JOURNAL
OF EUROPEAN ECONOMY
Vol. 22. № 1 (84). January–March 2023
Publication of West Ukrainian National University

Medical Economics and Digitization of Health Care

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DIGITALIZATION AND ORGANIZATION OF CARE: THE CASE OF ONCOLOGY

Abstract

Recently, many industries have seen disruptive changes due to the rapid progress in information and communication technology (ICT). This systematic literature review aimed to develop an initial understanding of what is known about new ICT in medicine and its disruptive potential. Since medicine is organized into subsectors, we focused on oncology.

Medline and Google Scholar were searched for relevant literature. We also hand-searched relevant journals not included in these databases. Retrieved articles were categorized and analyzed according to content evaluation methods. Articles from 2008 to 2021 in German and English were considered.

3,848 manuscripts were identified; after the application of inclusion/exclusion criteria, 30 articles were included in the analyses.

The majority of articles (26) used a non-experimental design or detailed expert opinion. We found 10 major categories articles dealt with, ranging from the

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future role of physicians and the patient's role to the purpose of ICT usage. Authors commented on many important topics that could change the organization of care massively; in almost all articles, there is significant disagreement about likely future development. ICT is becoming increasingly important in oncology and may impact both patients' lives and professional conduct. When looking into ICT, doctors have focused on new diagnostic and therapeutic procedures but rarely on their disruptive potential. We recommend healthcare professionals to put more effort into the investigation of whether ICT changes the way oncology is performed and who is in control of this process, and to engage in shaping the future of oncology.

Key Words:

digitalization; ICT; oncology.

JEL: I10, O320.

1 figure, 13 references.

Problem Statement

Digitalization, i.e., the rapid progress in and usage of information and communication technology (ICT), has demonstrated the potential to massively change various market sectors – often labeled as *disruption*. For example, new fintechs changed the financial industry, new sharing business models such as Uber or Airbnb reshaped the taxi and hotel business, and some former incumbents even vanished, such as producers of photo film rolls (Volberda et al., 2018). Almost 50% of jobs could be replaced by intelligent machines (Frey & Osborne, 2017). Thus, digitalization is not just a new technology, it influences the whole of society.

Disruption typically refers to processes originating from innovations that quickly erode competitive positions and impact systems of value-creating actors

by breaking and recombining linkages among resources; they are often orchestrated by one or multiple firms, but their effect on value creation and capture is systemic (Skog et al., 2018).

There is no reason to assume that medicine will be unaffected by digitalization and its disruptive potential. For example, radiologists already consider the possibility of being replaced by artificial intelligence (Bluemke, 2018). However, so far new ICT have rarely «disrupted»[1] medicine: the major part of health care's business model is still under the control of the medical community; medical guidelines, for example, which define what «good» quality means, are developed and maintained by medical organizations (Herrmann et al., 2018). On the other hand, this might change in the near future. We therefore analyzed what is currently known about the disruption of medicine.

The disruptive potential of new ICT differs across medical specialties. In an earlier article, knowledge about organizational changes in rheumatology was analyzed; one of the key findings was that there are only very few publications on this topic. It seems that rheumatologists are much more interested in new ICT for diagnostic and therapeutic purposes and care little about the questions of how ICT may change daily practice (Richter et al., 2022).

In this article, we focus on oncology for several reasons. Cancer is still one of the major causes of death, and it is especially serious for patients (World Health Organization, 2022). Due to new therapies, many oncological diseases are chronic in nature, emphasizing the process of care. Finally, current research especially in immunology and genetics is extremely IT-consuming (Lang et al., 2022). Thus, oncology is likely to be changed first by ICT – and is, therefore, a good specialty to determine what will happen to medicine as a whole.

Methodology

To better understand what is currently known about our topic – digitalization and organization of care –, we searched Medline and Google Scholar for relevant literature. In addition, we hand-searched journals mentioned on the webpage www.wirtschaftsinfo.de, including journals listed in rankings on that page.

We included articles in English and German from 2010 to 2022 and excluded articles that focus only on the use of digital techniques for diagnostic and therapeutic purposes in the context of conventional management of medicine; do not relate to medicine, but to nursing; do not pertain to the U.S. or Europe; focus

[1] The infinitive present is «disrumpere»; «disruptus» is past participle. From the perspective of Latin, ICT should «disrump» rather than «disrupt» something.

specifically on the effects of the Covid-19 pandemic; describe new methods as such (e.g., apps for data collection, telemedicine, robotics) and mention care effects only in passing; do not report on digitization effects but on organizational changes triggered by other factors (e.g., tumor boards).

We used the following search terms for Medline:

1. («neoplasms»[MeSH Terms] OR «neoplasms»[tiab] OR «oncology»[tiab] OR «oncology s»[tiab] OR «cancer s»[tiab] OR «cancer»[tiab] OR «cancers»[tiab]) AND («information science»[MeSH Terms] OR «digit*»[All Fields]) AND («health services administration»[MeSH Terms]).

This resulted in 40,152 hits which were truncated after the best 1,000 matches.

2. («neoplasms»[MeSH Terms] OR «neoplasms»[tiab] OR «oncology»[tiab] OR «oncology s»[tiab] OR «cancer s»[tiab] OR «cancer»[tiab] OR «cancers»[tiab]) AND («information science»[MeSH Terms] OR «digit*»[All Fields]) AND «profession»[tiab]).

This resulted in 94 hits.

The search terms for Google scholar were «Oncology digitalization medical profession», «Oncology digitalization patient-physician-relation», «Oncology digitalization organization medicine», «Oncology digitalization management health care», and «Oncology digitalization medical system», and the respective German translations. Results were truncated after the best 1,000 matches.

After retrieval, all articles were analyzed in detail. Those sections that related to the research question were marked. Following Mayring and Fenz (2019), these sections were evaluated by content analysis and sorted by content categories (see research results). The type of article (original work, commentary, etc.) and the proportion of the total volume of each article included were also evaluated.

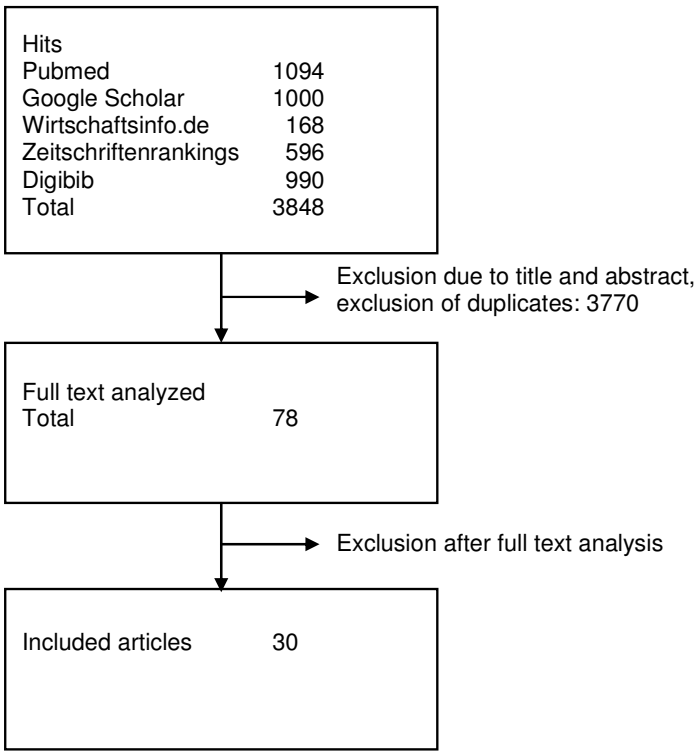
All analyses adhered to PRISMA standards (Preferred Reporting Items for Systematic Reviews and Meta-Analyses).

Research Results

In total, 3,848 hits were analyzed, of which 30 articles were included in our study.

Figure 1

Algorithm of article selection



All articles included are listed in the Appendix.

Most articles (26) are comments, reviews, or similar non-experimental publications. Four are original articles, and two are systematic reviews or were writ-

ten for educational purposes, respectively. One article was not published in a journal but as a book contribution.

The proportion of the total text of the articles that was related to the research question varied widely – from a few sentences to 100%. On average, the proportion was 38%.

Overall, the articles deal with an enormous range of topics. Through content analysis, we identified 10 main topics.

1. Role of physicians

A total of 17 articles address the question of how digitization is changing the role (incl. tasks and activities) of physicians. The topic can be further subdivided into (i) changes in physicians' activities (up to and including their abolition), (ii) liability issues, (iii) ergonomics of collaboration with digital systems, (iv) other. As for physicians' roles, expectations range from artificial intelligence (AI) as an «ultimate threat to radiology as a distinct medical speciality» (Hirsch, 2021) – that is, AI takes over physicians' jobs – to very relaxed forecasts saying that there has always been technical change in medicine, and it actually strengthens medics' roles. There is a variety of opinions in between: some authors think that a subsegment of doctors will lose their job (especially those who do not understand new ICT or don't work in centers), some expect ICT-enabled nurse practitioners to replace doctors, and some see «centaurs» (doctors in close cooperation with AI) ruling the future.

The question of liability (who is liable if a machine recommends something wrong – or vice versa, the machine is right but the doctors decided differently) remains unclear. Some authors discuss whether cooperation with machines creates discomfort among medics.

2. Medical education

Kleesieck (2020, see appendix) calls for AI knowledge to be integrated into the medical school curriculum to provide future physicians with an understanding of AI applications. Similarly, Ngiam and Khor (2019) suggest that physicians should be trained to distinguish between the data types and relative weights used in machine-learning evaluations if the machine-learning tool is designed to be understandable. Comparable to traditional laboratory testing, physicians should be able to assess the sensitivity and specificity of AI decisions.

3. Role of physician organizations

In addition to the articles addressing the role of physicians under the influence of digitization, there are three studies on the role of physician organizations. One article (Murphy and Liszewski, 2019) asks medical societies to manage digitalization; Gollust and Dwyer (2013), and Gowda et al. (2021) find that societies provide recommendations to some, but not all relevant issues, including liability.

4. Role of patients

Relatively few papers, two in fact, address the role of patients and how digitization changes it. Ambinder (2012) expects patients to take on a stronger role in healthcare by bearing a greater share of the costs, making their values and wishes known, and participating in important decisions. Hirsch (2021) analyses patients' expectations on new ICT, incl. competence, and personal interaction.

5. Quality of medical care

Five articles address the question of how the quality of medical care is affected by digitization. All authors expect that quality will improve with the use of ICT, however, they disagree on what this specifically means, e.g.: better availability of data, better diagnosis, higher efficiency, more patient participation / shared decision making, or other.

6. Black Box Problem

A special topic, namely the black-box problem, is examined by 5 articles. Especially when neural networks are applied, it can be difficult or impossible to determine why (i.e., based on which information) AI arrives at a certain decision. The user can then only accept this decision, but not *understand* it and therefore cannot critically question it.

7. Data protection and security

Chen et al. (2021) and Hirsch (2021) both point out that obtaining large amounts of data can lead to security issues; the former understand this primarily as an implementation problem, while the latter suggests that de-identification of datasets can help solve the problem. Ngiam and Khor (2019) also call for strong anonymization mechanisms to protect patient data, in addition for transparency about data use and prevention of discriminatory algorithms.

8. Implementation problems

Six articles address problems with the implementation or deployment of new ICT systems. Chen et al. (2021) discuss the question of how to safely store data. Chima et al. (2019), Hesse et al. (2019), and Kochanny and Pearson (2021) discuss reasons for resistance against new ICT.

9. Payment for new forms of communication

Three articles deal with the payment for new ICT services. Armbinder (2012) makes only a passing reference to the fact that new forms of communication (e.g., e-mail correspondence between patient and physician) are paid for by some health insurers. Other authors discuss payment in the context of implementation issues: a lack of reimbursement may complicate acceptance.

10. Purpose of AI development

As a potential ethical problem, Hirsch (2021) mentions that clinical decision systems may be programmed to maximize manufacturer profits rather than user benefits. For example, unnecessary diagnostic or therapeutic interventions might be recommended in which the AI manufacturer has a stake. Wilhelm et al. (2021) claim that digitization must not be misused for secondary (economic) purposes, but must primarily serve the welfare of patients and healthcare workers. They do not elaborate on this idea further.

Discussion and Conclusions

Based on our results, we conclude: (i) there is reason for concerns about organizational changes in oncological care due to digitalization, and (ii) there is great uncertainty.

For example, more than half of the articles expect the role of physicians to change. However, they do not agree on what that actually means. Thus, the question arises of whether medical societies and society as a whole should just wait and see what happens or play an active role in future development.

Few articles study the role of the patients. Those which do tend to expect that new ICT will empower patients because they will have better access to medical knowledge and their own data. Some scholars, however, question whether ICT – because AI may replace physicians – might lessen interpersonal patient-doctor communication, thus leaving patients alone.

In this context, the black box problem is often mentioned: if AI uses a hidden layer in a neural network, it may be quite good in diagnosing, but unable to explain why it came to its conclusion. Should a physician who does not understand why AI gave a certain recommendation follow its advice or not? And who bears the liability in these cases – if the physician does not follow a correct AI choice; or, if he does follow it but the AI is wrong? The articles we've studied are again uncertain as to whether the doctor, their employer, the AI vendor, or a third party should take the risk.

Other problems are equally important and difficult. For example, will ICT companies influence medical education? Is there burn-out risk if doctors work extensively with machines rather than with patients? If AI decides for physicians, will they lose their diagnostic abilities? Will the definition of good quality in medicine centralize? Are the new services paid for? Will pharma research decrease (because it might be too personalized and therefore too expensive)? If the future role of physicians is less medical in nature and mainly about accepting liability and communicating the AI's decision to the patient, do we need medical doctors or friendly lawyers?

Traditionally, physicians control data. Even today, large amounts of patient data are still underused in hospitals and clinics. Rather, data are collected and evaluated by insurers and various other stakeholders / companies operating in the healthcare market (although data are, originally, created by doctors). For example, in 2014 a mid-sized company already had access to 85% of global prescriptions by sales revenue and approximately 400 million comprehensive, longitudinal patient records (Tanner, 2014). Of course, big modern IT companies with more financial power could even buy better data access and keep these data for themselves.

Data are a new currency in ICT as well as in medicine. If oncologists want to stay in the game, they need access to them. This includes setting up and/or expanding their own databases, or at least guaranteed «unlimited» access to existing databases – so that they and AI/ML methods can then use them systematically for comprehensive multifaceted research that focuses on improving care.

Given the importance of these questions, it is astonishing that the problem is rarely analyzed – after all, we retrieved only 30 articles covering these issues. We think more research in this area is urgently needed. One part of the challenge might be that there is very little room for the publication of articles in this area (typical medical journals are – rightfully – focused on clinical studies). We think that physicians should avoid passively experiencing how digitalization changes oncology. Rather, they need to get a clearer view of future changes, they need to engage in data collection, to influence IT regulation efforts, and – maybe – to think outside the box, e.g., about unusual partnerships (for example with other specialties, faculties, or industries).

Competing interests

The authors declare no competing interests.

Acknowledgments

The authors would like to thank Stefan Smolnik for his valuable input (FernUniversität in Hagen, Chair of Business Information Systems).

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Received: February 2, 2023.
Reviewed: February 7, 2023.
Accepted: February 14, 2023.