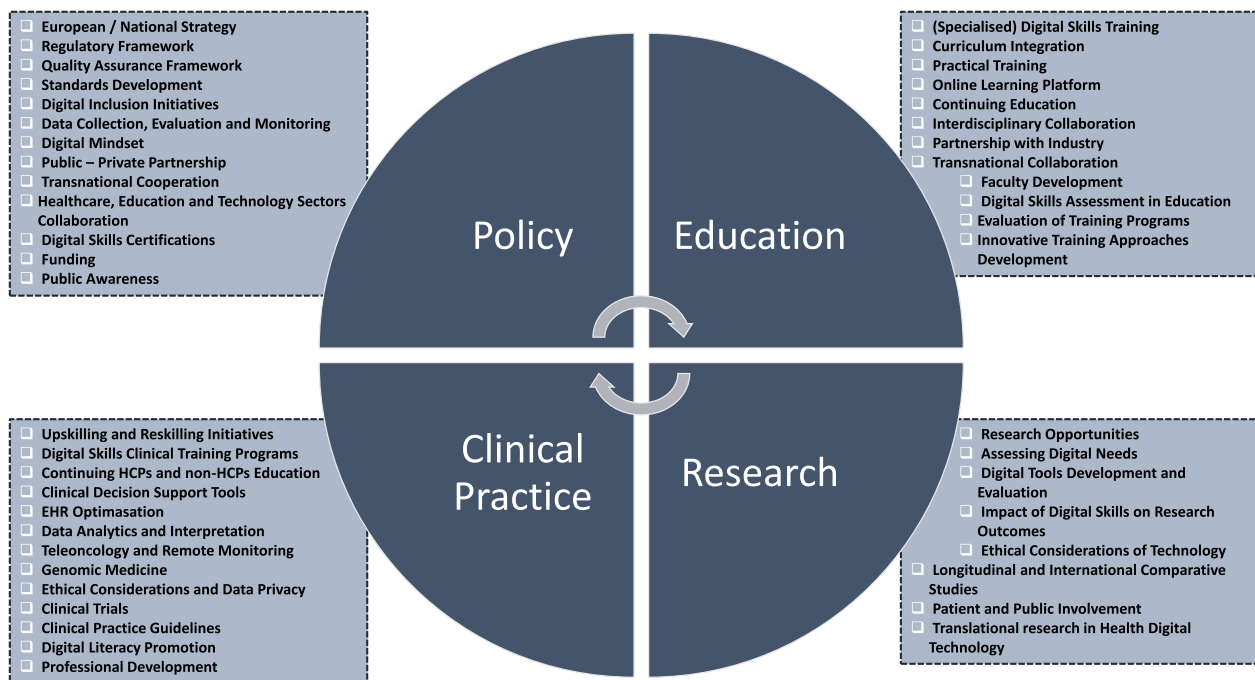
Policy
- European / National Strategy
- Regulatory Framework
- Quality Assurance Framework
- Standards Development
- Digital Inclusion Initiatives
- Data Collection, Evaluation and Monitoring
- Digital Mindset
- Public – Private Partnership
- Transnational Cooperation
- Healthcare, Education and Technology Sectors Collaboration
- Digital Skills Certifications
- Funding
- Public Awareness

Education
- (Specialised) Digital Skills Training
- Curriculum Integration
- Practical Training
- Online Learning Platform
- Continuing Education
- Interdisciplinary Collaboration
- Partnership with Industry
- Transnational Collaboration
  - Faculty Development
  - Digital Skills Assessment in Education
  - Evaluation of Training Programs
  - Innovative Training Approaches Development

Clinical Practice
- Upskilling and Reskilling Initiatives
- Digital Skills Clinical Training Programs
- Continuing HCPs and non-HCPs Education
- Clinical Decision Support Tools
- EHR Optimasation
- Data Analytics and Interpretation
- Teleoncology and Remote Monitoring
- Genomic Medicine
- Ethical Considerations and Data Privacy
- Clinical Trials
- Clinical Practice Guidelines
- Digital Literacy Promotion
- Professional Development

Research
- Research Opportunities
- Assessing Digital Needs
- Digital Tools Development and Evaluation
- Impact of Digital Skills on Research Outcomes
- Ethical Considerations of Technology
- Longitudinal and International Comparative Studies
- Patient and Public Involvement
- Translational research in Health Digital Technology

Fig. 1. Schemes of recommendations for digital transformation in Europe.

required include the introduction of incentives and support for participation in training programs and conferences to encourage professional development and to enhance their digital literacy, as well as the promotion of the use of digital tools to assist in treatment decisions and data interpretation. It is important to update clinical practice guidelines to include digital technology recommendations and remote patient monitoring, and engaging patients in digital care.

5. Discussion

In recent years, digital transformation of the healthcare systems, not only in Europe but globally, has emerged as a cornerstone in reshaping healthcare delivery. Such reshaping has been fueled by introducing and integrating innovative technologies across health systems that offer significant opportunities to improve patient outcomes, reduce costs, and enhance the accessibility and efficiency of healthcare services. However, there are critical challenges that need to be addressed for successful implementation and achieving sustainability over time. This paper on recommendations aimed at ascertaining critical strategies in digital transformation in oncology and key focus areas for advancing digital health innovation in European health systems. The findings indicate that digital transformation is recognized as a gaining momentum in oncology, and a sustainable way of impact for high quality cancer care that differs from what can be achieved through the traditional standard health services. Experts of the survey suggested a set of recommendations about how change for improved care will be achieved, and these directions shaped the proposed scheme about what conditions are necessary for success, and what changes need to be achieved along the way.

Similarly, to these findings, results from preceding studies showed that on a policy level the majority of the European Member States reported that having a national digital health strategy in place, and a health information system strategy are considered as top priorities to increase the accessibility, quality, safety, and efficiency of the health systems, strengthening health information systems, and improving information sharing and interoperability of data [16]. Moreover, the assessment of the digital transformation impact of health services has pointed out that the evaluation of digital health services requires various

specific aspects to be considered, thus investment in the development of methodologies and a European system for evaluation and evidence of digital health services is encouraged [17]. Healthcare leaders and stakeholders need to establish strategies in knowledge improvement, innovation development, motivation increment, global strategy and local strategy alignment, leadership support and partnership development in order to facilitate achievement of sustainable digital health development [18].

Fundamental strategy in policy is the development of robust digital infrastructure to support the integration of digital tools across healthcare systems. According to the World Health Organization [19], inadequate infrastructure and the digital divide are key barriers to implementing digital health solutions globally. Ensuring equitable access to digital health services is essential for achieving universal health coverage and reducing health disparities [20]. While developed member states may have the resources to support such initiatives, policymakers must consider how to balance digital health development with existing resource constraints, particularly in settings with inadequate technological infrastructure [21]. Digital health systems require the collection and management of sensitive health data, making the protection of patient privacy and data security a critical policy issue. The implementation of stringent data protection regulations, such as the General Data Protection Regulation (GDPR), which regulates the handling of personal health data and mandates transparency in data usage [22].

Literature also supports that sustainable, quality, and safe healthcare services require a workforce equipped with contemporary capabilities. Digital competencies are required for the healthcare professionals as well as the health managers, within a collaborative approach across healthcare organizations, government, educational, and professional institutions [23]. The urgent need to incorporate digital health-related competencies in the existing training curriculum for the health workforce and the provision of targeted training for digital health readiness of the professionals in health sector was also arisen as a strategy advocated by the experts in this study.

A critical recommendation for successful digital transformation in health is enhancing digital literacy among healthcare professionals. As digital tools become more integrated into clinical practice, it is essential that healthcare workers are trained to use these technologies effectively

[24,25]. The promotion of ongoing professional development opportunities, integrate digital health training into healthcare workforce education, and provide accessible resources to help healthcare workers adapt to new technologies. While the need for digital literacy is evident, one limitation is that healthcare professionals often face time and resource constraints that make it difficult for them to engage in additional training [26,27]. As resistance to technological change is common in traditional healthcare settings, developing flexible, easily accessible training programs, including online modules and in-practice learning with incentives for the workforce is needed.

Another important component for successful digitization in health is research. Progressive change in health care is about innovations and advanced technologies impact on individuals' well-being [28]. Advanced and digital change in health services is a structure square of individualized care [29]. The limited research in the field may not have identified all the opportunities and challenges of digital transformation and adaptation of strategy to a new digital reality is indicated [30].

Research in digital health advances offers both opportunities and challenges that can reshape how healthcare is delivered and experienced. While digitization has the potential to transform health systems by improving efficiency, quality of care, and patient outcomes, its widespread implementation raises critical issues related to equity, privacy, and data governance. This highlights the critical role of research in the digital health co-design process, focusing on the benefits, challenges, and future directions [31].

Studies demonstrate that digital transformation in healthcare can lead to improved efficiency, reduced costs, increased patient satisfaction, and better patient outcomes [32–34]. The use of digital technologies such as telemedicine, electronic health records, wearables, and mobile health applications has already started to revolutionize healthcare delivery. The importance and influence of digital transformation has been reported in previously as a strategy for improved care [35]. To this direction the future of clinical redesign to improve patient care is based on production of real-time data to ensure quality and safety of health services [36].

The importance of digital transformation in healthcare it is highlighted in this paper along with insights into key focus areas for advancing digital health innovation in cancer care. These recommendations could be considered as best practices for successful implementation for positive impact of digital transformation on patient and healthcare systems outcomes in oncology. Ultimately, the recommendations scheme of this paper provide a roadmap for stakeholders and policymakers to prioritize digital transformation and improve outcomes in cancer care.

6. Conclusion

The implementation of the recommendations suggested in this paper, could impact significantly in improving digital skills training for oncology workforce and enhancing the digital transition of cancer care in Europe and its states. Governments can create an enabling environment for digital skills training development. This will ensure that citizens will be well-equipped for the digital age, oncology workforce can enhance their digital skills, and improve patient care outcomes. This will enable HCPs and health managers to harness the full potential of digital technologies in delivering personalised, efficient, and evidence-based care to cancer patients. Moreover, educational institutions will equip students, HCPs and non-HCPs with the necessary digital skills to thrive in the digital era of oncology practice. This will contribute to the improvement of patient care, research outcomes, and contribute to the overall digital index in oncology practice. All in all, the field of oncology can gain valuable insights and evidence to inform the development of effective digital skills training programs and research will contribute to the advancement of oncology research capabilities and ultimately lead to improved patient outcomes and advancements in the field.

CRediT authorship contribution statement

Moreno-Alonso Deborah: Writing – review & editing. **Carrión Carme:** Writing – review & editing. **Kyriacou Efthyvoulos:** Formal analysis, Writing – review & editing. **Couespel Norbert:** Writing – review & editing. **Claveria Ana:** Writing – review & editing. **Charalambous Andreas:** Conceptualization, Formal analysis, Methodology, Supervision, Writing – review & editing. **Tsitsi Theologia:** Writing – review & editing. **Nicolaidou Iolie:** Formal analysis, Writing – review & editing. **Protogiros Dimitrios:** Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Cloconi Constantina:** Writing – review & editing.

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The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Authorship contribution statement

The authors confirm contribution to the paper as follows: study conception and design: Andreas Charalambous; data collection: Dimitrios Protogiros; analysis and interpretation of results: Andreas Charalambous, Dimitrios Protogiros; Iolie Nicolaidou; Efthyvoulos Kyriacou. Draft manuscript preparation: Dimitrios Protogiros. All authors reviewed the results and approved the final version of the manuscript.

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