Care pathway as the basis for collaborative business model innovation in healthcare

Abstract. Digital transformation has disrupted various domains of healthcare, yet we are just starting to witness the enrollment of digital solutions enabled by technologies such as artificial intelligence and machine learning. Stroke is one of the leading causes of death and permanent disability globally. Research evidence suggests that there is need for newer technology-enabled collaborative service models that will not only improve stroke care, but are economically viable for stakeholders (i.e., service providers, patients, and payers). A new collaborative service model equally requires the development of new collaborative business models in the stroke care cycle. In a large-scale research ecosystem in Finland, stroke care pathway is utilized to identify scope of digitalization in the areas of early stroke diagnosis, treatment, rehabilitation, and secondary prevention. This study presents how stroke care pathway has been used as the basis for new collaborative business models and healthcare service innovation.

Keywords: Collaborative business model, healthcare innovation, artificial intelligence, care pathway, stroke.

1 Introduction

The disruption caused by the use of data in the healthcare sector, e.g. the availability of biomedical data and the genetic makeup, has been compared with how information and communications technologies changed our society in the past decades [1]. Various forms of data and digital disruptions in healthcare help not only overcome existing long-term challenges in the domain (i.e., ageing population, growing noncommunicable disease patient group, etc.) but also to create novel vertical solutions [2], [3]. Furthermore, the immersion of ICT to health sector has not only enabled people to acquire care outside hospitals but also to control and share their personal health information and user-generated content for more personalized care [4]. Yet, we are only starting to witness the enrollment of digital solutions enabled by technologies such as artificial intelligence and machine learning [5]. One of the reasons for the inertia in embracing the possibilities of these new technologies is that the successful utilization of AI and ML technologies requires a holistic understanding of the implications of these technologies. The findings in [6] suggest that the capability to understand the requirements for the data, the impact of the technology adoption to the service and business environment and rigorous business processes and management procedures to support data governance are the most crucial competences of successful AI based business model innovation.

AI –driven innovations are considered crucial for healthcare organizations in bridging the gap between future possibilities and the actual delivery of healthcare [4].

Especially innovations related to new approaches in preventing [7] and managing illness call for new technology-enabled solutions. Stroke is a medical condition caused by a poor blood flow to the brain and it is one of the leading causes of death and permanent disability globally. The scope of digitalization in the areas of stroke diagnosis, treatment, rehabilitation, and secondary prevention have different implications and needs both for the recovering patients and care providers. Therefore, we need to draw attention to patient care pathways and how digital solutions during the treatment continuum utilize data in most optimal decision making. Trans-ischemic attack (TIA) is called a “mini-stroke", where the blood supply to the part of the brain is temporarily disrupted. TIA-patients have a higher risk of having stroke soon after TIA. On the other hand, normally TIA-patents do not have any symptoms after 24 hours of the attack and they do not need any care or rehabilitation afterwards, only lifestyle changes and preventive medication. In this article, we focus only on stroke care pathway.

Research evidence suggests [5] that there is need for newer technology-enabled collaborative service models that will not only improve health care, but are also economically viable for stakeholders (i.e., service providers, patients, and payers). This calls for the development of new collaborative business models in the care cycle that are based on patient care pathways. This empirical study focuses to understand *“how to use care pathway as a basis for collaborative business models in data-intensive healthcare innovation”*. This is done by examining what are the challenges and success factors when care pathway is used as a baseline for business model innovation in the ecosystem that is collaborating in order to create common business with data-intensive innovations for stroke diagnosis, treatment, rehabilitation and secondary prevention.

The research is structured as follows. First, the literature on patient care pathways is reviewed in connection with digitalization. Then, we will explore how business models are conceptualized in collaborative healthcare setting. Then we will present our empirical case and present the empirical findings and relate them back to academic discussions in the final chapter.

2 Care pathways and patient journey in digital health

2.1 Care pathways and the patient journey

A patient care pathway acts as a template of the care to be offered to a specific group of patients, however, it is not intended to compromise clinical judgement [8]. Care pathway is a complex plan to support the mutual decision-making and organizing of care processes for a well-defined group of patients, in most cases in a well-defined time period as well [8], [9]. One of key aims of building care pathways is to improve the quality-of-care across the treatment continuum. Care pathway as a concept has its roots in various management concepts and terms, such as: critical path method, six sigma, business process redesign and the theory of constraints [9]. However, works on care pathways have mostly focused on care “process” improvement and related innovation. Existing literature somewhat overlooks the need for improvement and innovation of care “products” and “systems” that can further improve the overall care pathway

performance. [9] mention product innovation cycles where a process innovation becomes necessary for implementation. Similarly, while process innovation can solve identified existing problems, it can also offer newer opportunities for problem solving that did not exist before.

Patient care pathways are often finalized as a formal document presenting steps in the care process, the period in each step that the treatment will require or even the period that needs to be elapsed before the next step can be started. Although formally organized care pathways become an integral part of the selected patient groups' treatment once implemented, often, the unformalized care pathways can be used as a tool for innovation and unit of analysis [10]. The concept of patient journey maps is closely tied to such unformalized patient care pathways. [11] write about the patient journeys where they emphasize on user centrism and how that could impact in designing future care pathways and solutions for healthcare. Patient engagement and their input about patients' expectation of solutions can enhance the acceptance of new medical and non-medical devices and systems [12], [13]. In the scope of this paper, we use the terms patient care pathway and patient journey interchangeably.

2.2. Digitalization in modern healthcare

According to [14], the total number of people ageing over 65 in the 28 EU states is expected to peak to 149.2 million in 2050 from 101.2 million in 2018. According to the same statistics, the share of elderly population will increase to 28.5% from 19.7% in the same period in the 28 European states. [15] states that among six WHO regions, the European region has the highest patients affected by noncommunicable diseases (diabetes, cardiovascular diseases, cancer, chronic respiratory diseases and mental disorders). These five major conditions together account for 77% of diseases and 86% of deaths in the European region.

While low- and middle-income societies have lack of direct financial resources to be invested in the healthcare systems, higher income societies also face lack of other human and technological resources that can help tackle the challenges caused by the impending ageing population and the noncommunicable epidemic stricken European society. [16] reports that despite massive efforts of resourcing new doctors, nurses, midwives and other healthcare professionals, there will still be a shortage of 10 million health workers globally. Added to that, there is an ageing risk within the health worker population in Europe. Nearly one in three doctors in Europe is over 55 years old. This infers that in under a decade, the overall health worker population will see off its' most competent and experienced physicians, more importantly who made up almost a third of the whole community.

[17] note that to address the prevailing challenges in healthcare, human centricity, personalization, and preventive care are more important than ever. They further identified key success factors for data-driven service delivery in digital healthcare. According to that study, data can be used as resources for better personalized healthcare services, that not only help the patients getting better care but allow healthcare professionals to organize the care they offer. Automatic data collection and use of

standard interfaces are among key technological success factors for new services in healthcare. Application and adoption of new technologies for healthcare purposes have a long history; however, when it comes to adoption of newer information technology, healthcare organizations are often slower to invest and adopt them [18]. To manage the various challenges in future healthcare, digital-intensive health solutions can be developed with the aim of optimal access, sharing, analysis and usage of collected data [19]. Future digital-intensive solutions are envisioned to bring together patients, doctors, nurses, and other healthcare professionals. The secure and proper data channeling between various stakeholders can be completed according to the MyData principle [20]–[22]. According to MyData principle, the individual (in healthcare context, it will be the patient) will have access control over their personal data.

Modern data-intensive digitalization in healthcare focuses on solving problems for the ageing society and noncommunicable diseases [2], [19], [23]. Within this scope, data becomes a vital resource, which is available for collection but in the healthcare domain it is often unavailable for analysis, innovation, and commercialization purposes. Data analytics and visualization techniques not only help in better decision making for individual patient treatment [24], [25], but can also help create better health policies for the population. AI capabilities and its application in healthcare as medical device, a step forward from traditional data analytics, still has different questions in regards to legislation, ethical use, standardization and approval. To enable AI deployment and governance for healthcare, collaboration between policy makers, healthcare professionals, technology developers and researchers is needed, as well as international cooperation and coordination [26].

3 Towards an approach for innovating collaborative business models

3.1 Business model innovation

Business models are often imposed by technological innovation that creates the need to bring discoveries to market, and the opportunity to respond to unmet customer needs [27]. [28] claimed that disruptive technologies should be matched with innovative business models. Business models can be described as a system of interconnected activities that determine the way an organization does business with its customers, partners, and vendors [29]. [30] conceptualize business models to be made of four elements: 1) a value proposition for customers; 2) resources, (e.g., people, money, technology); 3) the processes used by the organization to convert inputs to finished products or services; and 4) the profit formula dictating the margins, asset velocity, and scale required to achieve an attractive return [30, p33]. All of these elements are interdependent and need to be compatible for the business model to function [30]. The business model needs to describe how the solution brings value to its customers in a profitable way and how this value is delivered to the customers.

The health sector especially has long been criticized for its lack of business model innovation [28]. This resonates with academic research on business model innovation in the healthcare context. First of all, it is important to acknowledge that business models are not static description of elements, but they evolve over time, requiring constant innovation and experimentation [31]. Adding to the complexity of business model innovation in healthcare, it is also important to note that the creation of business models for new ventures emphasizes a different focus than the development of business models for more mature organizations. Therefore, business model innovation can be defined as the design of novel business models for newly formed ventures (BMD) or the reconfiguration (BMR) of existing business models [32] to explain the two types of business model innovation. While BMD refers to the entrepreneurial activities of creating, implementing, and validating; BMR involves reconfiguration requires shifting from an existing model to a new one through gradual to radical degrees of change in the new business model. In the case of business model reconfiguration, the innovation in the business model often has an epicenter [33]. As the business model is assumed to have a customer side, a resource and capabilities side, a value proposition element, and a cost and revenue element; the business model innovation can be driven from any one or more of these "epicenters".

3.2 Collaborative business models in healthcare

Traditionally, healthcare systems have suffered from fragmentation and a low innovation capacity, where challenges relate to both balancing the allocation of resources as well as performance [4], [34]. As the innovation process in healthcare is increasingly requiring access and combinations of knowledge from different departments and sectors in order to overcome these challenges, innovators are pushed towards collaboration [4], [5] with various types of actors. However, how organizations manage this collaboration and co-develop their capabilities in order to build mutually beneficial relationships becomes a central question [35]. Complementarities in resources, alignment in objectives, opportunities and advantages can create a basis for collaboration in healthcare business ecosystems [3]. Also, complementary strategic goals, opportunities, and combined advantages allow collaborating business entities to co-create and co-capture greater value [36].

Newer conceptualizations of business models take the external environment and ecosystem better into account and emphasize collaboration, synergy and compatibility [36]. Business models can be used as tools to bend the boundaries of organizations [37], where collaboration of the focal organization with its network can be considered one of the main functions of the business model [38]. Therefore, understanding how business models can be utilized as tools for developing and streamlining collaboration, more specifically the co-creation, co-capture and co-development of capabilities, opportunities and eventually solutions, becomes central. The search for collaboration, synergy and compatibility puts even more pressure for innovators of healthcare solutions, as in addition to internally matching the different business model elements,

they also need to ensure their business model is compatible with the partners in the process, who may present both private and public sector organizations. Therefore, this kind of interplay between the design and reconfiguration perspectives of business model innovation, coupled with collaboration, is of crucial importance both to academic discussion on business models as well as for practitioners.

4 Research Approach

4.1 Stroke-Data project

The research data for this study is primarily collected from a Business Finland funded Smart Life R&D project consortium titled "Stroke-Data". The consortium consists of various stakeholders from industry and academia; there are five active industry partners involved in the project and three industry partners are complementing the project as affiliates. The overall setup of the industry partners has a mix of SMEs and larger organizations in the ecosystem. In addition, the research consortium includes three research organizations and three hospital organizations. Together, the stakeholders form a specialized data-intensive healthcare ecosystem, with a mutual goal to create ways to provide better patient care through co-creation of novel data-intensive innovations for stroke identification, treatment, diagnosis, and rehabilitation.

While the R&D project primarily aims to create new data-intensive solutions for TIA and Stroke care to provide better care and save health costs; the consortium also creates an ecosystem of stakeholders working towards implementing research results for the future healthcare market. As a part of that, the R&D actions also include business model ideation, business models innovation with partners, co-creation of solution ideas, conceptualizing ecosystemic collaborative business models for Stroke-Data.

4.2 Data collection

The co-creation of data-intensive innovations requires real data, and the project consortium initially aimed for obtaining datasets from real-life situations along the care path of stroke or TIA patients. The initial mutual intention was to collect data in ambulances and emergency rooms, or even at the location where the first symptoms appear. However, this data-driven approach for organizing the data collection at these locations turned out to be not feasible during the clinical data collection period, without disturbing the treatment and care. Moreover, data protection and privacy were of concern, as people suffering from acute stroke possibly are not able to give consent, and together these required a more explorative data collection approach. The project consortium updated data collection plans and the data used for research and creating data-intensive innovations comes from a local birth cohort, Northern Finland Birth Cohort (NFBC), and by collecting new data sets with various sensors and devices at two hospitals and one rehabilitation center. The data collection at hospitals happened,

with patients' consent, when the patients had received the most acute treatment and were in the ward for follow-up. It was assumed that the data collected from this stage of the care path can be used for finding indicators that can also be used in the earlier stages of the care path, during acute situations. In addition, the collected data sets allowed the consortium to focus on co-creating solutions for the phases in care path after stroke, such as rehabilitation.

In the co-creation of collaborative business model, researchers adopted multiple qualitative approaches for data collection. First, during the early stages of the joint effor, six semi-structured interview sessions with industry partners focused on Stroke-Data objectives, technical infrastructure, existing business models, and co-creation opportunities among other topics. Further, a scenario mapping workshop was organized as a part of service ideation and innovation; this workshop was co-organized with medical professionals who are experts in the field of Stroke treatment and diagnosis, technology developers from multiple industry partners, and researchers. There were altogether 27 participants in this workshop. The results of the scenario workshop helped to identify the current state of technology, data utilization and the patient journey in the studied context and the preferable and probable scenarios for the future. Based on the results of the workshop, needs and challenges of the current patient journey were identified, which helped drafting an initial set of high-level requirements for the future preferable patient journey. From there, coupled with requirements and expert opinions from clinical experts, the research team in the Stroke-Data project started working on identifying a more detailed set of user needs and requirements, which were then further validated in project workshop. The collected user needs, and requirements were also consulted and approved within the project in collaboration with medical experts in the field of neuroscience.

Altogether, 157 high-level user needs were identified in this task that can be developed through software solutions. Based on these high-level user needs, Stroke-Data partners identify critical and feasible needs those they can address with their available expertise, resources, capabilities and organizational objectives. In addition, a second round of business model focused interviews were conducted with all the industry partners that also raised issues such as data security, privacy, access, innovation in healthcare, and collaborative activities within the ecosystem. Altogether 10 follow-up interviews were conducted in this phase. The follow-up interviews also covered topics of challenges in inter-organizational collaboration, data related issues in digital healthcare innovation, and validating the data collection approach.

5 Findings and analysis

Stroke, being one of the leading causes of permanent disability and deaths globally, has a broad impact on societies. The patient journey or the care pathway has been identified as a critical basis of service innovation in context of this R&D project. However, it is understood from the research data that the contributors agree to observe the patient journey on a general level, that will enable service creation opportunities to be broader. The generic stroke patient journey can be perceived to have five stages where medical

assistance can be provided to the patient: 1) the scene of stroke event and the ER, 2) The ICU and surgery facilities, 3) post-surgery care and Stroke ward, 4) rehabilitation in hospital care, and 5) rehabilitation in home care.

Based on the Stroke-Data patient care pathway, high level user needs were identified in the study that can addressed with software-capabilities. Altogether 157 user needs were identified which broadly covers the phases of prediction, emergency care, diagnosis, and rehabilitation of stroke patients. Further, these high-level user needs are defined for both users who are healthcare professionals and a lay person.

Initial interviews revealed that among all the industry partners in the ecosystem, some had clear research and development plan in the domain of digital health which contributes to the stroke patient care pathway. Some of the industry partners brought special skills and long-term goals that are aligned with the public research program's aims. In addition, the SMEs involvement in the project is for new solution development and validated references to their solutions. Most of the industry partners involved are not generic stroke or neuro care providers. Hence the devices and services created in the context of the program are significantly different to the usual offerings for most of the industry partners. The same can be argued about the business models for each of the industry partners involved in the case.

The original objectives of the research project included clinical data collection and researching of new services in four out of the five stages of the stroke patient journey. Data collection from the intensive care and surgery facilities were identified outside the scope from the onset of the project. However, during the Covid-19 pandemic, clinical data collection using new devices for foundational research proved to be unfeasible, especially for stroke patients who are often highly vulnerable. Hence the clinical data collection was planned to be reduced to stroke ward patients, and from rehabilitation hospital patients, beside data from control groups. While the clinical data is not the subject of this paper, the clinical data collection and research on new services affect the co-creation and collaboration outcomes.

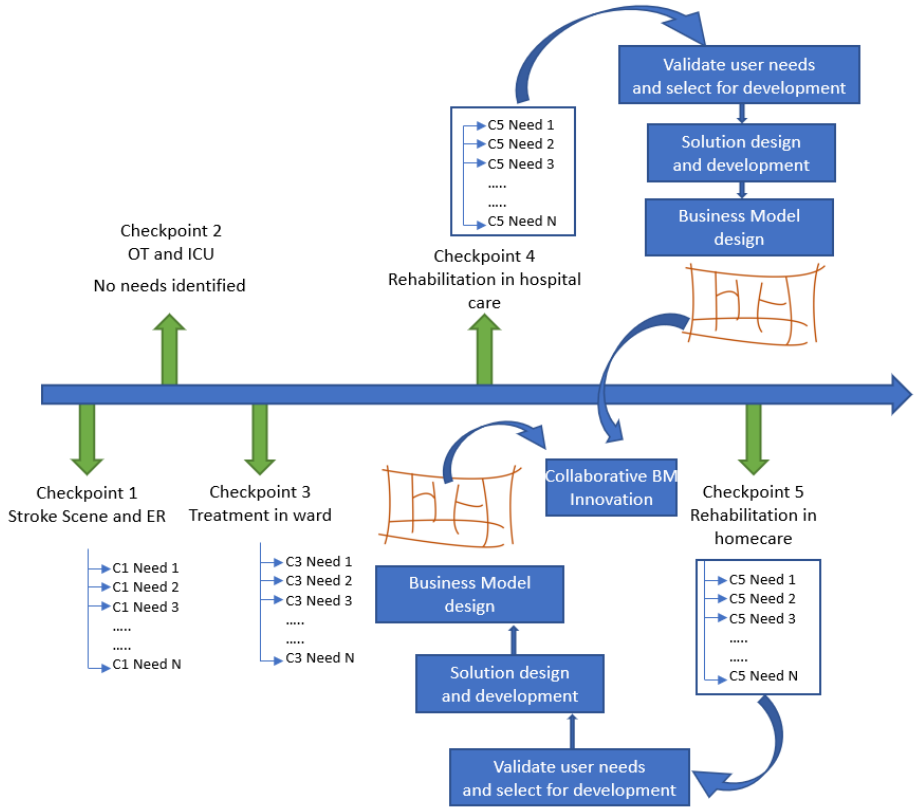

Fig. 1. The Stroke-Data process: from patient care pathways to collaborative business models.

The industry partners in stroke data project used the care pathway and business model workshops organized in the project as a baseline to identify the key focus areas of their stroke related services and businesses in area of overall stroke care. One of the partners decided to focus on pre-hospital care whereas two of the partners in the ecosystem focused on their efforts more on rehabilitation of stroke patients dividing their businesses to the one vertical solution including two perspectives 1) rehabilitation decision support and 2) personalized data-intensive service innovation for the stroke rehabilitation patients. Although the two companies focusing on rehabilitation case have clear distinction in the offering or basic value proposition and customer segments they are serving for; the partners agreed to co-create one "vertical solution" for the involved rehabilitation hospital having separate interfaces instead of creating two "horizontal solutions" which could potentially become competitors. The research data suggests that the decision to create one "vertical solution" was as much a "business

model decision", as it was a "technology decision" by the industry partners involved in the case.

From the collaborative business model perspective, we can observe that both partners targeted the same "phase/stage" of the stroke patient journey; although their targeted end users' group are different but working together in such a way that these end user groups are constantly connected for the whole care cycle to be completed is bringing them additional value compared to their competitors in the market. Further, from the value propositions elements, the partnering players identified complementarities in such a way by not only creating value for customers, but also by reducing future competition among themselves. A coherent technology strategy means reduced technical infrastructure cost for both parties. Although the vertical solutions are closely integrated to each other, they can be also sold as standalone systems to different customers where the need is as such. However, the closely integrated solutions also bring the opportunity of "piggybacking" sales for both partnering players; meaning, a new sale made by one partner can bring new customer for the partner organization too.

While looking closely at the collaboration in these two companies, there are few important continuous efforts that have helped this collaboration to succeed thus far. First, the partners have agreed on specific resource sharing between themselves. This indicates that both the partners are willing to identify the strength and expertise of the other side organization and utilize the collective strength. The resources not only include human or financial resources, but they can also include technology knowhow, specific skillset and expertise too. Second, both partners have actively participated in customer case meetings to ideate, identify, and develop the solution together on a regular schedule. Clear goal setting and following through with checkpoints have helped the collaboration to be smoother. Third, when it comes to solution testing, the organizations adopted an "open" strategy to allow the other party to test the solutions as standalone and together to build modular service. Fourth, seamless communication between partnering organizations has been identified as a key for inter-organizational collaboration. Fifth, although the companies are not yet in the commercialization phase, there are early discussions within the organizations on value sharing models that can benefit both parties.

Data-intensive innovation in healthcare domain in current European market is challenging due to data protection regulations if the innovating organizations are looking for using actual patient data for development. The original aim of this collaborative solution for Stroke-data rehabilitation case included data analytics and AI capabilities applied on actual patient data collected in the scope of the research project. However, due to current data protection regulations and the test use of the developed solution with actual patients meant that such analytics and AI capabilities cannot be trialed in the first phase. In the current scope, the collaborating partners agreed the vertical solutions will create seamless communication channel between the rehabilitating Stroke patients and healthcare professionals to digitally track their rehabilitation process. The inclusion of data analytics, AI and ML capabilities will be done in the future phases of the collaboration.

Looking at the Stroke-Ward phase of the studied case, although the clinical data collection and data-oriented medical research is being conducted; they are currently conducted as foundation research only. Meaning, only public organization (University and Hospital) researchers are permitted to access and analyze the collected clinical data for any potential ML or AI algorithms. Any personnel from organizations having commercial objectives are only going to be given access to an anonymized and aggregated data set which does not have any identifiable variables available. This in practice prolongs the product to market timeline for the participating partners in this phase.

6 Discussion and conclusions

In this article, we looked at the Stroke-Data ecosystem where multiple research organizations, hospitals and industry partners combined efforts to co-create data-intensive solutions to improve the current state of early stroke treatment, diagnosis, rehabilitation, and secondary prevention. From a business model innovation perspective, the case shows how a patient journey or patient care pathway can be used as a unit of analysis to locate the "epicenter of innovation" [33]. Based on rehabilitation case discussed in chapter 5, it can be argued that collaborating partners not only utilized these "epicenters" for innovation, but further for deepening the collaboration between them. The complementarities of resources, and alignment of objectives also enable creating such collaborative business models [35], [36].

To summarize the approach of using patient care pathway as the basis of collaborative business models in the scope of this study, it can be argued that the patient care pathway can be used to locate "epicenters of business model designing". We also observed in this case that the same epicenters can enable collaboration between multiple organizations. This collaboration can take various forms, such as: resource sharing, skill and expertise exchange, business case development, business model co-development, among other things. The care pathway approach for collaborative business model innovation is not only meant to identify the initial epicenter of collaboration, but rather continuously support collaboration throughout the development cycle. This is important so that the developed solutions will address needs of the "patient care pathway" besides the needs of the patient in the specific phase of the pathway.

Some of the identified benefits of this approach realized during this exercise include clear and validated value that the newly created solutions will have, solutions developed in this approach will base on actual user needs and requirements, close cooperation means faster development cycle, continuous customer feedback in the development cycle also improves the solution outcome. As one of the challenges of this approach, these activities seem to be individual oriented. Changes in personnel in partnering organizations can impact collaboration. Also, organizational objectives, resources, objectives are important in addressing specific pathway needs. Another challenge in

such activities is the strict regulations on data usage by commercial organizations and the lack of collaboration with healthcare professionals.

The identified limitations of this study include the research data being gathered from a single project. Although rich and diverse in qualitative terms, it is challenged by generalizability. Current data protection regulations stand, private organizations with commercial goals are not permitted to access and analyze personal data which are not "fully anonymized". To develop such solutions, the innovating companies need to test the developing solutions with "synthetic data set". The result is that, even digital solutions that require the certification of being "medical device" will need to go through formal clinical trials. The use of "synthetic data set" in the development rounds can end up being unrepresentative of the actual use case in various ways, resulting in unreliable trial attempts. Hence the cycle of idea to product to implementation can be significantly longer than expected. Future research is called especially on tackling how to speed up the commercialization of data-driven healthcare solutions, as well as how collaborative methods can help validating especially personal data at individual level and scaling these solutions for wider industry use. We also need to increase our understanding of the challenges that the companies face when making AI driven innovations in the ecosystems making certified medical solutions.

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