HEALTHCARE OF THE FUTURE

The digital revolution of the healthcare sector – ecosystem, use cases, benefits, challenges and recommendations for action

Porsche Consulting

Porsche Consulting GmbH is a wholly owned subsidiary of Porsche AG. We were founded in 1994 as an outcome of the successful restructuring and improvement process initiated at Porsche AG in the beginning of the 1990s.

More than 400 of our employees counsel companies around the world in various industries.
Porsche Consulting is also engaged in the healthcare sector – such as medical technology and pharma companies as well as hospitals. Futurologists, economists, and entrepreneurs all agree: digitization will change the business world more rapidly and comprehensively than did the Industrial Revolution 150 years ago. Supported by our Competence Center of Digitalization, we develop sophisticated and visionary digital strategies, and work together with our clients to put these strategies rapidly into practice. The aim is to increase the value of the company as a whole as well as the value for the customer and patient on a sustainable basis.

In addition, the Porsche Consulting management consultancy has partnered with the MHP management and IT consultancy to offer a combined range of services. This will enable clients to draw all services for projects related to digital transformation.

Porsche Consulting has offices in Bietigheim-Bissingen near Stuttgart, Hamburg, Munich, Milan, São Paulo, Atlanta, and Shanghai.

Porsche Consulting

Position Paper

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ecosystem, use cases, benefits,
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Method and aims of this position paper

The management consultancy Porsche Consulting has created a position paper to investigate digitization in healthcare. As technology will fundamentally be embedded in the healthcare industry in the coming years, it is important to understand the changes the health sector will undeniably have to face in the wake of a daunting new digital era: unleashing the power of creating a patient-centered health ecosystem supported by technologies that fundamentally reinvent how healthcare will be delivered in the future. Therefore, Porsche Consulting has set out to forecast the healthcare of the future, in finding new ways of solving the healthcare industries' problems, creating unique experiences for patients and accelerating all stakeholders' growth in delivering more powerful – digital – healthcare.

This position paper incorporates the summary of current public discussion, existing knowledge of science as well as excerpt results from representative studies recently conducted by Porsche Consulting – i. e. openness towards robotic surgery, robot nurses and willingness to share personal medical data. The combined insights from the recent studies and this future healthcare position paper can help pave the way for the healthcare sector in planning its next moves along the journey toward full digizitation.

Aims of this position paper in envisioning future healthcare:

→ **Learn from the digital revolution in adapting to future health**
How will trends of digital disruption affect healthcare and can the industries' stakeholders use disruption to create digital impact in healthcare?

→ **Exploit future benefits and overcome challenges of digitized healthcare**
Which benefits play into the future of healthcare's full potential and how can prospective challenges be considered on the path to digitized healthcare?

→ **Assimilate three digital healthcare progressions towards a patient-centered health ecosystem**
Which gradual stages of digitization must healthcare internalize in order to redefine the industry from a patient-oriented approach?

→ **Recommend a Porsche Consulting action plan for future healthcare**
What must be done for healthcare stakeholders to fully grasp future possibilities that lie within the healthcare transformation?

1

THE DIGITAL REVOLUTION

The digital revolution, sometimes referred to as the third industrial revolution[1], developed slowly but with increasing speed over the last century. The exponential development is based on the accelerated increase in the performance of microchips with simultaneously declining prices, the increasing automation of manual activities and the rapid expansion of the Internet. In 2002, the 'digital age' was defined; for the first time in that year, more information was stored digitally than analogously[2.] The following 15 years in the digital era were characterized by exponential developments in which well-established companies from various sectors were outshined by innovative new players within a very short time. Media was the first sector to be disrupted; for example Google has over-taken the classic newspapers in advertising revenues[3] in the US and the national cinema chain Blockbuster had to surrender to online streaming services such as Netflix. Well-known examples like Kodak, which was driven into insolvency by digital cameras[4] and smartphones, showed that the revolution gradually extended to other industries. Even the telecommunications sector, which had already been digitized to nearly 100 %, has been deprived of its lucrative SMS business by Whatsapp[5]. Other established industries, such as the financial and insurance industry, are increasingly being attacked by agile FinTechs[6]. These examples show that the digital age has already and will continue to affect all areas of life and industries in the near future.
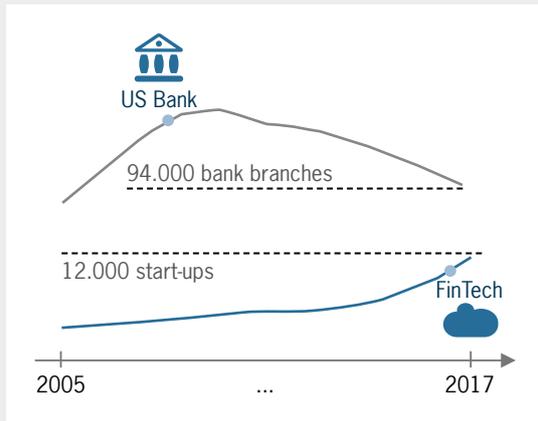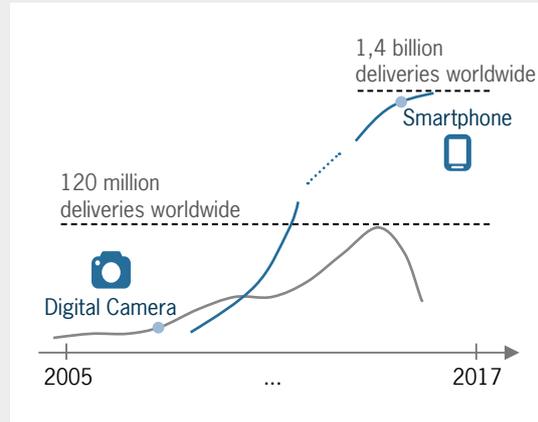
Fig. 1

MEDIA
Google leads all US newspapers combined in advertising revenue

70 billion USD advertising revenues

NEWS

US Newspaper ● ● Google

32 billion USD

1950 ... 2017
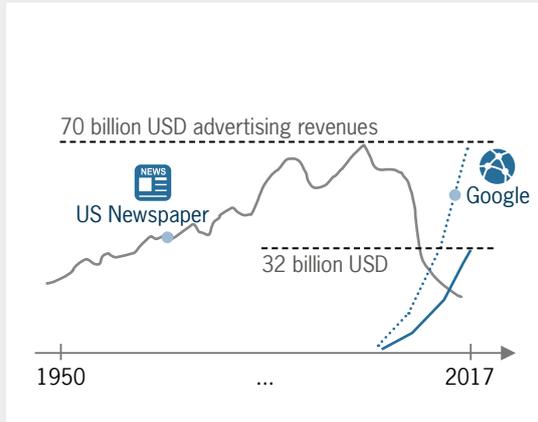
CONSUMER GOODS
Smartphones as all-in-one devices kick digital cameras out of the market

1,4 billion deliveries worldwide
------- ● Smartphone

120 million deliveries worldwide

Digital Camera ●

2005 ... 2017

US Bank

94.000 bank branches

12.000 start-ups

FinTech

2005 ... 2017

6,000 bank branches have closed in the US, while 12,000 FinTech start-ups were founded worldwide

FINANCIAL SERVICES

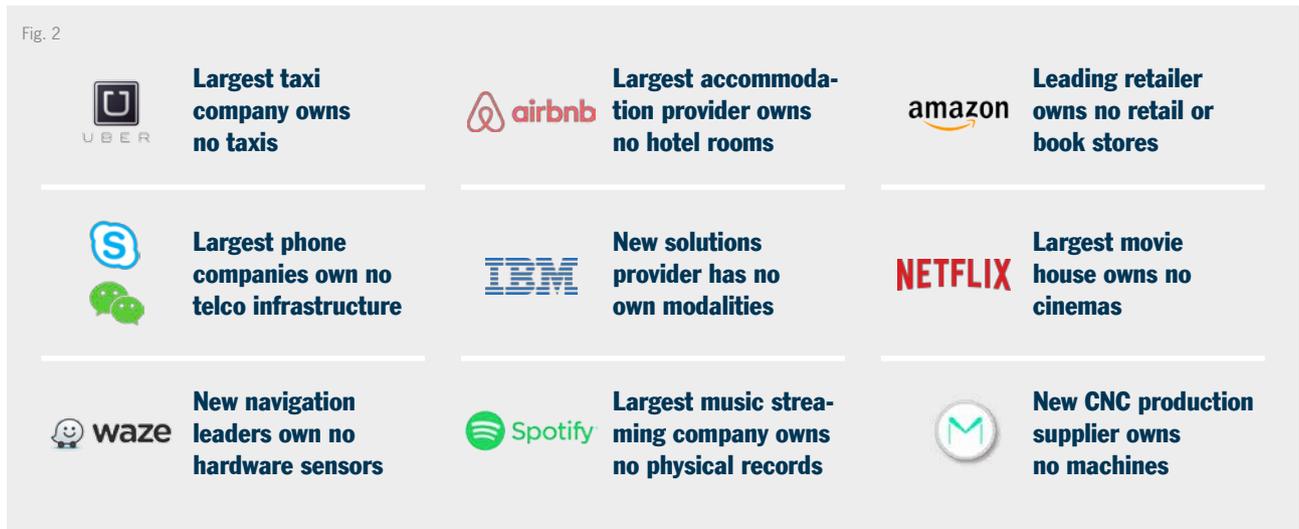WhatsApp ●

20 billion daily messages

SMS ●

1995 ... 2017
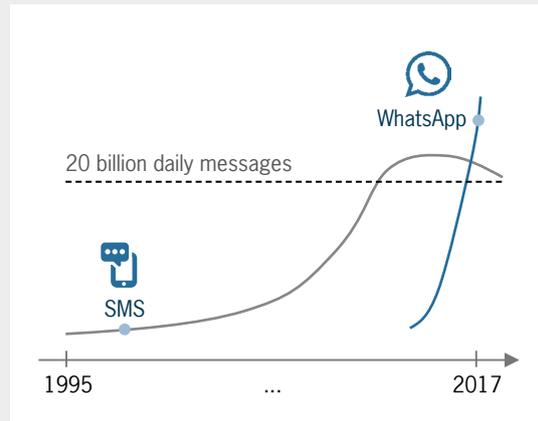
With more than 30 billion messages a day, WhatsApp combines more messages than all mobile providers

COMMUNICATION

Source/graphic: © Porsche Consulting | Statista[3], Business Innovation St. Gallen[4], MobileHCl[5], Forbes[6]

This first wave of digitization has been driven by platform technologies and new business models which often represent a disruptive change for established companies. The platforms leverage already existing assets or technologies and resources, and therefore are able to scale easily. Uber for instance does not own any taxis and uses privately owned vehicles for their service. A similar model is pursued by Airbnb: without owning any lodging, the company rose to become the largest provider of accommodation worldwide. Platforms offer a superior customer experience, for example, through constant availability of high-quality products, which leads to high customer loyalty. These platforms clear the information asymmetry between supply and demand in giving access to marketplaces with ever growing product ranges and provision of additional information about the products through customer evaluations. The networking effects are even more important in other platforms, such as Skype or Waze, where each additional user of the service increases its attractiveness.
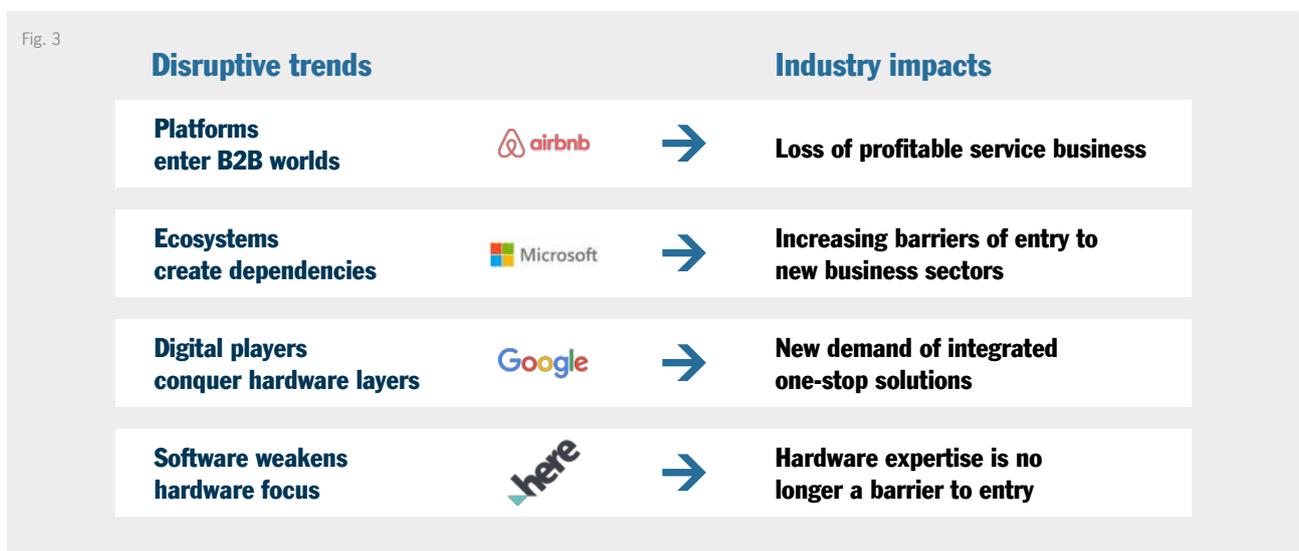
PLATFORMS ARE DRIVERS OF DISRUPTIVE CHANGE

Fig. 2

UBER	**Largest taxi company owns no taxis**	airbnb	**Largest accommodation provider owns no hotel rooms**	amazon	**Leading retailer owns no retail or book stores**
Skype / WeChat	**Largest phone companies own no telco infrastructure**	IBM	**New solutions provider has no own modalities**	NETFLIX	**Largest movie house owns no cinemas**
waze	**New navigation leaders own no hardware sensors**	Spotify	**Largest music streaming company owns no physical records**	M	**New CNC production supplier owns no machines**

Platforms are gaining great momentum in sweeping across all economic landscapes, yet they are anything but new. Rather, they are a depicting a repeatable pattern for disruptive innovation. The impact of Airbnb on the traditional hotel industry is a prime example of restructuring the value chain of traditional industries, and it does not necessarily include the adoption of a radically new technology to do so. Instead, the platform exists in order to make better use of the customer interface: connecting producers and consumers and facilitating their interactions and exchange – hosts and travelers in the case of Airbnb – thereby solving a problem the traditional market players were not able to do. Hence, the platform only becomes disruptive by generating answers to four fundamental assumptions that govern business[7]: How is value created? How is value consumed? How is quality controlled for the value creation? How does value creation scale? In answering these assumptions of disruption, the platforms continue to improve at an amazing pace as they expand around the globe in order to fundamentally establish themselves and ward off threats from an even newer platform. After all, any platform business whose value comes from serving as an intermediary between different groups of customers – and that is not harnessing and keeping pace with relevant technology – does have a target on its back. The trend of platform models entering economies will be of major importance throughout this position paper in depicting the shift in future digitized healthcare. Yet, there are other disruptive trends that will impact almost every industry – including healthcare – in the forthcoming years. Thus, it is important to achieve a common ground of understanding for all disruptive trends, as they will be picked up and related to healthcare throughout the entirety of this paper.

HARDWARE INDUSTRIES ARE THREATENED BY A WIDE RANGE OF IMPACTS ON EXISTING BUSINESS MODELS

Fig. 3

Disruptive trends		Industry impacts
Platforms enter B2B worlds	airbnb →	**Loss of profitable service business**
Ecosystems create dependencies	Microsoft →	**Increasing barriers of entry to new business sectors**
Digital players conquer hardware layers	Google →	**New demand of integrated one-stop solutions**
Software weakens hardware focus	here →	**Hardware expertise is no longer a barrier to entry**

To begin, ecosystems provide products (both hardware and software) and services as part of a solution thereby avoiding silos and targeting specific parts of a market or a market as a whole. By expanding marketplace reach to buyers and sellers, this creates dependencies for all industry stakeholders involved and increases barriers of entry to new business sectors to gain similar consumer loyalty as the ecosystem. Microsoft for example has conquered the desk-top (Windows) and console (X-Box) offerings within their ecosystem, expanding its business models for consumer buy-in. Over the course of the next years, most current and future consumers will start to commit and invest into ecosystems and consciously begin to make decisions about products based on whose ecosystem they desire to be a part of. Secondly, digital players – most notably tech giants such as Google, Amazon or Apple – will likely converge their software technologies to offer hardware layers and expand their business models, thereby creating new demand for one stop solutions. Google for example has established itself well within the technology market by layering in five domains[8]: hardware, software, content, communications and connectivity. Any successful digital company will constantly compete in at least three or four of these domains, and tend to increase their scope and reach across the domains over time. Thirdly, the continuous focus on software will considerably weaken the hardware aspect of the business, thereby decreasing barriers of market entry and shake up hardware-burden industry expertise. In the future, most hardware companies will also be software companies in disguise – and the sooner they realize it, the sooner they'll become successful in the digital era. Nokia for example has invested years of its manufacturing know-how in cellular phones, taking a leading role in bringing the first mass-compatible portable handhelds into the market. Due to quick market stagnation and the hike in substitute products (e. g. the rise of smart phones), the company had missed out on the momentum shift and was practically forced to reinvent its business model. Hence, after years of almost non-existence, Nokia has now resurfaced – yet as a software-oriented B2B company focusing progressively on new levels of intelligence and automation, for example with its recently sold mapping services solution (Nokia HERE).

2

DIGITIZATION IN HEALTHCARE

The transformation towards a digital healthcare system is undeniably going to cause a major turmoil and hence, a digital turning point for existing healthcare incumbents – from large pharmaceutical conglomerates, globally acting medical technology companies or insurance providers to public state care funds, hospitals and care institutions, to name a few currently prominent ones. These stakeholders who currently influence today's healthcare industry will have to undergo fundamental changes in excelling for digital opportunities to catalyze a united future healthcare world, for which adaptation to digital health will be dearly needed. However, as the following stakeholder mapping shows, a digitized health world is going to attract new healthcare challengers to eventually burst into the market of digital health and compete for market share with existing traditional stakeholders. More importantly, digitized healthcare will provide the opportunity for completely new, non-traditional insurgents to enter into the market for digital health, providing new products and services that aim to generate and maximize patient value in understanding future patients' digital health preferences and combining this know-how with their well-advanced digital business models[9].

HEALTHCARE STAKEHOLDER MAPPING: INCUMBENTS VS. INSURGENTS

Fig. 4
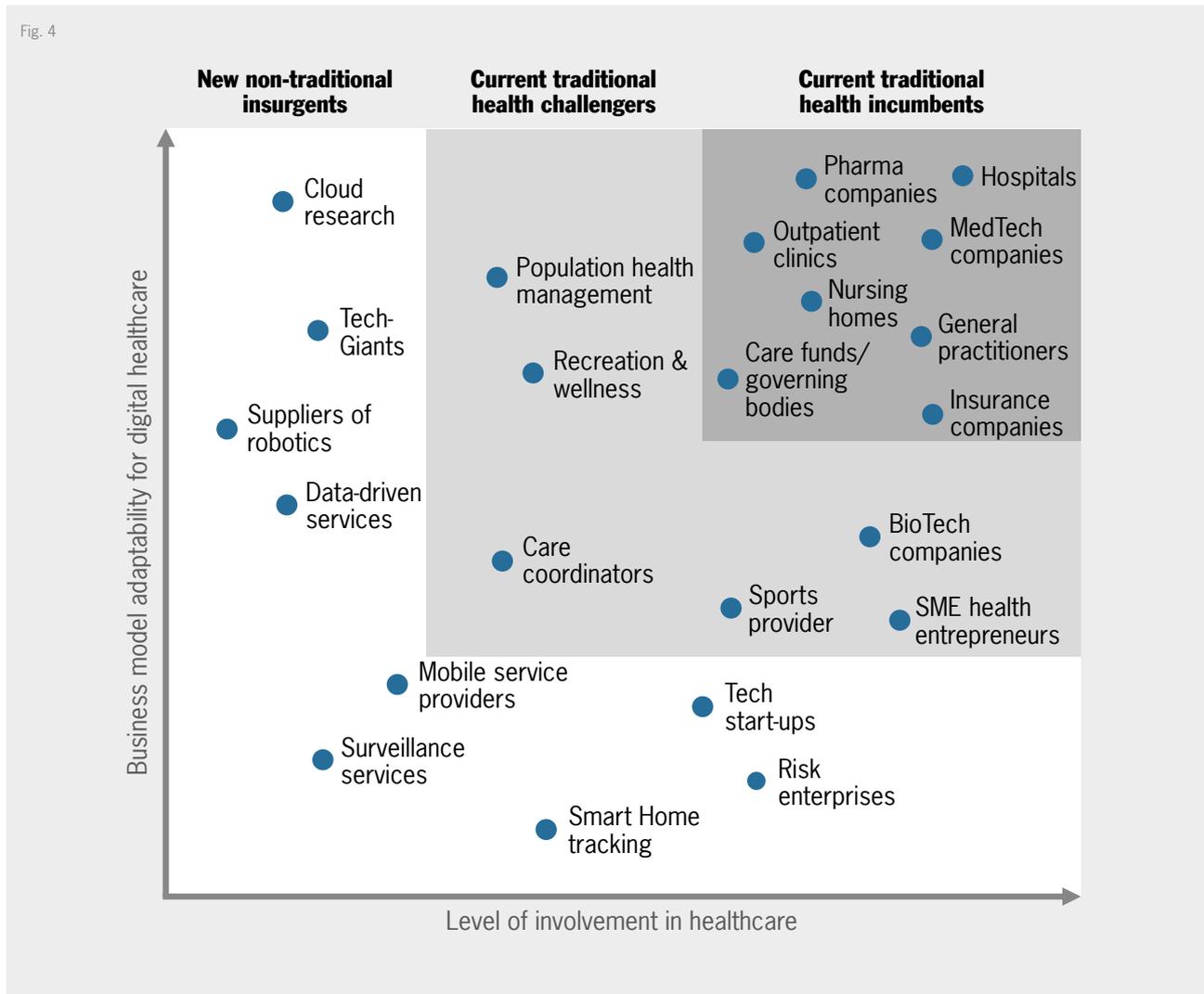
Source/graphic: © Porsche Consulting

While this stakeholder map merely provides an extract of some of the most important existing and new players in tomorrow's world of healthcare, it does depict the great opportunities for market players to initiate a paradigm shift for the industry – especially for future non-traditional market participants e. g. Tech Giants[10]. The rise in healthcare participation in technology and start-up fields prove that engagement in digital healthcare and medical research can be created with more service and patient orientation. The technologies that are utilized will partly also lead to upheavals in other industries: artificial intelligence, virtual and augmented reality, wearables, genome analysis, nano-technology, robotics, tissue engineering and 3D printing. Those technologies are currently in focus of healthcare entrepreneurs and will have a significant impact in the near future by changing the way patients proactively care for themselves and how diagnosis and treatment are performed[11].

Watson by IBM[12] is an example for a general trend: big data and artificial intelligence allows a whole new quality of treatment through analysis. By utilizing massive amounts of data derived from patient's examinations, clinical trials and research projects, a previously unimaginable data basis is used for diagnosis. In the future, this will be further improved by the integration of additional sensors such as fitness bracelets. Apple has proven that patient engagement in research projects 'ResearchKit'[13] and 'CareKit'[13] can be more efficient through new digital interaction opportunities and as a recruitment tool for ongoing disease research. Other big players like Alphabet via Google's sister company Verily Life Sciences[14] have dedicated themselves to MedTech. Projects include contact lenses for glucose measure-ment, nanoparticles for the detection of diseases or a new study to redefine health at the genetic and molecular level. Calico[15], another Google sister, is working on a pill against aging. Other digital health start-ups have launched online platforms to participate in clinical trials. These service offerings are just some of many examples that show that no matter its size or focus, digital healthcare firms can create completely new opportunities for their future patients.

COMPANIES FOR HEALTHCARE OF THE FUTURE (ABSTRACT OF EXAMPLES)

Fig. 5

Robotics	Virtual/ Augumented Reality	Artificial Intelligence
INTUITIVE SURGICAL®	appliedVR™	GE Healthcare
ReWalk More Than Walking.	ImmersiveTouch	FDNA
microbot medical	VBI	IBM Watson

Nano-Technology		Telemedicine
verily	**Companies for the future of healthcare**	CIRCULATION
ROIVANT SCIENCES		amwell
PARVUS THERAPEUTICS INC		Concentra®
CytImmune		Dr DOCTOR ON DEMAND
NanoBio		Nomad

3D Printing/ Tissue Engineering	Genomanalytics	Sensors/ Wearables
XELTIS	23andMe	TITAN PHARMACEUTICALS
CELLINK®	editas MEDICINE	Intarcia
Silk BIOMATERIALS		proteus DIGITAL HEALTH
insphero		verily
		Braeburn pharmaceuticals

As new players change the competitive conditions in the healthcare market, the twenty-first century healthcare is facing profound pressures besides disruptive technologies – from rising costs to increased expenditures. Therefore, it is timely to reimagine an outdated healthcare industry and initiate a conversation about a radically different healthcare landscape of the future.

3

THREE STEP ROADMAP TOWARDS COLLABORATIVE DIGITAL HEALTH

Surely, one might argue that the healthcare industry has come a long way from the early 19th century when the stethoscope was the most technologically advanced tool in a doctor's bag compared to today's advancements in healthcare technology. Yet, against the backdrop of this holistic view of today's digitization practices in almost every industry, healthcare is only slowly adapting to the new digital age and must therefore pave its own way into a far more informed, innovative and personalized digital care paradigm. As previously highlighted, the digitization trends do not stop with the healthcare industry. Therefore, it is crucial to redefine healthcare and implement a roadmap for the sector to fully prepare for tomorrow's digital healthcare along three major digitized stepping stones. As Figure 6 shows, in the desired state, the healthcare ecosystem surrounding all its stakeholders must internalize a gradual shift towards creating a common goal of full patient-orientation. Surely, all health players can not merely move into the desired patient-centered healthcare ecosystem state but must follow the three steady steps towards new collaborative health to transform from (1) nowadays healthcare on 'loose strings' lifted on to (2) a central 'healthcare platform' for digitally compatible stakeholder networks to be established in order to lay out the foundation of a common digital playground for (3) progressing towards 'patient-centered' healthcare that induces total system-patient evolvement around a collaborative ecosystem[18].

THE 3-STEP HEALTHCARE ROADMAP

Fig. 6

Today's World	New World	Future World
Healthcare on 'loose strings'	Central 'healthcare platform'	'Patient-centered' health
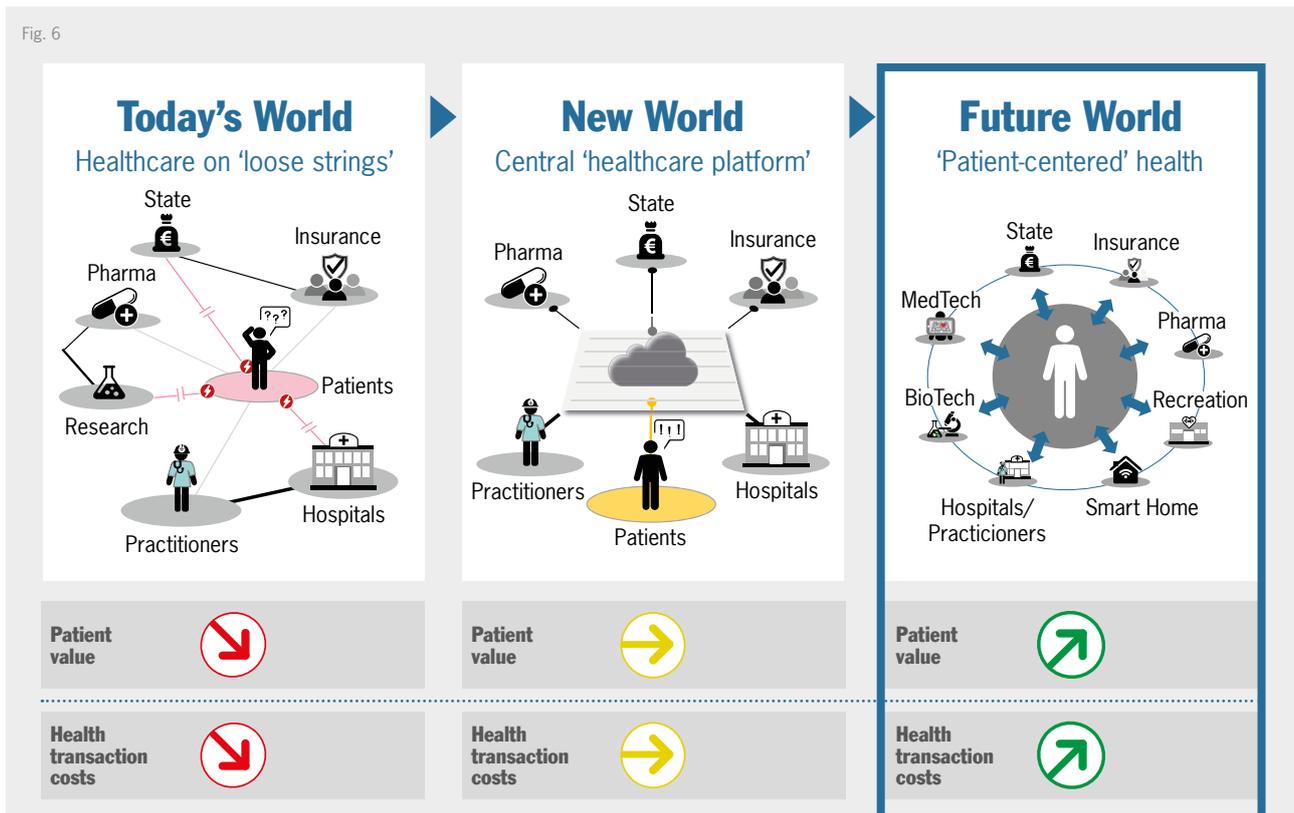
Source/graphic: © Porsche Consulting | University of Kentucky[20]

As of today, the patient is merely part of the system. The stakeholders are only loosely tied together and system discontinuities exist. This lack of cohesiveness between the stakeholders is a result due to a lack of transparency and hence a lack of digitization that impedes exchange. As a result, healthcare players follow their own agendas, perspectives and goals.

For an intermediate second step towards a central healthcare platform[19], stakeholders need to be digitally connected to one central entity. If the healthcare players were to pursue their own agendas, they would still be reliant on input from other stakeholders within the system. As a result health transaction costs would be reduced and digital ties would be created. This platform would be in accordance with the digital trend of establishing a disruptive innovation tool of interaction, while shifting from a hardware-centered, output-based care model to a more software-affine model of data-driven information sharing and outcome-based goals.

The desired third step towards a future world, a patient-centered healthcare ecosystem[20], is virtually intertwined throughout all stakeholders. Patients are now able to control the stakeholder interaction through the release of their own data. Consequently, all healthcare stakeholders are reliant on collaborating both with the patient and other stakeholders in order to achieve their goals. Following, the transaction costs between healthcare players will be significantly reduced to a minimum as information will have to be shared symmetrically, targeting for healthcare players' assigning resources.

Hence, these levels of sophistication in the healthcare industry not only require high levels of technological transformation but a shift in mindsets. Only when these progressive steps for transition are manifested with all healthcare players can the benefits of tomorrow's digitized healthcare reap today's fragmentations of the sector to allow a seamless patient-centered experience. The complexities involved in today's healthcare industry must therefore first be untangled if digital healthcare is to become a reality. While it is imperative that all healthcare stakeholders take an active role in shaping a common platform and collaborating towards a future world of healthcare, the above mentioned three steps, when taken into careful and proactive consideration, can revolutionize a digitized healthcare industry compatible with the future. The industry may not transform overnight but it can certainly start aiming for lower hanging fruits in early transformation stages to commence long lasting digitization success – and the benefits for both stakeholders as well as patients will be worth the effort.
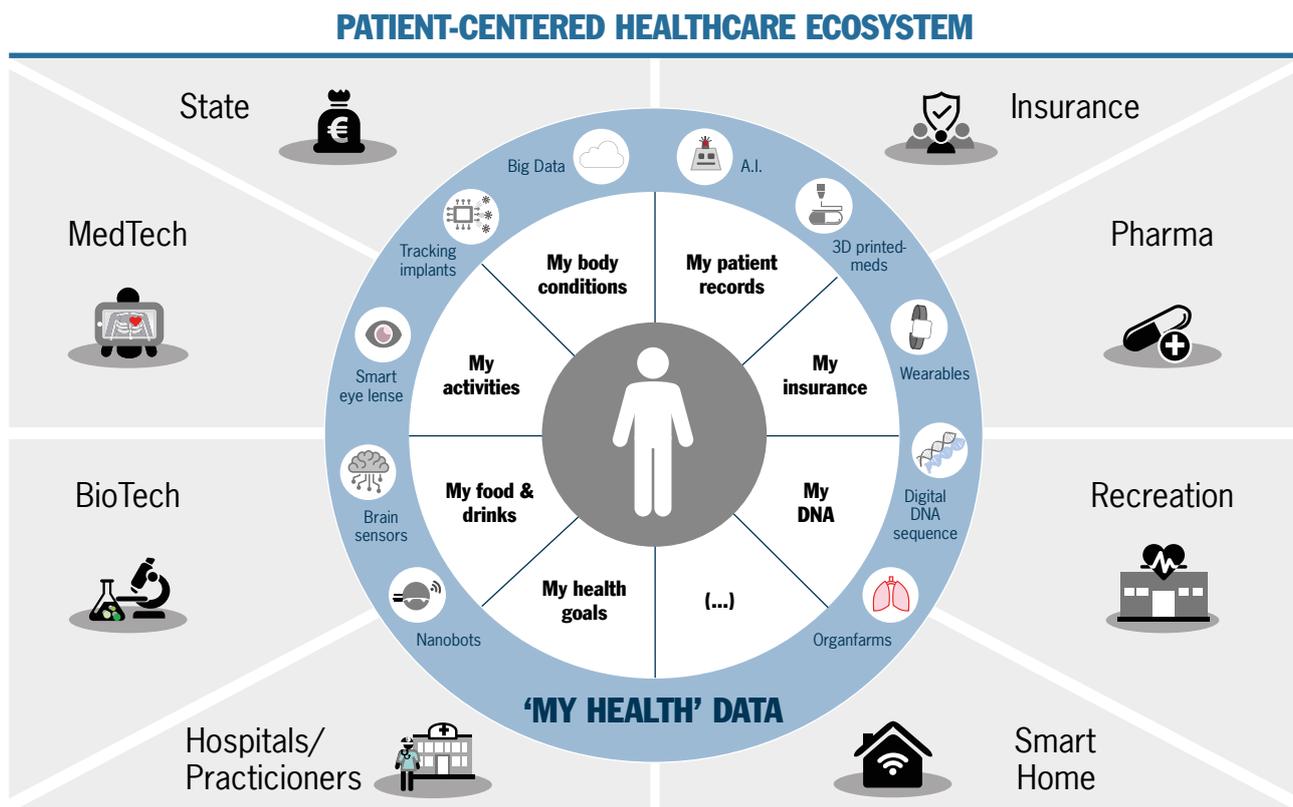
4

PATIENT-CENTERED HEALTHCARE ECOSYSTEM

In shifting towards stage three of a fully integrated patient-centered ecosystem, the future will hold a participatory healthcare system which is centered around the individual as an engaged consumer of 'health', as shown in Figure 7[20]. With this new patient-centered approach that is based on inclusion, a trend towards 'bottom-up' medicine can be foreseen, in which digitally-empowered patients not only participate in, but take an active role with regards to their health and related care. The stakeholders can collaborate about the information that is selectively received and processed in real-time by the patient to address their individualized needs more prominently and accurately.

Fig. 7

PATIENT-CENTERED HEALTHCARE ECOSYSTEM

State

Insurance

MedTech

Pharma

BioTech

Recreation

Hospitals/ Practicioners

Smart Home

Big Data · A.I. · 3D printed-meds · Wearables · Digital DNA sequence · Organfarms · Nanobots · Brain sensors · Smart eye lense · Tracking implants

My body conditions · My patient records · My activities · My insurance · My food & drinks · My DNA · My health goals · (...)
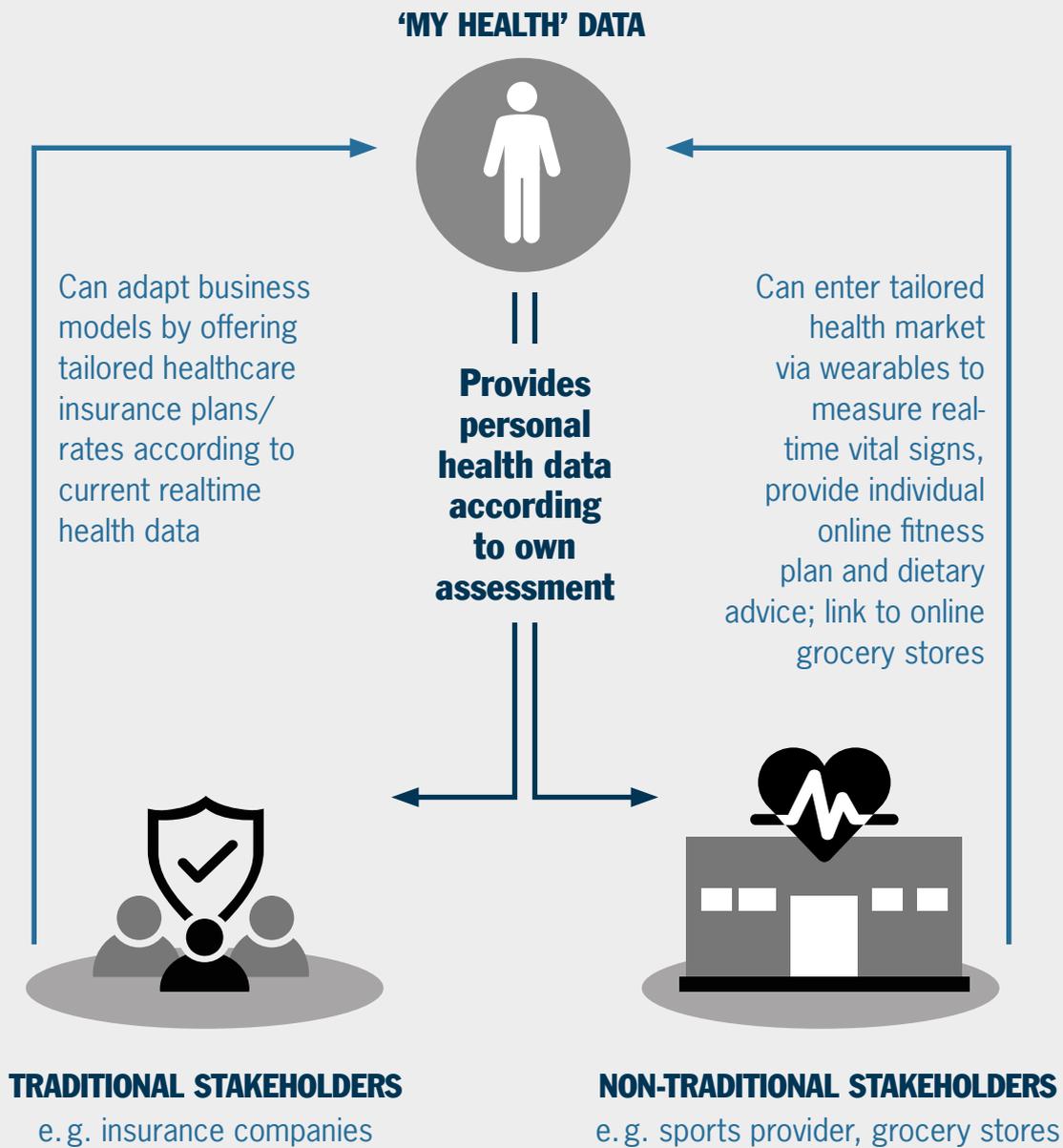
'MY HEALTH' DATA

Source/graphic: © Porsche Consulting | University of Kentucky[20]

The shift in roles for the patient of the future becomes apparent: due to the rapid uptake of modern technologies, such as vital monitoring tools[21] (i.e. wearables, tracking implants, in-vitra sensors), this stage ultimately redefines how health consumers manage their health data and choose to share their personal information thereby the level of engagement with all other involved stakeholders in the ecosystem. Individuals are no longer bound to merely adapting to the stakeholders sole interests but take control in shaping a common ground of interest, as the focus shifts from principal-agent towards a 'patient-health-partner' relationship.

The role of the health stakeholders will also be redefined. As part of this new-age health ecosystem, the stakeholders become capable in redefining the process of patient interaction by focusing away from outdated health process needs towards measurable and real-time patient needs. Increasingly permeable and blurred boundaries of this patient-centric health system give rise to completely new paradigms for the stakeholders that choose to take on this digital opportunity and engage in the new collaborative model: on the one hand, existing and traditional healthcare players are provided with the opportunity to rethink prevailing business models within their health engagements and identify new growth fields in digital products and services that are tailored to patient-centered health information. On the other hand, new (and perhaps even non-traditional) players can seek to enter patient-driven healthcare to further ignite sustainable market innovation that revolves around the patient and disrupt traditional healthcare business models substantially. Non-traditional players in the health sector will be given the chance to develop completely new offerings and business models and will thus force their way into the lucrative healthcare market. These new providers are bound to prioritize health quality in ways that are unfamiliar to the incumbents in the healthcare sectors, namely through understanding the patients' digital preferences in both channel and services.

In order to demonstrate patient value-add for all involved parties of this new patient-centered healthcare ecosystem through vertical and horizontal integration of incoming patient-data, the advantages are laid out in Figure 8. The example shows how these newly-embedded healthcare systems are fundamentally changing the way industrial care processes will be set-up and functioning, adapting to old and also creating new healthcare business models. Consequently, they show how health as a whole will be consumed: as tailored services to individuals driven by data in a continuously global and hyper-connected world of healthcare services.

Fig. 8

'MY HEALTH' DATA

Can adapt business models by offering tailored healthcare insurance plans/ rates according to current realtime health data

Provides personal health data according to own assessment

Can enter tailored health market via wearables to measure real-time vital signs, provide individual online fitness plan and dietary advice; link to online grocery stores

TRADITIONAL STAKEHOLDERS
e. g. insurance companies

NON-TRADITIONAL STAKEHOLDERS
e. g. sports provider, grocery stores

Source/graphic: © Porsche Consulting

However, it would be naïve to suggest that the fundamental transformation of the way health value will be created for the patient in the future can happen overnight. The vision of an interlinked, patient-centered world merely depicts the paramount of a long road of digital changes ahead for a sector that is in great need to address fundamental digitization transformation – conceived from its very start rather than its ending. In fact, nowadays many healthcare strategies that aim to address the 'digital age' are still driven by myths of information that is just not readily accessible for the market. Thus, it is important to always keep in mind the gradual three step roadmap towards a new-age, patient-oriented healthcare ecosystem platform for complete digital transformation.
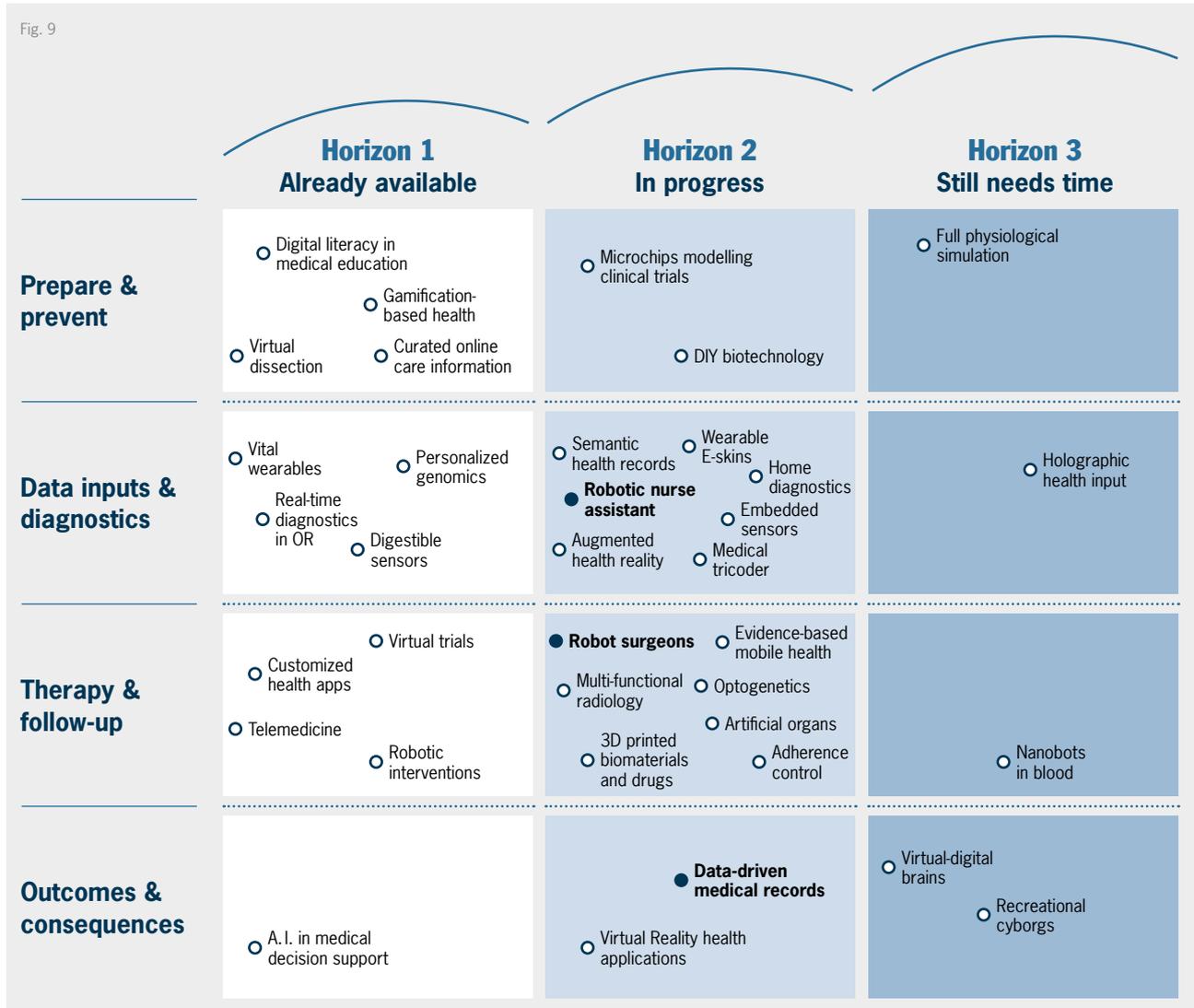
5

FUTURE MEDICAL USE CASES IN HEALTHCARE

Undeniably, fostering a patient-centered ecosystem will produce better patient health in the future. The environment for all healthcare stakeholders will eventually transition from an isolated approach to a collaborative approach around the future patient, however this transformation does not guarantee a sure-fire success in putting the 'digital' in the healthcare of tomorrow. Part of this transformation will rely upon future medical use cases and individual healthcare technologies. Our vision of a patient-centered ecosystem can only bank on its full potential if future disruptive technologies are brought into daily healthcare practice to support the digitized patient-platform. Arguably, the 'robotic doctor' may sound like the title of a sci-fi movie at the moment, yet it will likely become an integral part of future healthcare, if the technology behind this use case can comply with the patient-centered ecosystem. These future healthcare use cases will have to address a host of different challenges posed by medical and scientific advancement within this new ecosystem. Porsche Consulting envision a patient-centered healthcare and increasing patient empowerment without neglecting the compatible use case developments in the field of digitized healthcare that will ultimately provide the 'toolkit' to function in the new healthcare ecosystem. From genetics, nanotechnologies or 3D printed medicine to humanoid robots in surgery and nursing, to name a few, these future use cases will ensure a more individualized approach to healthcare.

FUTURE MEDICAL USE CASE COLLECTION FOR HEALTHCARE STAKEHOLDER AND PATIENTS[11]

Fig. 9

	Horizon 1 **Already available**	**Horizon 2** **In progress**	**Horizon 3** **Still needs time**
Prepare & prevent	Digital literacy in medical education Gamification-based health Virtual dissection Curated online care information	Microchips modelling clinical trials DIY biotechnology	Full physiological simulation
Data inputs & diagnostics	Vital wearables Personalized genomics Real-time diagnostics in OR Digestible sensors	Semantic health records Wearable E-skins Home diagnostics **Robotic nurse assistant** Embedded sensors Augmented health reality Medical tricoder	Holographic health input
Therapy & follow-up	Virtual trials Customized health apps Telemedicine Robotic interventions	**Robot surgeons** Evidence-based mobile health Multi-functional radiology Optogenetics Artificial organs 3D printed biomaterials and drugs Adherence control	Nanobots in blood
Outcomes & consequences	A.I. in medical decision support	**Data-driven medical records** Virtual Reality health applications	Virtual-digital brains Recreational cyborgs

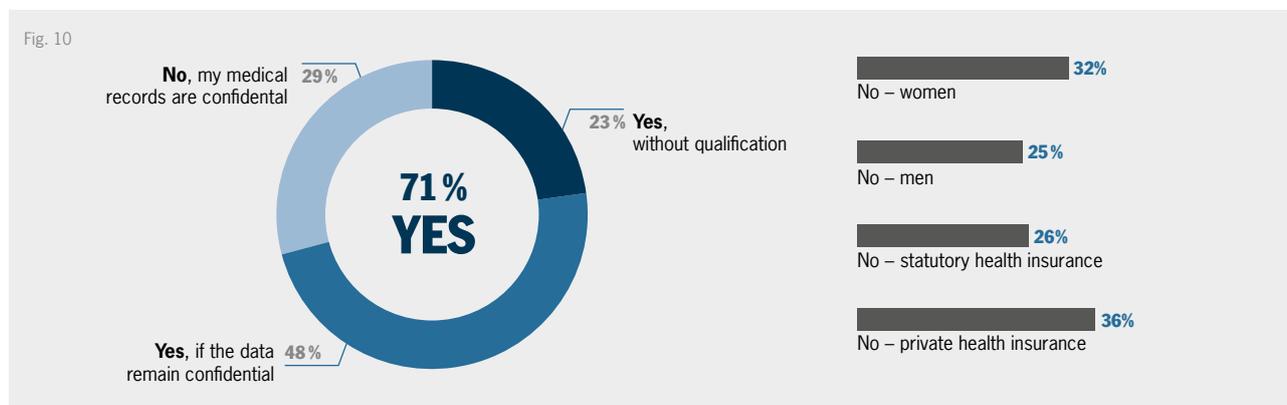Source/graphic: © Porsche Consulting | Medical Futurist[17]

The use cases presented provide a glimpse into the future practice of healthcare, projecting a fascinating new world capable of complete patient-orientation that could become very real within the next few years. For the sake of this position paper, Porsche Consulting has chosen to highlight three use cases: 'data-driven medical records', 'robot surgeons' and 'robotic nurse assistant'. For all three future use cases, a short description will depict the likely changes forthcoming within the industry. More importantly, the use cases are quantitatively evaluated based on patient's willingness to put them into practice. Accordingly, all three use cases are backed by the findings from recently conducted Porsche Consulting studies in order to perpetuate their importance in the future of digitized healthcare.

1 Data-driven medical records

In the future, patients will be able to store and share their automated medical records e. g. on their health insurance chip cards or via cloud-based solutions. Whether in the hospital or at a doctor's office, the patients' treatment paths will be automatically generated onto their own digital medical records. This will allow a widespread and meaningful use of fully functional health profiles, creating a robust medical record infrastructure for broad-based health information exchange. For example, practitioners can make better clinical decisions with instantaneous access to complete medical patient history, while automated medical care progress makes it faster and easier to accurately track diagnoses results. In turn, patients will have online access to their own information and can selectively share it with other healthcare stakeholders to not only better coordinate their own care, but ensure to receive the best possible care from the patient-centered ecosystem's collaborative function. Hence, data-driven medical records are going to improve the quality, safety, and efficiency of future healthcare.

Porsche Consulting has interviewed 1,000 people who eventually could be future patients in Germany about the possibility of storing medical data[22]. According to their findings, 48% would be willing to store their medical records without qualification. A total of 71% of patients would further promote medical record storage if there was a guarantee that their data would remain confidential. Only three out of ten patients find their medical records too confidential to store their medical data on respective insurance health cards. 32% of the 'no responses' represented females, 25% were men; 26% of the 'no's' where statutory insured patients, while 36% of the 'no's' came from privately insured patients. Figure 10 provides a detailed overview of the Porsche Consulting study findings for data-driven medical records.

MAY MY MEDICAL RECORDS BE STORED ON MY HEALTH-INSURANCE CHIP CARD?

Fig. 10

No, my medical records are confidential — 29%
71% YES
Yes, without qualification — 23%
Yes, if the data remain confidential — 48%

No – women — 32%
No – men — 25%
No – statutory health insurance — 26%
No – private health insurance — 36%

Basis: Representative survey from Porsche Consulting of 1,000 people in Germany carried out April 24—27, 2017.
The management consultancy commissioned Forsa to interview individuals chosen by systematic random selection.
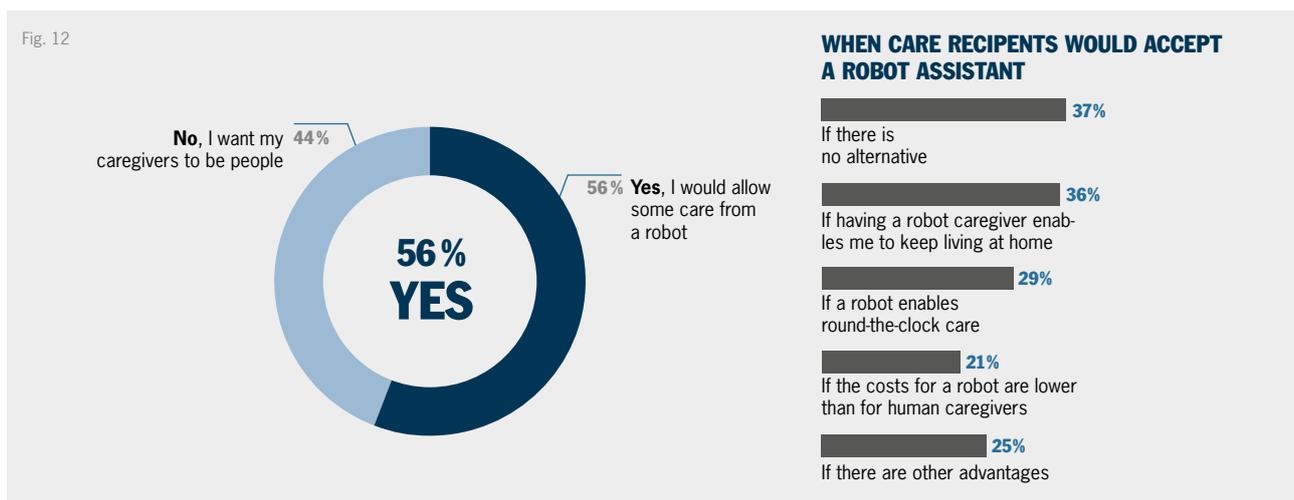Source/graphic: © Porsche Consulting[22]

2 Robot surgeon

Surgeons today are already becoming more familiar with using automated robots as a helping hand during surgery (i.e. for knee replacements, laser eye surgeries or hair/skin transplants). The future will hold an expanded view for surgical robots to perform complete surgeries on patients without any human intervention. By eliminating all human interaction, robot surgeons can potentially reduce any complications or risks of mistakes, thus improving the safety and efficiency of future operations. More importantly, the use of surgical robots will ensure that the patients receive the best possible care, regardless of the surgeon's availability and qualification since the robot surgeon compiles all specialist surgeon knowledge bases (e.g. heart, cancer) data-driven into one.

Porsche Consulting's representative study 'Digitization in Healthcare'[22] has further investigated the openness to robots performing operations in the future. The findings conclude that overall, a total of 74% of future patients would be willing to have robots perform surgeries on patients autonomously. Of these 74%, 33% would do so without reservations. 41% would be willing to let themselves be operated on by robots if the robotic operation offers a lower risk. Only 23% of patients would prefer the human surgeon instead of a machine, with 29% of them being females and 18% men; 24% of the 'no-responses' where statutory insured patients, while 17% of the 'no's' came from privately insured patients. Figure 11 provides a detailed overview of the Porsche Consulting study findings for robotic surgeons.

WOULD YOU ALLOW A ROBOT TO OPERATE ON YOU?
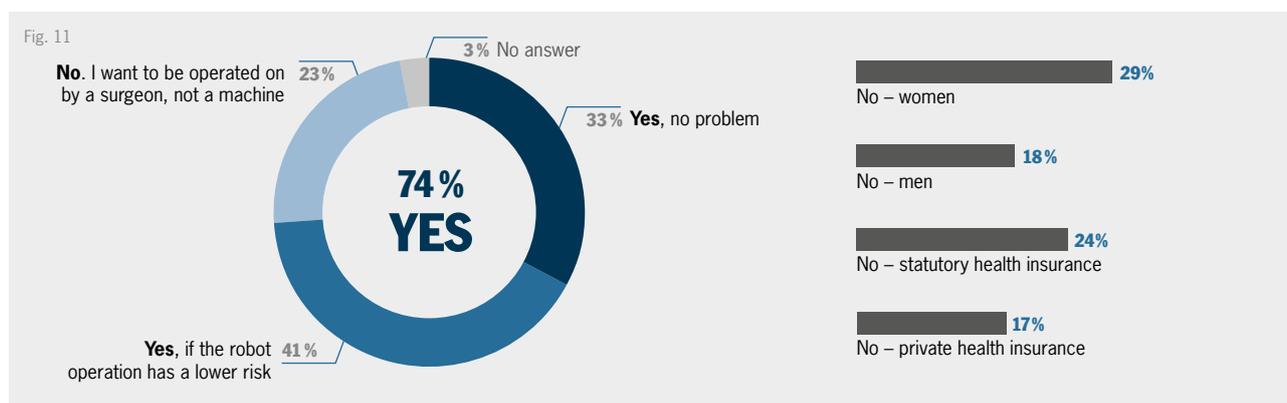
Fig. 11

No. I want to be operated on by a surgeon, not a machine — 23%
No answer — 3%
74% YES
Yes, no problem — 33%
Yes, if the robot operation has a lower risk — 41%

No – women — 29%
No – men — 18%
No – statutory health insurance — 24%
No – private health insurance — 17%

Basis: Representative survey from Porsche Consulting of 1,000 people in Germany carried out April 24—27, 2017.
The management consultancy commissioned Forsa to interview individuals chosen by systematic random selection.
Source/graphic: © Porsche Consulting[22]

3 Robotic nurse assistant

As the population ages in industrial economies, the future will provide a patient care model where autonomous nursing robots can help the aged to live more independently for longer. Future nursing robots can act as companion robots that aim to improve the psychological aspect of aged loneliness via communication, keeping patients in need of care aound-the-clock company. These robots can also act as assistive nursing robots to complete daily care tasks, for example lifting elders out of bed, assisting them downstairs or preparing meals.The robotic nurses can also provide medical assistance in emergencies via a patient-robot connection (i. e. through a wearable vital trace device) and can connect with the outside world through emergency calls while performing fundamental first-aid. These robots do not necessarily have to work alongside human care givers in the future, thus improving overall healthcare.

In regard to robot nurse assistants, the study[22] conducted by Porsche Consulting has further investigated the possibility of allowing robots to provide future nursing and care for aged patients. 56 % as opposed to 44 % would allow themselves to be cared for by robots. Porsche Consulting has further analyzed the reasons why every second patient would be open to future robotic care: today's lack of qualified nursing staff leads 37 % to be willing to accept an alternative – namely robotic – way of nursing. 36 % of future patients would prefer a robotic nurses, if this would allow them to receive care at home. Other reasons for robotic nursing includes the 24/7 care aspect (29 %) and substantial cost savings through robotic care (21 %). In summary, young people, most notably men, who are privately insured are more likely to envision a world where a robot nurse assistant will take care of them when they are older. Figure 12 provides a detailed overview of the Porsche Consulting study findings.

WOULD YOU ALLOW A ROBOT INSTEAD OF A HUMAN TO PROVIDE YOU WITH OLD-AGE CARE?

Fig. 12

No, I want my caregivers to be people — 44 %

56 % Yes, I would allow some care from a robot

56 % YES

WHEN CARE RECIPIENTS WOULD ACCEPT A ROBOT ASSISTANT

37 % — If there is no alternative

36 % — If having a robot caregiver enables me to keep living at home

29 % — If a robot enables round-the-clock care

21 % — If the costs for a robot are lower than for human caregivers

25 % — If there are other advantages

Basis: Representative survey from Porsche Consulting of 1,000 people in Germany carried out April 24—27, 2017. The management consultancy commissioned Forsa to interview individuals chosen by systematic random selection.

Source/graphic: © Porsche Consulting[22]

> These three medical use-cases have provided a deep-dive into the future of healthcare from a practical approach. Looking back at the big picture of envisioning a patient-centered healthcare ecosystem, all future use cases have one very important trait in common in functioning well within a transformed healthcare environment; that is patient-driven data. By building both technologically advanced medical use cases as well a platform for use case interaction based on patient data, all healthcare stakeholders who will embrace this digital healthcare transformation can ultimately reinforce the ability to innovate in line with the future industry, becoming this era's future innovators. After all, in using science-based innovations of medical use cases to transform the healthcare practice of tomorrow within the aspired patient-centered system, the 'robot doctor' does not sound so fictional and improbable anymore, does it?

Sensitive robots are on the way

SCIENTIST HADDADIN SEES GREAT POTENTIAL IN THE FIELDS OF MEDICINE AND SUPPORT FOR CARE PERSONNEL.

A study by Porsche Consulting showed that three out of four residents of Germany would allow themselves to be operated on by a robot. 41% of those surveyed predicated their answer on the condition that the use of the robot would be less risky than treatment by a surgeon. With regard to care, in particular of the elderly, 56% of Germans also had no qualms about being cared for by a robot. Now Porsche Consulting has asked Professor Sami Haddadin about the current state of the technology. Haddadin is an expert in the field of highly sensitive robots and directs the Institute of Automatic Control at Leibniz Universität Hannover.

Photo: Franka Emika GmbH

Professor Sami Haddadin is the Director of the Institute of Automatic Control at Leibniz Universität Hannover. Highly sensitive robots are his metier.

Are robots already 'sensitive' enough to treat and care for humans?

Haddadin: For the first time, we have the technology to enable safe and sensitive cooperation and interaction between humans and robots. This technology includes real-time 3D image processing for environment and person recognition as well as learning speech recognition. Intelligent methods allow synchronized and coordinated movements of multiple actors. Highly sensitive robots would make it possible to close the ever more severe shortfalls in terms of medical treatment and care. With demographic change and rising life expectancies, the number of patients is growing much faster than the numbers of qualified personnel. With automated support and lower workloads for care staff for time-consuming and physically exhausting activities, staff could again turn their focus primarily to people in need of care.

What roles will robots take on in the care scenario?

Haddadin: They will work as assistants. A new term has been coined for this discipline: geriatronics. The concept involves the use of robotics, mechatronics and information technology in the living arrangements and care of the elderly. The assistance technologies will make it possible for seniors to maintain their independence for as long as possible and participate in the life of the community and stay mobile to the greatest extent possible. To do that, we need intuitively operable, learning and personalisable assistance systems.

Would robots be more expensive or cheaper to operate?

Haddadin: I am confident that in the not-too-distant future we will see the first commercially available systems that are eminently affordable.
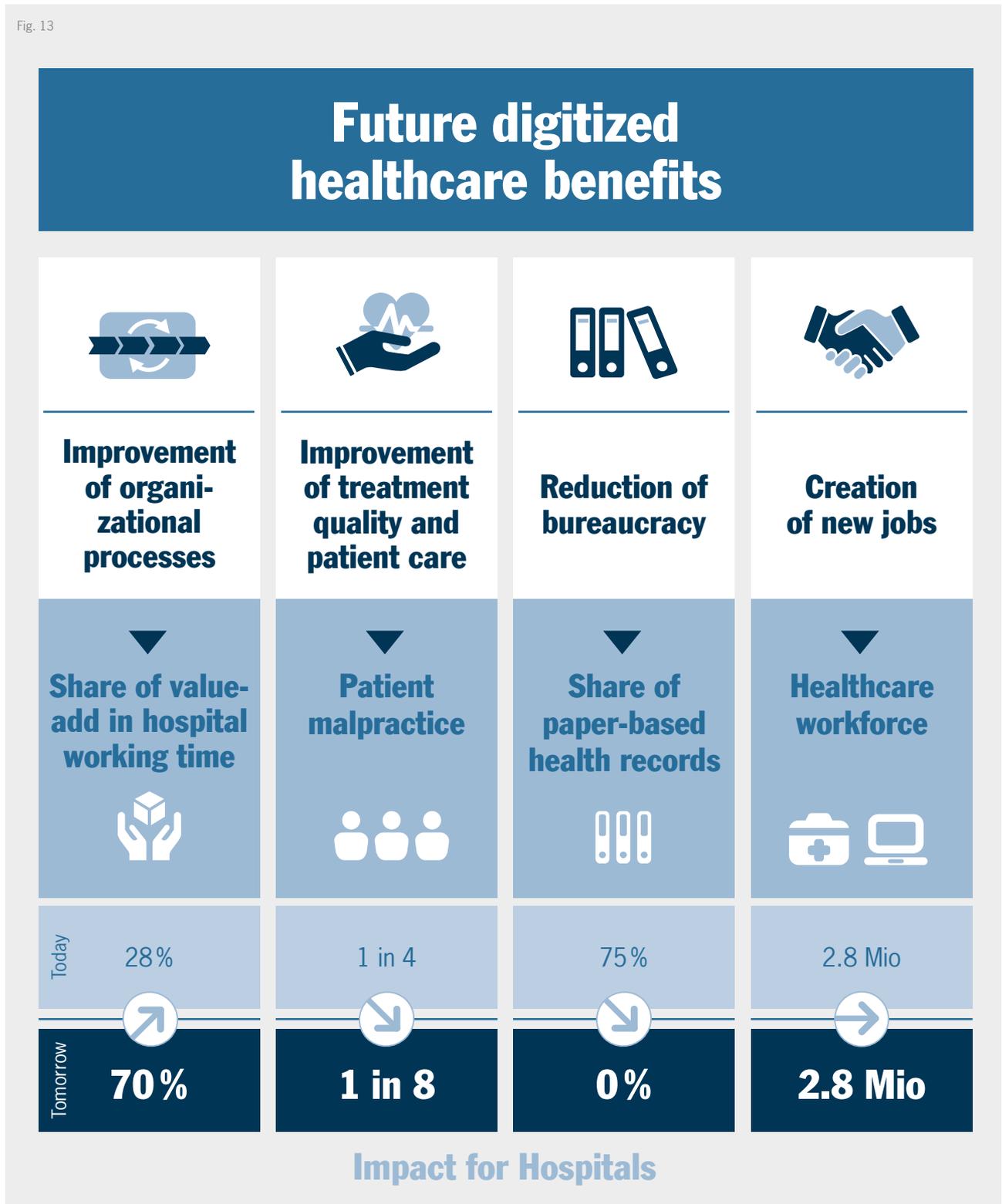
6

BENEFITS OF DIGITIZATION FOR HEALTHCARE

Within the third and final stage of the patient-centered digital healthcare model and its supportive use case technologies, all participants will reap the benefits of the future system: improved organizational processes, higher quality of treatment and patient care, reduction of bureaucracy and the creation of new jobs[23], as highlighted in Figure 13. These main improvements provide an insight on how to understand the future possibilities that lie within the transformation of healthcare, thus resulting in a new and rapidly changing global healthcare landscape. The benefits will likely affect all related players throughout the digital transformation, yet describing the impact for everyone would go beyond the scope of this position paper. Therefore, the 'future scenario' of a digitized hospital as the chosen stakeholder has been used as an example to illustrate what to expect when the digitized health movement transitions into its final stage.

Fig. 13

Future digitized healthcare benefits

Improvement of organi-zational processes	Improvement of treatment quality and patient care	Reduction of bureaucracy	Creation of new jobs
▼	▼	▼	▼
Share of value-add in hospital working time	Patient malpractice	Share of paper-based health records	Healthcare workforce

Today	28 %	1 in 4	75 %	2.8 Mio
Tomorrow	70 %	1 in 8	0 %	2.8 Mio

Impact for Hospitals

Source/graphic: © Porsche Consulting[24] | MDS[25], Bundesministerium für Arbeit und Soziales[26]

Improvement of organizational processes

- IT supported and virtually-connected overarching planning tools will improve foresighted scheduled appointments by uniting all patient-interfaces between the various health stakeholders.
- Health stakeholders will be able to focus on value-added tasks through automated process improvements without neglecting patient care.
- Proactive planning of patient care enables a fully-automated treatment path that respects treatment deviations e. g. emergency patient-developments can be dynamically accounted for by intelligent planning algorithms.
- Digital planning safety can be used for patient communication i. e. the patient will have total transparency of treatment plan (examination schedule, appointments, dismissal schedule) and can anticipate upcoming treatments in advance without having to contact healthcare entities separately.

Exemplified hospital scenario:

The hospital is able to prepare for the patient's arrival by creating an individual treatment plan prior to his/her visit; all relevant data from all medical entities as well as personal health-related information have been compiled in a central document for example combined information from prior hospital departments (e. g. blood work, lab results and recently visited general practitioners) as well as personally tracked health-related information (e. g. body conditions, foods of last week). As a result, indefinite cause findings lead to a tailored digitally available treatment plan – during and after the hospital visit. Over the course of the hospital stay, the path of the patient is fully transparent and automatically optimized (e. g. from anamneses to diagnostics to treatment), reducing inefficiencies for the patient in waiting time, complexities of multiple diagnoses and in making appointments. In regards to the hospital workforce in extracting patient information, planning and scheduling appointments for diagnoses, administering patient's medical records and providing multiple visits with insights on proceeding treatments. Moreover, the medical staff can plan shifts according to daily/weekly forecast of hospital in/out traffic with a predictive diagnosis tool, optimizing resource allocation at all times.

Improvement of treatment quality and patient care

- Data availability for practitioners ensures faster (real-time), more accurate and target-oriented diagnosis and individual treatment as digital patient information is readily available and individually-tailored.
- Through data mining of available data pool mass, comparative patient values can be extracted to validate patient diagnosis with prior cases and emphasize on treatments that have led to previous data-based successes.
- Reduction of medical errors through digital standardization and implementation of error-prevention tools indiagnosis and treatment promotes treatment stability. Digital health protocols enables overarching diagnosis (e. g. individual traits vs. population traits), further increasing the chance of correct cause and treatment.
- Increased interest of patients in their own hands-on care (e. g. own effects on demographic changes) leads to stronger patient-practitioner relationships and more patient-value adding information exchange.
- More preventive check-ups and more effective continual monitoring of patient's vital data.

Exemplified hospital scenario:

The patient is remotely diagnosed through his automated electronic health information consisting of previous medical treatments and daily vital signs; an artificial-intelligent based system evaluates the patient's symptoms, compares the patient's data to previous cases (within the overall population), and suggests the most accurate and promising treatment in advance. The practitioner selects the targeted treatment best suited for the patient. Upon arrival, the chosen treat-ment plan is transferred onto the patient's wearable device which also tracks the patient's vital signs both during the hospital stay and/or 24/7 after the hospital visit for follow-up care.

Reduction of bureaucracy

- An electronic health file is created for every patient, which leads to a reduction in documents and time since medical records are automatically generated.
- Digital medical records update automatically whenever new patient information is available, i. e. when patient progression is achieved during certain treatment stages. This information can be extracted by both the patient and healthcare stakeholders simultaneously.
- Health records become easier and faster to retrieve when needed; internal and external patient information can be transferred in real-time to those healthcare stakeholders in need of information.
- Cross-institutional documentation of therapy activities and treatment patterns helps optimize customized care products based on patient data and promotes effortless mass customization of individual patient treatments.

Over the course of the ‚digital' patient's hospital stay, the patient's treatments and appointments are recorded, tracked and added in real time to the patient's electronic healthcare records. Through standardized medical record compatibility, automated reports are generated during each visit and can be seamlessly and easily transferred to the general practitioner or other specialists during the patient's pre-/post-hospital treatment (i. e. with the use of voice-over information). The automated, loss-free exchange of information enables doctors and nurses to withdraw from burdening administrative tasks e. g. manually implementing treatment results, formulating doctor letter's, communicating with laboratories in extracting further patient information. Cross-over information includes suggestions of individual treatment preferences in customized medicine (e. g. 3D printed pills from home).

Creation of new jobs

- IT specialists with process and medical knowledge are trained to fully support existing IT projects (i. e. roll-out of automated health recordings) and drive new digital transformation projects (i. e. data inclusion of real-time patient tracking post-care) in various digital hospital departments.
- Healthcare providers, both online and offline, can communicate with current and future patients to promote healthier habits and lifestyle choices.
- Qualified healthcare and non-healthcare professionals can tap into individual information to expand their business model to tailor their needs online (e. g. supplementary dieting routines, exercise plans etc.). In the process, data can be used to identify new patterns of diseases for individuals and populations, creating new business ventures.
- Redefinied regulation and rules (e. g. adaptation of test drug phases) provide new business opportunities for ecosystem stakeholders.
- Discrepancies in rural vs. urban care medical services can be better met for example by adding more medical-practicioners needed for certain less populated areas.
- Collaboration destroys silos and creates a common ground for partnerships e. g. health start-ups[27] can collaborate with Research and Development (R&D) departments, healthcare organizations and other industry players to innovate and find gaps in patient-tailored health technologies.

The future hospital will have its very own IT department comprised of data scientists (for patient treatment data mining), algorithm programmers and IT developers. Generated patient data is selectively sent out of the hospital to various stakeholders in each individual patient's ecosystem in order to further grow the hospital's capabilities to expand its reach of every patient's value. Other stakeholders can profit from patient information exchange to further address all-in patient-values (i. e. wellness centers provide individual patient-plans, nutritioners suggest dietary programs and combine hospital treatment with grocery orderings for tailored nutrition programs). This induces the involvement of completely new stakeholders to join the individual care movement around the hospital, creating further jobs in the making while at the same time unburdening non-value-adding work away from the doctors and nurses in the hospital.

7

OVERCOMING CHALLENGES ON THE PATH TO DIGITIZED HEALTHCARE

Potential obstacles and challenges may substantially hinder the digitization of healthcare. In essence, there are three main barriers to digitized healthcare that need to be taken into consideration when embarking upon a new frontier. As Figure 14 highlights, these three barriers can be broken down further along four major questions in providing righteous answers for the future transformation of healthcare[28, 29]:

a) Why is this challenge essential as a potentially harming 'show-stopper'?

b) What is today's status quo?

c) Can healthcare learn from analogies of use cases in similar industries?

d) How can the healthcare industry overcome this barrier?

Fig. 14

	1 Noteworthy investments in technology platform & IT health specialists	**2** Data security & regulations: to share or not to share personal & population data	**3** Promote suitable business models for new healthrelated innovations
a) Why is it essential?	• Digitally-compatible technology (software/hardware) for common-platforms • War of IT talents	• Increase in personal/population data • Safeguard patient control of data donor • Use patient data for improved health	• Consumer-focus & technology drive innovation • Innovation lead to increase of choice: performance ↑ prices & costs ↓
b) What is the current situation?	• Only slow advancements in digital IT adaptation • Lack of IT health specialists	• Patients are open to sharing health data • Conflict: No clearly regulated environment for patient data • Lack of IT systems	• Slow innovation pace = too many involved stakeholder • Incentivization lack • Supply-reliant offering: volume beats value in patient care
c) Are there industry analogies to learn?	Platform technology companies 	Data-driven software companies 	Consumer-focused business model innovations
d) How can healthcare overcome this?	✓ True technological investments ✓ Learn & embrace from today's lack of technology ✓ Dust-off old and out-dated industry perception	✓ Healthcare stakeholders = data stewards ✓ Datashare platform ✓ Implement data & regulatory safeguards	✓ Redefine strategic objective ✓ Redesign health business models →patient value focus ✓ Overcome short-term financial hits

Source/graphic: © Porsche Consulting

1 Noteworthy investments in technology platform & IT health specialists

a) Why is it essential?

All industry transformation must go hand-in-hand with investments for excelling into the new digital healthcare landscape and must create a revolutionized sector to better manage horizontal and vertical value chains. After all, the question is not if digitized healthcare will be arriving, but when. Therefore, it is important to invest early into the development of hardware and software in order to create a new shared platform that provides digitally compatible technology for future processes and to implement systems that benefit from a new digital wave. Though, IT infrastructure investments alone will only win half the battle in lifting healthcare into the digital age: compared to other industries, the 'war of talents' for IT health specialists is especially prominent considering all the regulations, reforms, data security aspects and changing payment methods the health sector has to comply by. Thus, investments in both IT infrastructure and IT health specialists will be of great relevance in adapting to and comply with embedded digital healthcare processes.

b) What is the current situation?

It is no secret that healthcare has long been insulated from disruption and is therefore lacking behind today's modern digitization waves. Due to its intricacies of navigating impervious billing systems, semi-free markets that suppress competition or its physician-centered approach, to name a few, its technological advancements are lagging way behind players in 'free' market models. Let's take hospitals as a prime stakeholder example for today's level of digitization: outdated communication infrastructure, manual health records or little online patient coordination complicate the digital ties to other stakeholders (e. g. pharmacies, insurances, etc.). Moreover, even in the midst of an impending digital transformation (in case a hospital is given the financial muscle to implement a digital transformation), the move to digitization is far from being merely a trivial matter: Partners Healthcare, a large-Boston-based hospital system, is planning on spending around US$ 1.2 billion for implementing an all access electronic health record system alone, in order to standardize the health connections both to the patient of the future as well as other system partner[30]. Though, a complete absence of IT funds in general is most often the rule rather than the exception. Indeed, there is an urgent need for action, as Dr. Med. Dominik Pförringer[31], surgeon at the Klinikum Rechts der Isar in Munich states that 'some German hospitals do not even possess an IT budget and even if they do, they are handicapped by one that is considerably too low'. Thus, there are simple yet systematic lacks: insufficient funds to promote IT advancements, inexperience from previous digital adaptations and IT manpower to create and implement new digitized healthcare systems – not to mention a general reluctance from conforming healthcare stakeholders to invest heavily in much needed technologies.

c) Are there industry analogies to learn?

With the advent of the Internet, mobile usage and big data as the bulwark for the modern economy, the sector has the opportunity to close in on the digital gap that digital disruptors such as Airbnb or Uber have already accomplished in their respective industries years ago. While these companies have fundamentally disrupted the market, they have done so using great cash initiatives by implementing digitization enablers and creating a centralized platform to connect respective market players with a strong focus towards the future customer needs, thereby inducing a critical mass for platform success. Hence, the future healthcare industry can learn from these new-age companies in transitioning their market-models towards a centralized platform, accordingly.

d) How can healthcare overcome this?

The healthcare sector needs to first catch up on true technological investments in order to benefit from ubiquitous and real-time access to patient information facilitated by a new ecosystem and health technologies that surround a digital health platform. After all, the fact that today's healthcare system remains woefully fragmented, siloed and simply disconnected from the holistic needs that revolve around the patient is not necessarily an indicator for a challenging transformation time ahead. Quite the contrary, today's shortcomings can stimulate healthcare's inner transition and promote disruptive change: by identifying, learning and embracing today's deficiencies, future IT investments can be implemented selectively, allowing new health processes to be built from scratch rather than transforming outdated and inflexible ones. Of course these precise IT investments in healthcare systems not only necessitate common digital tools and a platform for interaction, but a detailed implementation roadmap of putting envisioned care processes into digital practice. In doing so, the sector has the chance to dust off its image of an old-fashioned industry for attracting future IT healthcare specialists. Following, future talents may want to use their IT skills on more than merely renting out houses and taxis, but creating meaningful impact and aiding people all over the digitized world of health.

2 Data security & regulations – to share or not to share personal and population data

a) Why is it essential?

A new patient-centered health ecosystem will undeniably have a major impact on the health of populations globally. Personal as well as population data collections will be frequently processed in the future for improved digital healthcare products and services. For that reason, both the data that is transferred in real-time as well as the regulations that surround the usage of the data must abide by the highest standards of digital healthcare systems. First, when it comes to the usage of future health data, much needed oversight will be required to establish a balanced agenda that on the one hand safeguards the patients' control of their own data 'donorship' and allows for a 'quantification' of individuals as well as populations, while on the other hand promotes the use and analysis of patient data to improve health digitally and on a global scale. Secondly, the regulatory framework must be aligned to the emergent healthcare technology frontier. Completely new regulations focused on patient data will need to be created in order to overcome today's perceived regulatory uncertainty in a sector that traditionally lies within strict and sometimes outdated regulation.

b) What is the current situation?

Even though the data-driven potential for a patient-centered ecosystem to transform both public and private healthcare services has been recognized, a clear guidance of the data and information shared through a clearly regulated digital health platform has yet to be established. The uncertainty of the future use of data and regulations are indeed greatly affecting the healthcare stakeholders and the planning for their future healthcare industry set-up. Yet, surprisingly, behind all the uncertainty regarding data and future regulations, the binding tie around the future health platform – the patient – is turning out to act as the front-runner in promoting the datadriven healthcare digitization. As the previously mentioned Porsche Consulting study[22] has shown, future patients are indeed open to a shift in mindsets when it comes to data sharing: the findings of the survey conducted by Porsche Consulting contradict those of a perceived tradtional German, oftentimes data-security driven society, since the majority of patients would indeed be willing to store and share their data-driven medical records.

c) Are there industry analogies to learn?

In the last few years, data, exchange of data, and platform solutions to exchange data have emerged as the new currency in various industries. Facebook as a social media platform provides personal information for billions of people around the globe. Uber tracks its drivers and riders in real-time using global customer data to optimize surge algorithms. While the data contained within medical records is indeed more sensitive information than the likes of a 'thumbs up' or 'driver' ratings, these tech industries have been able to implement regulations that allow data to be protected from illegal activities while optimizing the existing platform business models. Both clients and customers from various industries are therefore taking a progressive view about sharing data and diminishing mutual data reservations in the future. After all, these data-driven industries have induced a favorable platform, for which all parties can actually feel secure to share their personal data on, and so can healthcare.

d) How can healthcare overcome this?

In the future, healthcare stakeholders must discontinue viewing data as proprietary – questioning who can and cannot access and share medical records. Instead, all players must learn to act as stewards of new patient data in a state-of-the-art regulatory system to create the most benefit for the patient. After all for patients, data is a matter of trust. If patients are willing to take on more accountability for their care through data, regulatory institutions and stakeholders must also do the same. Of course, no data is more private than our medical data. Initially, secure safeguards must be put in place to ensure that information is safely transmitted between intended parties and protect against cyber attacks. Next, a platform has to be created so that all participants must be able to overcome the technical barriers to collecting data, for example through healthcare enterprise data warehouses (EDWs). Only then can the industry attempt to tackle one of the biggest hurdles in the quest for data-driven healthcare by taking advantage of the data collection in a favourable regulatory environment.

3 Promote suitable business models for new health related innovations

a) Why is it essential?

Innovations in healthcare are crucial and can best be characterized by two main drivers for modern health innovation business models: consumer-focus and technology will drive sustainable as well as new health business models that are going to achieve long-term sustainability in the future. Initially, consumer-focus will result in more convenient, more effective and less expensive patient treatments. Secondly, new technology will offer the hope of better care and more affordable healthcare that is also less disruptive and painful. Regardless of the industry, these two innovation drivers increase options and tend to improve performance and reduce costs.

b) What is the current situation?

These typical rules of innovation do not naturally apply for the unique healthcare industry, and thus make it hard and unappealing for healthcare market players to get involved in a slowly-adapting digitized health ecosystem. One of the big barriers to innovation in healthcare is that, unlike other industries, there are simply too many stakeholders who must be addressed first before bringing new products and services to market, thus decreasing the pace of innovation. Innovators of healthcare have to make sure their innovation cycle pace is similar to the pace of the healthcare system, otherwise new business models could be ruined. Another major barrier is that the industry's reimbursement mechanism is very often based on activity rather than outcomes (volume beats value). Hence, new innovations by healthcare market players are further dampened due to a non-incentivized supply-reliant system for market participants.

c) Are there industry analogies to learn?

Healthcare business models have to be redesigned to be able to deal with how the patient experiences health. In moving away from a supply-sided mindset that does not focus on the patient towards a value-based model, this shift can yield to tremendous opportunities for business model innovation in the healthcare sector. Other industries have already become very sophisticated in anticipating their own consumers' ('patients') needs, expectations and preferences in order to come up with new value propositions and innovations to win over consumer preferen-ces in their respective business models' success. Amazon serves as a prime example in shifting its business model to a consumer-focused one prompting innovations. Incremental adaptation in Amazon's business model have produced minor, yet successful innovations of personalized product recommendations based on previous purchases, moving away from merely supplying the customer with a broad product portfolio/service selection. The fundamental adaptation within Amazon goes a step further in creating new innovations that allow the tech giant's entrance into other industries: The 'Amazon Go'[32] store concept has understood the customer preference from a bottom-up perspective (long waiting lines at checkout equals time waste) thus creating a suitable grocery store concepts that uses RFID to automatically register and check out collected groceries upon exiting the store – no waiting lines, no cashier, no manual payments hence getting rid of all past inconveniences for their customers altogether. As a result, traditional stores will likely have to enter this automated grocery store race, repeating disruptions and yielding better product and service experiences for future customers in the process.

d) How can healthcare overcome this?

Thus, new and reinvented strategic business model solutions need to be implemented for this innovation-averse industry to turn from a toxic into a patronizing healthcare environment that embraces innovation around the new digitized patient. A shift in healthcare business models from volume-based to patient-centered and thus valuebased healthcare is inevitable. By moving healthcare business models away from fee-for-service revenues, reducing volume and increasing patient-value, a first step into digitalized healthcare can be assured. The new vision for healthcare business models isn't just about access, quality and affordability, it is also about social and financial inclusion. Even if this shift may imply that stakeholders' business models achieve short-term financial hits in the process (after all, most traditional healthcare business models have become all too acquainted with steady revenue streams from volume-outputs), it will redefine their strategic objective in the process, which consequently will promote new innovation around future patient value. Ultimately, the patient of the future is going to be more open-minded and will welcome new business models and technologies in healthcare that can function within the patient-centered ecosystem, as highlighted in the representative Porsche Consulting survey[22] of having robot surgeons perform autonomous operations or providing robotic nursing and care for elders. Though healthcare lags far behind other industries, the opportunities for innovation will be plentiful just by turning back to patients and understanding their needs, expectations and preferences in a much deeper way than the oversimplifying traditional approach to patient satisfaction. Hence, while healthcare is ripe for digital disruption, its shortcomings and obstacles toward digitization must be taken into account in order to establish sustainable digital healthcare development that fosters innovation in the sector through redesigning care with value for all.
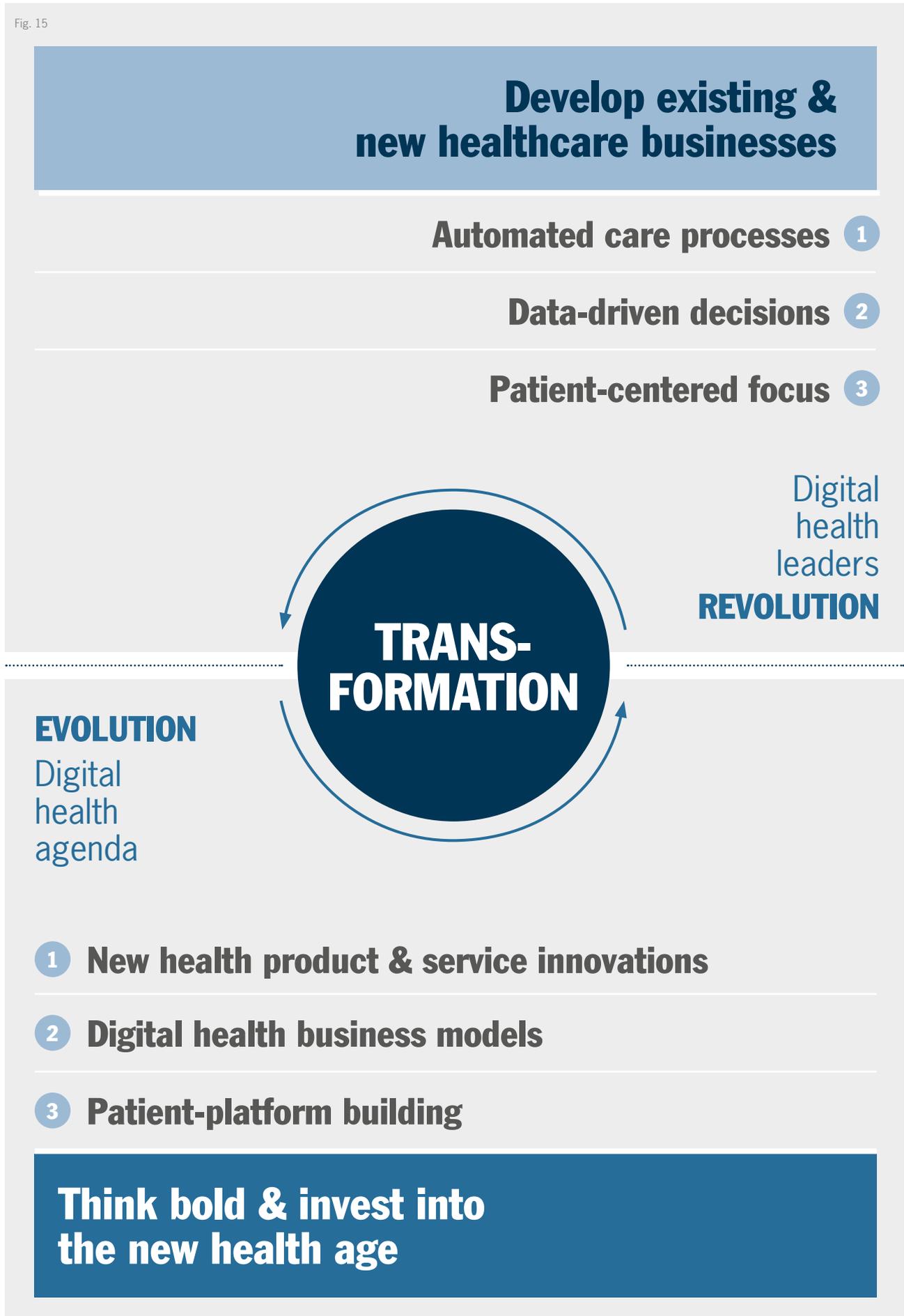
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PLANS FOR ACTIONS –
PORSCHE CONSULTING RECOMMENDATIONS

In summary, the new health era envisions patients who take charge of their own healthcare. As a result, all stakeholders will eventually be forced to adapt to this new wave of digital disruption or risk falling behind competitors – whether it is existing market incumbents or new insurgents to the healthcare industry. Therefore, it is of the utmost importance that digital disruption of an entire healthcare system is viewed by all participants from a strategic standpoint and not just as a temporary business reoccurrence. Existing business models will have to be redesigned, new business models will have to be created from scratch and technological health innovations have to be fostered for all healthcare players. Only then can the health stakeholders position themselves well in a changing healthcare environment that increasingly will embrace the concept of four P's[33]:

predictive, preventive, personalized and participatory health. Thus, having depicted the future digitzed world of healthcare, promising medical usecase innovations, a new ecosystem environment as well as its benefits and challenges, Porsche Consulting provides a set of recommendations in Figure 15 which all healthcare players will inevitable have to internalize for themselves in generating answers to the question of how to best position themselves for the forthcoming digital health revolution. After all, digital disruption and transformation within the healthcare industry is something we all can count on progressing sooner rather than later; even if it may not be the imminent future, let us not bet against the trend and prepare for this forthcoming change in healthcare industry, accordingly.

Fig. 15

Develop existing & new healthcare businesses

Automated care processes **1**

Data-driven decisions **2**

Patient-centered focus **3**

Digital
health
leaders
REVOLUTION

TRANS-FORMATION

EVOLUTION
Digital
health
agenda

1 New health product & service innovations

2 Digital health business models

3 Patient-platform building

Think bold & invest into the new health age

Source/graphic: © Porsche Consulting

In order for healthcare to successfully adapt to the digital age, Porsche Consulting sees the industry's transformation to strategically occur from an incremental and evolutionary approach as well as a fundamental and revolutionary viewpoint, as these two directions must constantly interact in successfully shaping and implementing digital healthcare. Considering this, future stakeholders must develop existing and new healthcare businesses and focus on investing into the new health age.

1 First, automated care processes must be incorporated into health business models. Automation will have to be blended into future health workflows to make care processes more efficient hence improving health productivity. From pharmacist's medication counting tasks to automated hospital patient engagement for check-ins and reminders, the automated advantages are vast. Though, the level of future health automation should not be confounded with simply replacing health workforce and taking away from the bedside of the patient, as automation is often negatively associated with the loss of jobs. Rather, care processes must be adapted to function as a tool in aiding stakeholders to work smarter within a patient-focused setting, elevating them into higher-functioning roles that allow to make use of their fundamental healthcare expertise.

2 Second, healthcare will have to be more data-driven in order to ease the decision-making of all stakeholders, as health information will become a top value driver in the future healthcare industry. Business models that are based on collecting and connecting the sheer bulk of health data will ultimately yield performance improvement in care. The groundwork to data-driven healthcare is already in place, as the industry produces great amounts of it to date – both consciously and unconsciously. Yet the key to ongoing success in data-driven healthcare will lie in knowing how to further acquire health data, retain access to it and interpret it in continuous health feedback loops to generate value for decision-making from it, both now and in the future.

3 Third, future digitized healthcare must emphasize on patient-value. As the National Academy of Medicine (NAM)[34] iterates, providing care that is respectful of, and responsive to individual patient preferences, needs and values, ensures that patient-value will guide all future healthcare decision-making. While this evolution will surely be marked by sets of new standards and regulations not within full control of health stakeholders, they should still put their focus on complying to a future patient-centered infrastructure in order to move healthcare business models away from volume-based to a valuebased care.

4 Fourth, technology investments into new products and services must be accompanied for and brought to market in agile fashion in order to drive care delivery innovation. Of course it is not realistic – nor appropriate – for healthcare stakeholders to jettison all existing healthcare technologies and infrastructure when beginning the move to innovate digital healthcare products and services. Therefore, whilst adaptation to existing technologies must be granted to achieve compatibility where possible, new digital innovation approaches in care delivery need to be tried out for (and ‚failed-fast‘ for) to quickly be able to abandon unsuccessful healthcare innovations for the sake of embedding and scaling successful ones up to market, hence driving the development of digital healthcare products and services.

5 Health innovation is a created idea sustained over the long-term, so as a fifth, it takes successful digital business models to detect future health innovations and conceive new businesses for all stakeholders involved. By critically reviewing the basic set behind future value creation – from resources, processes to cost assumptions – care stakeholders can determine what type of value they can deliver in the future. To drive the transformational change needed to meaningfully impact the metrics that matter to patients, all stakeholders in the healthcare system need to deconstruct and rebuild the healthcare delivery value chain of their business models. Only then can stakeholders better prepare for the transformation from an old-aged and outdated health business into a new and future compatible digital one. Namely one with a long-term digital vision for healthy patients, healthy business and clear value propositions for all parties involved.

6 Sixth, a smart patient-centric service platform will ultimately combine innovative health products and services with health business models of tomorrow. This patient-centric ecosystem will play a key role in capturing future healthcare value. Core competencies and traditional virtues of health stakeholders will have to be redefined in the process for a new patient-service model. Therefore, it is important to incorporate a platform that views health no longer by the absence of a certain disease but in the more holistic context of a patient's wellbeing. As a consequence, this platform approach will require the interdisciplinary connection and collaboration of all future healthcare stakeholders – traditional and nontraditional.

These recommendations are of major strategic imperative – both evolutionary and revolutionary – for the future of healthcare and all stakeholders of a patient-centric digitized health system. Yet, for healthcare transformation to succeed, digital health leaders and the creation of a digital health agenda are greatly needed to constantly guide the way towards realizing above-mentioned digitization strategies and combining them into the big picture of a self-sustaining digital healthcare vision. The new era of providing care in a digitized healthcare industry can seem paradoxical at first glance, as the change will need to be executed by people who, based on their in-depth healthcare experience, have grown so accustomed to the old and well-oiled healthcare model.

Therefore, all leadership – from pharmaceutical CEOs, to hospital management or senior physicians – must embrace the digital journey towards a patient-centered ecosystem as it involves new ways of working and thinking. These senior digital health leaders must decide the ultimate goals for transformation and embed a new mindset across their organization as a prerequisite for achieving maximum impact in the healthcare industry. In doing so, leadership should take concrete steps to ensure that their organizations are not only open-minded but also well-prepared for healthcare transformation by laying out a concrete digital agenda. This digital plan can range from broadly transforming the core healthcare organization as a whole, laying out gradual stages of digital transformation to a much particularized digitization plan of bringing in new talent to conquer a certain transformation of an outdated healthcare process.

> After all, digitization and digital transformation are likely the most obvious buzzwords in healthcare today. Porsche Consulting can lean on the digitization knowledge it has gained over the past years – both in the healthcare sector as well as from other industries – to decipher the current trends in the digital era. In doing so, Porsche Consulting has recognized the nature of the transformation that is slowly but surely starting to take shape in healthcare today and can guide the way for future clients to take active control of their own digital destiny and reshape their place in the digital healthcare environment of the future.

Additional healthcare publications:

Porsche Consulting regularly publishes reports and articles on major trends, innovations, and ways to keep hospitals competitive.

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Top Management Study,
2017:
Improving Quality at Hospitals

Porsche Consulting
Lean hospital processes
Hospital Management Strategies, Concepts, Methods

Porsche Consulting
Representative patient survey,
2016:
Hospitals from the Patient's Perspective

Porsche Consulting
Survey of Swiss hospitals:
Hospital Management and the Swiss DRG System

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Lean Hospital Management in Germany

Porsche Consulting
Hospitals–future pers-
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How Hospitals Can Become Cost-Effective

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