THE
DIGITAL PILL

What Everyone Should Know about the Future of Our Healthcare System

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Acknowledgments

To Carmen, Isabelle, and Michaela

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About the Authors

Elgar Fleisch is a Professor of Information and Technology Management at ETH Zurich and University of St. Gallen (HSG) and Director at the Institute of Technology Management.

His research interests focus on the current fusion of the physical and the digital world into an Internet of Things. His current largest lab, the Center for Digital Health Interventions, investigates how digital technologies are changing our healthcare system. Elgar Fleisch and his team have published their results in over 600 scientific papers.

Elgar Fleisch is a co-founder of several university spin-offs and serves as a member of multiple academic steering committees as well as supervisory boards including Robert Bosch, Mobiliar Insurance Group and Uniqa Insurance Group.

Born 1968 in Bregenz, Austria, Elgar Fleisch was trained in mechanical engineering, computer science and business administration. He received his PhD in Artificial Intelligence in 1993 and devoted his postdoc time to the "networked enterprise". 2002 he was appointed full professor at University of St. Gallen (HSG), 2004 also at ETH Zürich. Elgar Fleisch spent his sabbaticals at MIT and Dartmouth College, both USA.

Christoph Franz is Chairman of Roche Holding AG. Prior to this, he served as CEO of Lufthansa as well as Swiss International Air Lines. Prior to joining Swiss Air, he spent nine years in top management positions with Deutsche Bahn, the German national railway, later becoming a Member of Executive Management in charge of passenger transport. Born in 1960 in Frankfurt, Germany, he studied business and engineering at Technical University of Darmstadt and at École Centrale de Lyon, finishing up with a PhD in Darmstadt and a postdoc at UC Berkeley.

Further mandates include the boards of Stadler Rail AG and Zurich Insurance Company Ltd. He is a Member of the Board of Trustees of Ernst Goehner Foundation, the Advisory Board of University of St. Gallen (HSG) and Member of the Assembly and Counsel of the International Committee of the Red Cross, Geneva. Moreover, he was appointed Honorary Professor for Business Administration at HSG in May 2017.

Andreas Herrmann is a Professor of Marketing at the University of St. Gallen (HSG) and Visiting Professor at the London School of Economics (LSE Cities).

His research interests focus on consumer behavior, market research, and product development. He has set up several labs, each collaborating with companies and international organizations. He has published extensively, more than 250 scientific papers and 15 books.

Born in 1964 in Germany, he graduated from Koblenz School of Corporate Management and completed his doctoral thesis in the field of consumer decision-making 1991. After his habilitation on the subject of means end chain analysis at University of Mannheim he was appointed as Full Professor to University of Mainz in 1997. In 2002 he moved to the University of St. Gallen.

Foreword

Writing a book about the opportunities that digital technologies bring to the healthcare sector is a particular sort of challenge. Every day and everywhere across the globe, new health apps are created, as well as innovative approaches for using patient data to develop new treatments. They have the power to redefine the roles of patients and doctors, supplement drug-based treatments with digital ones, and facilitate a shift from curative to preventive medicine. There is also a tremendous opportunity to alleviate the burden on healthcare systems which, in many countries, are underfunded and already operating at their limits, and to provide proper medical care to many more people than in the past.

It is not possible to provide an overview of all these technological developments, to fully explore them, or to conclusively evaluate them at this point. So this book does not provide an exhaustive outline of digital technologies in the healthcare sector, but is more like a diary kept along a journey that is still ongoing. At the same time, it seems worthwhile to embark on this journey, because we currently have a unique opportunity to completely rethink our healthcare system and to actually reshape it as well. The time has come bring these digital options in the healthcare sector onto the stage of public discourse, and thereby help change all of our lives for the better. Which is why this book is written for laypeople, who are interested in the subject rather than as a purely academic treatise or textbook. It is focused more on the patient and less on the processes in hospitals or doctors' offices.

Exploring this topic has moved and captivated us as authors, too, because only at first glance is it merely about technology, apps, algorithms, data, and sensors. Much more fascinating are the stories behind it, the new opportunities that the digital world is opening up to humankind. In addition to all these opportunities, we are particularly moved by the further awareness that we are currently far from being able to provide each and every individual with access to the best medical care. With the help of apps, digital physician assistants, automated mini-clinics, telemedicine, etc., going forward many more people – regardless of where they live and what financial means are at their disposal – could have access to affordable and effective medical care. Digital technologies thus contribute to the democratization of the healthcare sector, which is an important step in offering people the hope of a brighter future, especially in developing countries.

The pandemic of 2020 has opened our eyes in many ways. It has also showed us the importance of digitalization in the healthcare sector, of keeping things up and running in times of physical distancing and of quickly and reliably collecting

and consolidating data when public health is at risk. In addition, the last months have shown us how much we as a society are capable of changing when it comes to moving toward digitalization.

For all our enthusiasm for digital technologies, they are never an end unto themselves, but always an important means of improving medical care for humankind. Which is why this book is not simply intended to paint a picture of the course taken by the healthcare system or to illustrate digital applications using the examples of current startups and established corporations and organizations in the healthcare sector. Rather, our aim is – based on these technological opportunities – to identify and explore the principal response patterns and pillars of a new healthcare system. We offer these for discussion in the conviction that by implementing them, we could change people's medical care for the better. With the 25 patterns and five pillars of the healthcare system of tomorrow, we hope to stimulate debate, question the status quo, and even stir up controversy, invite criticism and meet with agreement – but, even more importantly, to point the way to a more effective and efficient healthcare system.

The image of a broad-leaved tree perhaps most clearly illustrates the goal we are pursuing with this book. We are not simply out to collect examples of digitalization from all over the world and pile them up like a colorful heap of leaves. Rather, we want to use the examples to depict the tree that carries the leaves– complete with its roots, trunk, sturdy branches, and slender twigs. These are what give the tree its structure and its strength, making it a thing that lasts for decades, yet is constantly growing and renewing itself, creating new shoots and letting old ones fall. The leaves come and go every year; the roots, trunk, and branches remain.

This book focuses in the five most important non-communicable diseases (NCD) – cardiovascular diseases, respiratory illnesses, diabetes, cancer, and mental disorders such as depression. These diseases cause great suffering among patients and negatively impact on the quality of life of many people. As they become more widespread, they are pushing the healthcare systems of many countries to their limits. The good news, however, is that NCD can be prevented or at least mitigated through lifestyle changes and preventive medicine. This is precisely where digital technologies come into play. They can be used to modify lifestyles, improve prevention and medical care, and develop innovative treatments. If we succeed here, we will not only be able to alleviate people's suffering, but also lighten the load on our healthcare systems. We use the example of NCD to illustrate the digital patterns of the healthcare sector, because they are responsible for the greatest global suffering and the greatest social costs. However, most patterns apply just as well to acute and contagious illnesses.

We have organized this book in three sections. Each can be read and understood separately without the information contained in the other sections. Readers who are interested in the development and consequences of NCD should start with Part I. If you would like to jump straight to the 25 patterns of digitalization, you can begin with Part II. And Part III brings together the lessons learned in the first two sections to form the five pillars of the healthcare system of tomorrow.

"Digitization" simply means the transformation of analog information into a digital, machine-readable format. In this book, we are talking instead about "digitalization": digital transformation in the sense of using of all manner of information technologies to create new products, services, customer experiences, forms of collaboration, and business models. And what exactly do we mean by the book's title, "The Digital Pill"? We are not using this juxtaposition of terms, which is almost paradoxical and therefore thought-provoking, to simply mean a tablet or treatment containing bits and bytes, but any use of digital technologies that changes our healthcare system, accelerates medical progress, or creates new therapeutic or preventive options.
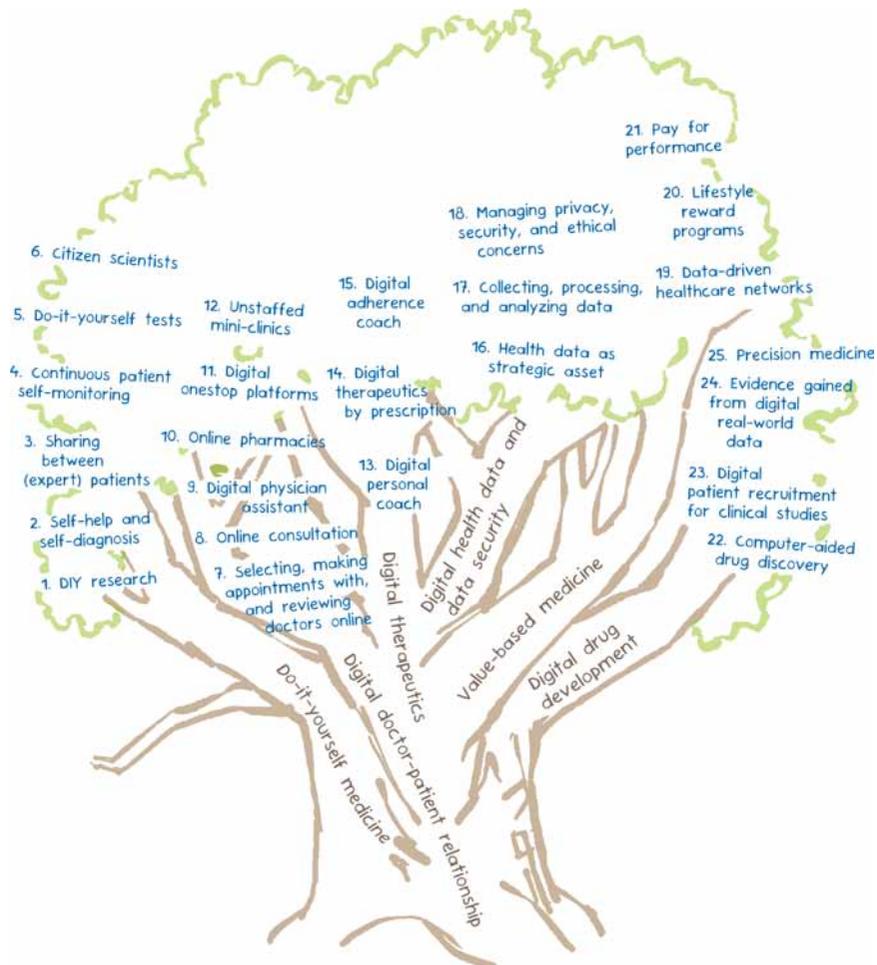
This book never could have been written without the inspiring, critical, and illuminating conversations with many people who are working to develop digital technologies for the healthcare sector and test them on the market. Troy Cox, Doug Hirsch, Andrew Thompson, Nat Turner, Zach Weinberg, Frank Westermann, Thorsten Wirkes, and many others will all shape our approach to digital therapeutics in the coming years with their medical experience, pioneering spirit, and entrepreneurial mindset. Through their expertise, they are making a significant contribution to ensuring that apps, innovative data analyses, and more will find their way into the healthcare sector. We thank them for taking the time to share their insights and their passion with us.

Many physicians, employees, colleagues, and experts, as well as prominent figures from medicine, government, business, and society, contributed their suggestions and feedback. Our thanks go to them all for their willingness to share their knowledge and experience. Among them were Lisa Marsch, Gerald Fleisch, David Gorgan, Tobias Kowatsch, Tim Jäger, Joseph Kvedar, Dave Kotz, Sandy Pentland, Florian von Wangenheim, Florian Wirth, and Felix Wortmann. The detailed, critical reviews, notes, and comments provided by Martin Brutsche, Thierry Carrel, Steffi Gassmann, and Christoph Stettler were particularly valuable, as were those of Daniel Grotzky. He was involved in the creation of this book from the very beginning and continuously sought the advice of his medical colleagues at F. Hoffmann-La Roche AG wherever there was uncertainty. A special thanks goes to Annette Mönninghoff. She took care that we never lost track on this exciting journey. Her inputs were most valuable and extremely helpful. Working with her was a great pleasure!

We particularly wish to thank Niall Kennedy of Emerald-Verlag and Patrik Ludwig of Campus-Verlag for their support. They have shown their enthusiasm for this project from the very start.

We hope we have produced a book that incorporates many different perspectives and contributes to an open, honest, multifaceted, and nuanced discussion of digital applications in the healthcare sector. As authors, we have been tremendously inspired by the potential of digitalization. And we have also been moved by the questions and challenges that have emerged in this context and which are addressed in this book.

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Elgar Fleisch
Christoph Franz
Andreas Herrmann

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21. Pay for performance

20. Lifestyle reward programs

18. Managing privacy, security, and ethical concerns

6. Citizen scientists

19. Data-driven healthcare networks

15. Digital adherence coach

12. Unstaffed mini-clinics

17. Collecting, processing, and analyzing data

5. Do-it-yourself tests

16. Health data as strategic asset

25. Precision medicine

4. Continuous patient self-monitoring

11. Digital onestop platforms

14. Digital therapeutics by prescription

24. Evidence gained from digital real-world data

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13. Digital personal coach

23. Digital patient recruitment for clinical studies

9. Digital physician assistant

2. Self-help and self-diagnosis

8. Online consultation

22. Computer-aided drug discovery

1. DIY research

7. Selecting, making appointments with, and reviewing doctors online

Digital health data and data security

Digital therapeutics

Value-based medicine

Digital drug development

Do-it-yourself medicine

Digital doctor-patient relationship

Preface

Thanks to the successes of modern medicine, the healthcare systems of this world are being pushed to their limits – the one-sided cost spiral is increasingly jeopardizing the access of disadvantaged populations to healthcare and, consequently, endangering the social order as well. Can the "digital pill" generate the veritable quantum leap that will cure our society?

Generally speaking, every healthcare system is under considerable pressure to change and digitalize. A lot could already be done today. However, many service providers are digitizing their paper-based processes in an inward-focused manner, squandering the opportunities of a real partnership-based digital transformation. Rarely do new applications result in more time for hands-on work with patients – for the most part, computer work is becoming more and more of a priority. At the same time, too much is at stake for the individuals concerned in the change process – fears of reduced income, loss of employment, or potentially less interesting work are dominating the discourse. So across the globe, money is being thrown away on unsustainable IT silo solutions. The slow grind of legislation, the strong segmentation of the healthcare market, the inertia of regulatory authorities, and, finally, the widespread fear of change on all sides also contribute to the preservation of the status quo. It must be remembered that changes in healthcare systems affect not only the employees working in the healthcare market, but, at a fundamental level, every citizen – and therefore every one of us. Maintaining each individual's right to privacy demands the highest standards of ethics, processes, and technology, and gives rise to the question of who should own the data, who manages it, and who earns money from it. Although the individual right to privacy must remain intact, each individual can make an important contribution to public health by contributing their anonymized health data, whatever the source. Here, it is the volume of data that is important – the more complete the data is, the larger in quantity and the better in quality, the greater is the potential that can be mined by artificial intelligence. The necessary sociopolitical effort that is required, at least in Western style democracies, to establish such a data alliance, is comparable to the push that led to the creation of essential social services in twentieth century Europe. The logical conclusion is that the proceeds must belong to the innovators in the healthcare market, but primarily to the individual and to society as a whole. In truth, the hurdles posed by these challenges and expectations seem insurmountably high. Digital transformation requires time for cultural change to take place and social solidarity to arise.

In many countries, healthcare systems are governed by financial considerations. We might say that medicine is dependent on the infusion of money. An ungodly, supposedly "free" healthcare market reigns supreme, one that responds to financial incentives. Often enough, this is not governed by medical criteria, but, in a compartmentalized healthcare system, is subject to the special interests of the service providers and professional groups. This results in an inherent risk that the shifts generated by new incentives will lead to further distortions in the healthcare market that are not sufficiently focused on patient benefit. As long as there are enough resources available within the system, there is little pressure for revolutionary change. Popular wisdom tells us that "necessity is the mother of invention." Healthcare systems, however, will steer the economies of many nations into dire straits in the foreseeable future, so that this state of necessity will slowly but surely spread across the globe – with poorer regions of the world never even progressing beyond this status in the first place. In other words, change will come – so let us approach it in a timely and controlled manner.

The Covid-19 pandemic in early 2020 gave the world a time-lapse demonstration of how this could work. Suddenly, medical concepts had to be rolled out in a matter of days. Medical knowledge evolved sometimes in a matter of hours – even health professionals were entirely dependent on information from the internet. During the lockdown, in many countries there was a minor revolution in the way we work. Working from home, virtual meetings, and remote training became widespread and widely accepted. Following the initial cancelation of all events, within weeks digital offerings were created to take their place and have now come to be seen as more than just a substitute and earned themselves a permanent place. Within days, consultations via video calls suddenly became billable, popular, and appreciated. The anticipated benefits from the use of contact-tracing apps suddenly seemed more important than the absolute right to privacy of the individual citizen – a new phenomenon, at least for Europe. So change is possible.

Digital transformation requires cultural change, a bird's eye view, an outside perspective. Which is what makes this book a seam of gold that is well worth mining. Following strictly Hegelian dialectics, it maps the current state of the world's healthcare systems in language that is easy to read and understand. It considers their current capacity for meeting the challenge of the prevention, treatment, and costs of the increasing number of cases of NCD in the context of the changing demographics of our aging population. This book outlines the immense, as yet unleveraged potential of digitalization in the areas of health maintenance and therapeutics, from which, like a phoenix from the ashes, ultimately rises a realistic and positive picture of how to arrive at a healthcare system that can master the challenges. It is richly and colorfully illustrated with vivid and touching examples from different corners of the world. The authors communicate 25 practical problem-solving approaches, which the book calls "response patterns," that when combined, improve the resilience, fitness, and agility of healthcare systems, allowing positive outcomes for patients to materialize. Due mention is made of the extremely creative and pioneering global startup scene in the field of digital health and medicine. The potential risks associated with the new technologies are also given sufficient attention. After all, new developments invariably entail not

only positive effects but negative ones as well. The latter must be countered with appropriate measures. The risks of digital transformation must also be weighed against the risks of delayed action – as well as those of not pursuing it at all.

We must and will succeed in using digital medicine to consolidate forward-looking healthcare systems that are able to meet the challenges of the increasing number of non-communicable diseases in an aging society – through an increased commitment of resources to the areas of health maintenance, smart treatments and care models, digitally supported research, and innovation. Thanks to the scalability of digital care and medicine, all social classes, groups, regions, and even countries of this world can be granted access to an affordable healthcare system.

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and President of the Swiss Society for Pulmonology (until 2018)
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