connected **care**

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intel

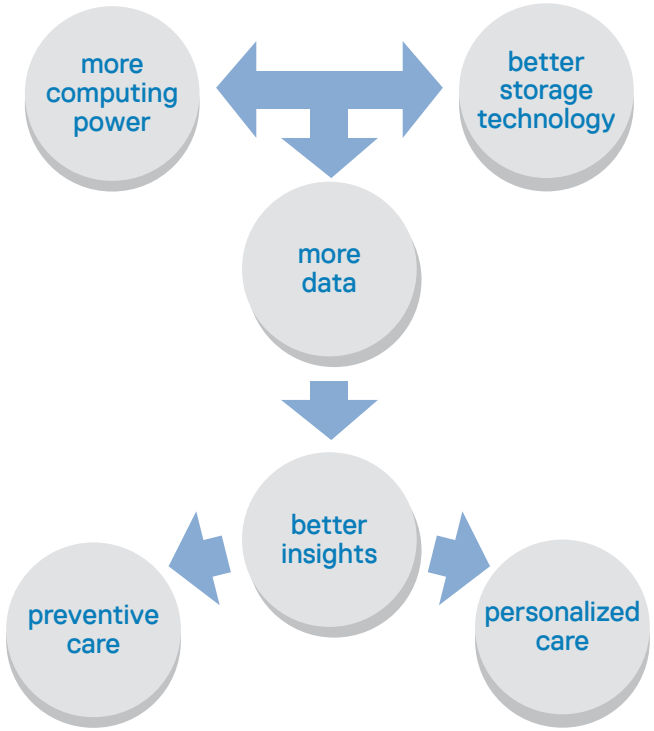
Dell EMC, a part of Dell Technologies, enables enterprises to reinvent their business through Digital Transformation.

'No man is an island.' Nor is any system, organization or industry. The CONNECTED series dives into this new reality of 'everything connected'. It gives you the latest insights on digital transformation.

Also available:

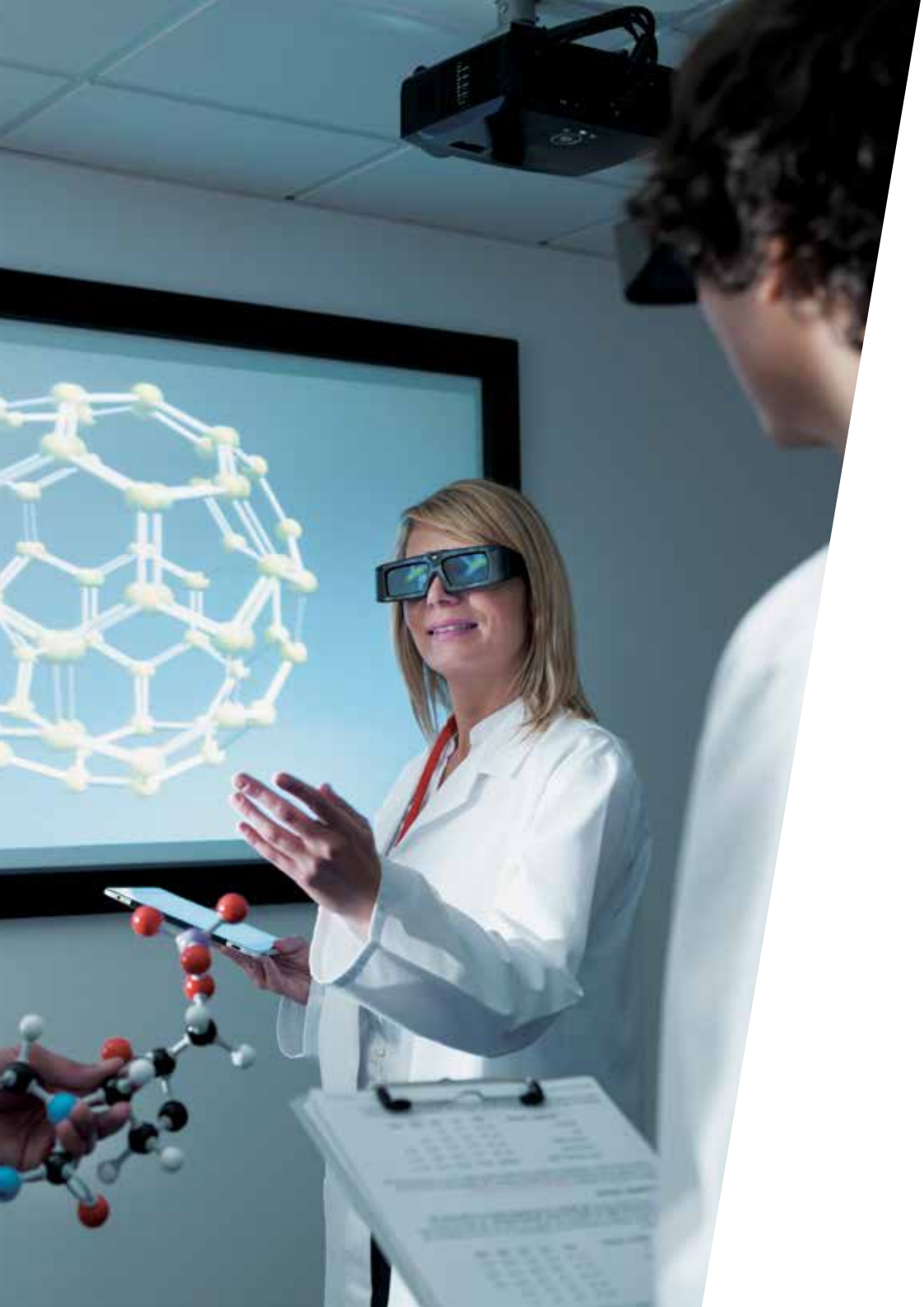
EXECUTIVE SUMMARY

Connected data is leading us to preventive and personalized care



The increase in **computing power** and storage technology, fuelled by **mobility**, is generating an **avalanche of data**. As the limitations on data storage are continually decreasing, the current challenge in IT is **connecting all this data**. As the connection hurdles are lowered, smarter **Big Data** technologies increasingly generate far **more and better insights**. As such, **connected data** is paving the way for more **preventive and personalized care.**

Connected data improvements in the healthcare industry generate gains for the whole of mankind.



CHAPTER 1

Healthcare & life sciences in the 21st century

Digital transformation in the healthcare and life sciences industry is happening in every field. But due to the high density of compliancy rules and regulations, the industry itself is not the fastest of the herd.

The industry is, however, making great strides forward in digital transformation. And this evolution is fuelled by a broad range of factors, many of which lay outside its direct sphere of influence. Across the multiple factors influencing the healthcare industry, connected data is one of the key **unifying** elements.

The life sciences sector may very well be the most regulated industry in the world.

27%

THE PHARMA INDUSTRY'S DIGITAL QUOTIENT. THE GLOBAL AVERAGE SCORE IS 33%. INDIVIDUAL DIGITAL LEADERS' SCORES RANGE FROM 70% TO 80%.

Source: McKinsey & Company

HEALTHCARE EXPENDITURES ARE EXPECTED TO CONTINUE TO RISE. Governments worldwide face daunting **healthcare expenditure challenges** and any measure that helps them to regain control over the budget, is up for consideration. Prevention is therefore gaining ground on the agenda. But while **chronic diseases** are eating up the lion's share of the budget, research has shown that prevention could reduce costs significantly. In order to better manage costs, many governments are also re-examining their current funding and **reimbursement models.**

THE R&D AND PRODUCT LIFE CYCLE IS UNDER PRESSURE. The traditional drug development and corresponding sales model is faltering and **the patent cliff** also forces companies to recoup the investments in a limited time frame. No surprise then that a growing number of life sciences companies are looking for alternative approaches: **merger and acquisition policies** have changed (focusing more on promising healthcare start-ups) and there is a desire for more **open and innovative business models.** The silver bullet hasn't been found yet, and **compliancy** makes it difficult to speed up the R&D cycle.

POPULATIONS ARE AGEING. Life expectancy at birth in the developed world continues to increase. As a result, a decreasing number of workers will have to subsidize **a growing elderly population.** This puts additional strain on governmental budgets and it fuels the public debate over what constitutes **a pensionable age**. How many of us are willing / able to work until the age of 70 or over? Are our health systems sufficiently equipped to deal with aging populations?

CAN TECHNOLOGICAL ADVANCEMENTS COME TO THE RESCUE? The cry for **outcome-based healthcare** sounds increasingly louder. Some of the answers may come from technological advancements, from 3D printing to improved medical imaging and more. Most importantly, **the ever-increasing influx of data** holds great promise. By maximizing the potential of the already available data, new insights that were before impossible to generate now become within reach. Companies that can more forcefully demonstrate the value of their treatments to the EMA and FDA will be able to gain **quicker access to the market** and a **higher reimbursement** compared to alternative treatments.

80%

80% OF CARDIOVASCULAR DISEASES, 90% OF TYPE II DIABETES AND 50% OF CANCERS ARE PREVENTABLE.

Source: Eurostat

10%

WHILE THE EU SPENDS AROUND 10% OF ITS GROSS DOMESTIC PRODUCT ON HEALTHCARE, ONLY A FRACTION OF THIS (3%) IS FOCUSED ON PREVENTION.

Source: Eurostat

80.9yrs

LIFE EXPECTANCY AT BIRTH IN THE EU (2014) HAS RISEN TO 80.9 YEARS AND IS EXPECTED TO INCREASE FURTHER.

Source: Eurostat

10yrs
$1 billion

AS IT TAKES, ON AVERAGE, 10 YEARS AND $1 BILLION BEFORE A DRUG IS BROUGHT TO THE MARKET, THERE IS LITTLE ROOM FOR ERROR ANYMORE.

Source: Tufts CSDD

CAN WE MATCH PREVENTIVE WITH PERSONALIZED CARE?

There is a **contradiction between preventive and personalized care.**

- Preventive care helps to avoid illnesses which can greatly improve the efficiency and effectiveness of healthcare expenditures.
- More personalized care and medicine (fuelled by genomics) mean better attuned treatments and improved outcomes but this could also lead to higher healthcare expenditures.

Can the evolution towards more personalized care (which could potentially burden the healthcare budget) happen in sync with more preventive care (which could potentially alleviate the healthcare budget)?

In a best case scenario, the combination of more preventive care, with more personalized care leads to lower healthcare expenditures. In a less optimal case, both evolutions are not in sync and healthcare expenditures may continue to rise whenever more personalization is combined with a delay in more prevention.

Efforts and investments from the whole industry will be required to tackle this.

TO CONCLUDE

Three challenges

National health services face a triple challenge:

1. **ageing populations** and changing demographics lead to
2. **increases in chronic and lifestyle diseases**, which, in turn, lead to
3. **spiralling healthcare costs**, also as more complex and sophisticated diagnoses and treatments become available.

Ways to combat these challenges is to:

1. reduce demand while, at the same time,
2. improving healthcare efficiency.

Connected data plays a key role here:

- Better informed people can make better health decisions, crucial for more preventive care.
- More collaboration and sharing of data can lead to better informed medical decisions, improved research overall and smarter usage of the limited healthcare resources.

Connected personal and clinical data are the first stepping stone.

30/70

THE UK DEPARTMENT OF HEALTH ESTIMATES THAT 30% OF THE POPULATION (= PEOPLE WHO SUFFER FROM ONE OR MORE LONG-TERM CHRONIC CONDITIONS) COSTS 70% OF THE TOTAL AMOUNT SPENT ON HEALTH AND SOCIAL CARE. Source: Volterra Partners, 2014

CHAPTER 2

Personal & clinical data

The key to unlocking value is data. The great thing about it, is that data is omnipresent. That is also the tricky thing about it: anything we do, is now monitored. What we look for on the web, what we watch on TV, where we are. Through smartphones, wearables, and an increasing number of other devices and 'things', records are kept, unbeknownst to us and in different locations.

Our digital footprint becomes larger every minute of every day.

48%

HEALTHCARE DATA IS GROWING AT 48% PER YEAR THROUGH 2020. IN OTHER WORDS, THE HEALTHCARE DIGITAL UNIVERSE IS (ALMOST) DOUBLING EVERY 2 YEARS.

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ON PERSONAL DATA

Personal data within connected care extends **beyond patient data**. While patient data remains crucial for many domains (such as drug development), increasingly, data from healthy people is gaining in importance. 'Healthy data' helps us lead a healthy life. It fuels preventive care and empowers people to take control over their health.

Personal data in connected care = patient data + healthy data

The Internet-of-Medical-Things is coming (IoMT).

More and more things are being connected and the healthcare industry is following suit. By connecting wearables and implantable devices with networked systems and remote monitoring, **an unparalleled wealth of more accurate data** can be continuously captured. Insights from IoMT could be used to improve adherence, define better diagnoses, and, more generally speaking, amass from these data lakes, new insights to advance drug and treatment development.

More and more data is being collected **from patients and healthy people alike.** Consider, for example, the various **fitness trackers** that collect an avalanche of data from a very diverse set of (healthy) people, or the **electronic health record (EHRs)** for patients that enable GPs and specialized physicians to get an overview of a patient's medical history. But connecting all this data remains troublesome, for a variety of reasons. Compliancy with privacy laws and ethical management of personally identifiable information (PII) keeps data within silos. And often, rightfully so. Additionally, putting all data together just like that, isn't necessarily the right answer either. Data is only valuable when it generates relevant insights and conventional IT systems are unfit to capture, analyse or manage the continuously evolving volume and variety of data.

Today, technology is evolving so fast that legislation, as well as our human, moral and ethical standards have a hard time to keep up.

40+%

... OF HEALTHCARE ORGANIZATIONS ACROSS THE WORLD WILL USE IOT-ENABLED BIOSENSORS BY 2019.

Source: Worldwide Healthcare IT 2017 Predictions, report

$305 billion

A REPORT BY GOLDMAN SACHS ESTIMATED THAT THE TOTAL SAVINGS OPPORTUNITY OF IOMT COULD REACH $305 BILLION. CHRONIC DISEASE MANAGEMENT ALONE COULD AMOUNT TO SAVINGS OF $200 BILLION.

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A CLOSER LOOK – DELL EMC CUSTOMER CASE
HEALTHEAST REDUCES COSTS AND INCREASES AGILITY

1 **The situation** – HealthEast Care System is the largest, locally owned healthcare organization in the East Metro area of Minneapolis-St. Paul. The organisation comprises four hospitals in addition to outpatient services via primary and specialty care clinics, home care, and medical transportation services. HealthEast employs 1,500 physicians and 5,800 staff members.

2 **The challenge** – HealthEast's legacy systems were holding the organization back and putting it at risk. Space, power and cooling were at 89% of capacity. The organisation was using a variety of inflexible systems cobbled together. Too much time and budget was spent keeping everything running, rather than adding value to the business. On top of all that, HealthEast relied on a single data centre while its second location had only limited capabilities.

3 **The approach** – HealthEast deployed two Vblock Systems 720, one in its primary data centre and the other in a secondary data centre, in addition to EMC® Isilon® storage to provide archiving for MRIs, X-rays, and anything related to **medical imaging**.

The primary Vblock 720 also serves as the Target Platform for HealthEast's Epic **Electronic Health Record (EHR)** system, in addition to supporting more than **300 other applications** to deliver a full continuum of care.

Having a production-capable Vblock 720 in the secondary data centre allows HealthEast to completely **fail over** to that location in the event of a disaster. The secondary centre is used for development and testing as well. EMCs VPLEX assures near real-time data replication between the two sites. Now, systems can be brought back up quickly after a failure.

4 **The result**

- Increased **agility**: the IT team can now respond to requests for new servers in hours rather than weeks. The introduction of innovations – such as Epic's MyChart Bedside, an interactive, tablet-driven application that enhances in-patient care – is streamlined.
- Five-year **TCO** is expected to be 30% lower. The system now accommodates 1,100 virtual machines (VMs) compared to 500 VMs before – while only reaching 58% of data centre capacity
- First-year operations **savings** are even greater at 50%. Those savings were

Read the case study: www.vce.com/asset/documents/healtheast-casestudy.pdf

"We now have a total cost of ownership that's projected to be 30% lower than before."

Lou Gallagher
Systems Director, HealthEast Care System

ARE YOU GDPR READY?

On 25 May 2018, 2018, the General Data Protection Regulation (GDPR) takes effect. This European regulation is intended to strengthen and unify data protection for individuals within the European Union (EU). It also prescribes the rules governing the export of personal data outside the EU. The aim is to give citizens control over their personal data while simplifying the regulatory environment for international business. But GDPR comes with additional challenges, and many organizations are now confronted with a regulation that goes much further than anything that existed before.

Can we get some privacy, please!

There are good arguments for collecting and assembling as much personal data as possible and then connecting it with as much other data as possible. But this also makes **the great importance of privacy** clear.

For example, the data used to find a more optimal treatment for **orphan disease** could, in the hands of an **insurance company**, be cause for potentially not accepting certain people. More thorough insights on the health history of employees can inform company hiring decisions. Overgeneralizations and a too simplistic usage of data may lead to biases that disproportionally disadvantage certain people or certain groups. This could ultimately lead to a less fair society.

With big data, comes great responsibility.

While the industry has already strict rules about anonymizing **personally identifiable information** (PII), this becomes even more important as much more data becomes available. Under the right conditions, interoperability between health systems hold enormous opportunities. As patients, many of us would be happy to pass on lots of our personal (anonymized) data if it can lead to more personalized care in combination with bettering healthcare for mankind as a whole. But **transparency** will be key. As an individual, can I trust my data to be safe?

TOWARDS MORE OPENNESS – 3 MORE CASES

There is no lack of data as such. But generating useful insights from the data remains challenging. Here are three more cases on how more openness can lead to healthcare benefits for all.

- **Epidemiological data** – better data capturing and more data sharing combined with predictive analytics can help to take measures to prevent or limit the impact of outbreaks.
- **Open data** – more and more healthcare data is open, but accessibility is still limited due to a lack of data standardization and hurdles to sharing it. The industry, however, continues to work on this, for example through initiatives like CDISC (Clinical Data Interchange Standards Consortium). Awareness around open data also continues to evolve, not in the least amongst publicly funded research institutes and universities.
- **Patient-generated health data** (PGHD) – more patients (and their caregivers) create, record and gather health-related data, such as biometric data, symptoms and lifestyle choices. This data helps to fill the information gaps, it supplements clinical data and it generates a more complete view on ongoing patient health.

"As more and more techniques become available to extract sensitive information for almost anyone who's regularly online, companies may need an additional CEO, a Chief Ethics Officer, to guarantee proper use of personal data."

Philippe Gosseye
Sr. Director HighTouch Marketing – EMEA, Dell EMC

15% to 60%

THE RANGE OF EFFICIENCY IMPROVEMENTS IN THE HEALTHCARE SECTOR THAT COULD BE REALIZED THROUGH MORE CONNECTED DATA. Source: Volterra Partners, 2014

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A CLOSER LOOK – DELL EMC CUSTOMER CASE
ST. CLOUD ORTHOPEDICS TACKLES CYBERTHREATS

1 **The situation** – St. Cloud Orthopedics is a leading provider of bone and joint care from Minnesota (US).

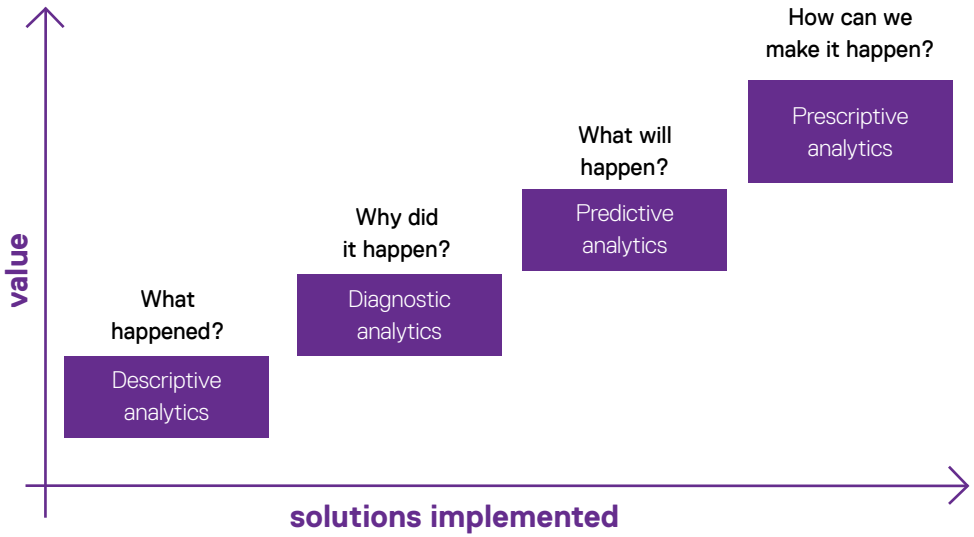
2 **The challenge** – After a ransomware attack at a partnering hospital, St. Cloud Orthopedics conducted a security audit. This yielded the recommendation to add an anti-malware solution to protect against advanced persistent threats (APT).

3 **The approach** – The focus was on protecting patients' data from cybercriminals, avoid becoming a victim of ransomware, comply with increasing regulations but, at the same, keep accessibility to data for staff high. St. Cloud Orthopedics implemented the Dell Data Protection | Endpoint Security Suite Enterprise. To better manage the insight and control over software on client devices, the Dell KACE K1000 Systems Management Appliance was installed as well.

4 **The result** – The clinic now manages 350 devices with Dell solutions that encrypt drives, protect against APTs, and automate endpoint management including event ticketing and software patches. Ransomware and other malware is now stopped before it can execute. Patients' health and credit card information is fully protected. Compliance with federal regulations is simplified while mobility for clinicians and other employees is facilitated.

IT employees now spend less time manually monitoring client devices, while they also have one, single tool for encryption, anti-malware and reporting.

Read the case study: i.dell.com/sites/doccontent/corporate/case-studies/en/Documents/2016-st-cloud-orthopedics-10022974-data-security-data-protection.pdf



Source: The analytics maturity model by Gartner

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"Our providers can work at the clinic or from home because we can allow client devices to leave our network and still stay HIPAA compliant with Dell data security solutions. If we are audited, we can prove all our devices are always encrypted and protected."

Jeff Duclos
IT Director of Network Administration, St. Cloud Orthopedics

Securing & protecting the healthcare organization

A key tenet of Digital Transformation is security and protection. Many health organizations and their IT departments are challenged to combine:

1. a **going concern** with
2. business and technological agility.

In other words: how to keep your operations going, in full safety and security, while also **innovating** on new business models and new technologies?

Increasingly, health organizations look at specialized suppliers to guarantee patient data safety, detect possible threats, safeguard IP, and more, while keeping data as accessible as possible through whatever device. No small feat by any account. For example, to protect their organization from security threats and the possible loss of critical customer data, a growing number of hospitals is now insured against hacking, cybercrime and extortion. There is a certain urgency, as care institutions carry an increasing amount of medical and patient data.

Better connected data moves the analytics needle. Therefore, improved descriptive information can enable more accurate diagnoses.

This holds the potential to impact the complete healthcare value chain. And this can greatly benefit the individual as well, who can now make better informed health decisions and play **a more proactive role i**n staying healthy or getting better.

This is where preventive care comes in.

KEY TAKEAWAYS ON PERSONAL & CLINICAL DATA

- More and more data is collected
- This is fuelled by the Internet-of-Medical-Things
- With this comes a stronger need for more data security
- More connected data can make every stakeholder within the health ecosystem a whole lot smarter

CHAPTER 3

Preventive care

Our societies are troubled by lifestyle diseases. We all live longer, but staying healthy remains challenging. To keep it all affordable, much is expected from the individual as well as from many other stakeholders in the healthcare ecosystem.

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ON PREVENTIVE CARE

Preventive care - often linked to lifestyle diseases (e.g. diabetes, obesity, alcohol and drug abuse, sedentary behaviours and physical activity, and nutrition) - consists of a wide series of actions and measures taken to

1. prevent chronic and acute diseases and
2. promote individual and community health.

It can be as diverse as

1. staying healthy by regularly working out and adopting healthy nutrition habits, to
2. closely monitoring existing conditions to prevent further escalation.

Healthy people = happy people.

The broad spectrum of disease prevention

Increasingly, individuals are considered the gatekeeper of their own health.

But each of us face personal and diverse challenges that limit the way we can offset future health issues. We do not control our own genes. We can only moderately control our environment. We even have only modest control over our lifestyle. Over-emphasizing individual responsibility poses risks of creating a less fair and less ethical society.

While companies are expected to operate ethically, often under a corporate social responsible umbrella (CSR), our meritocratic societies and cultures increasingly emphasize **ISR: individual social responsibility**. But such a is, in many cases, too limited and often neglects the social fabric of our societies, genetic dispositions and elements of pure chance and bad luck.

Much can be expected of individuals, and technology can definitely help many of us to manage our health even better.

But health cannot become the sole responsibility of the individual.

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GENOMICS ENGLAND

The **100,000 Genomes Project**, initiated by Genomics England, sequences 100,000 genomes from around 70,000 people. Participants are 1) patients with a rare disease (and their families) and 2) patients with cancer.

With around 160,000 cancer deaths a year and over 330,000 new cases reported a year in the UK alone, every advancement in this field is most welcome. Especially as these numbers are expected to rise due to the ageing population.

"Many more cancer types, including those for which there is hardly any successful current treatments such as lung cancer, could be helped if only we knew which gene changes were important."

Although rare diseases may seem less common, because there are so many of them (between 5,000 and 8,000), a staggering 3 million Brits are impacted. That amounts to 6 to 7% of the UK population or 1 in 17.

Read the blog:
emergingtechblog.emc.com/big-data-genome-project/

"Knowledge of the whole genome sequence may identify the cause of some rare diseases and help point the way to new treatments."

The 100,000 Genomes Project intends to speed up the diagnosis stage and, in time, enable the development of more precise treatments as well as personalized medicine.

Genomics England – made possible by the National Institute for Health Research, NHS England, Public Health England and Health Education England – uses a DELL EMC hybrid cloud platform for its large scale analytics. An Isilon data lake is used to collect all the data during genome sequencing. The Isilon data lake will store 17PB of data and make this available for multi-protocol analytics. Alongside this, 24 X-Bricks of all-flash XtremIO is in place to support virtualised applications. EMC's Data Domain and Networker are used to provide back-up services. The net result is a resilient infrastructure that supports massive scalable data storage with robust analytics.

Evidence based medicine 2.0

The modern healthcare profession has always been driven by evidence. But **evidence-based medicine (EBM) is expected to enter a new age once semantic bots are able to analyse all the available data automatically.** Much is expected from computer programs running through the ever-increasing mountains of data, not just from scientific literature and clinical reports, but from any relevant source available.

The combination of big data, text mining, artificial intelligence and machine learning, could potentially yield new insights that would be impossible for any individual or group of individuals to retrieve. These new insights could greatly help HCPs make better decisions for their patients.

"Evidence-based medicine (EBM) is the conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients. It means integrating individual clinical expertise with the best available external clinical evidence from systematic research."

David Sackett
Professor, NHS Research and Development Centre
for Evidence Based Medicine, Oxford

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A CLOSER LOOK – DELL EMC CUSTOMER CASE
UNIVERSITY OF IOWA HOSPITAL AND CLINICS

1 **The situation** – Surgeons at the University of Iowa Hospitals and Clinics needed to know if patients were susceptible to infections in order to make critical treatment decisions in the operating room. The infection rate impacts overall patient health and overall costs.

2 **The challenge** – Predict which patients have the biggest risk of surgical site infections, in order to reduce the infection rate, thus improving patient care and decreasing costs.

3 **The approach** – Historical EHR data was merged with live patient vital signs to predict infection likelihood. This provided doctors with real-time, predictive analytics during surgical procedures.

4 **The result** – By harnessing the power of big data analytics, the surgical team now makes better evidence-based decisions during surgical procedures. Surgeons are able to keep more patients safe. Surgical site infections decreased by 58%. The total cost of care decreased. Readmissions decreased by 40%.

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A CLOSER LOOK – DELL EMC CUSTOMER CASE BEIJING GENOME INSTITUTE (BGI)

1 **The situation** – The Beijing Genome Institute (BGI) is a leading company in biological research. Its high-performance computing (HPC) capabilities, however, ran against its limitations and the IT architecture, therefore, was quite complex.

2 **The challenge** – Upgrade the HPC, in order to 1) bring down the cost of sequencing, 2) make sequencing more widely accessible, 3) enhance the organization's biological research capabilities.

3 **The approach** – BGI adopted a Dell modular infrastructure to enhance its HPC platform for biological computing. Since using a more modular architecture, peak values of 288.5 teraflops (Tflops) have been achieved.

4 **The result** – BGI was able to develop the gene sequencing system, BGISEQ-500, a one-button sequencing technology that supports DNA sampling and delivers an analysis in just 24 hours. Precision of human genome testing has increased to **99.99%**. At the same time, the total cost of ownership (TCO) of the biological computing HPC platform diminished by **20%**. Since the inception, around 214 thesis articles have been published in international top-tier magazines, including Nature.

Budget control vs. personalized medicine

Logically, governments want to control healthcare expenditures. But this may be at odds with the personalized care paradigm. Although the cost of individual genome sequencing has dropped dramatically, **the reimbursement model for personalized medicine is, as yet, unclear.** Considering the controversy around the cost of some orphan drugs, we can expect a heated debate over this in the coming years. The costs of **treatment for a rare disease** for one single patient can quickly run as high as several tens of thousands of euros a year.

Personalized care and medicine may deliver far better results compared to the blockbuster drug model, but at what cost?

One approach could be to give personalized medicine a similar treatment as orphan drugs: additional subsidies and measures to grant quicker market authorization could help boost the development of personalized medicine. As technology continues to evolve, costs are expected to drop further as well, giving personalized medicine a further boost.

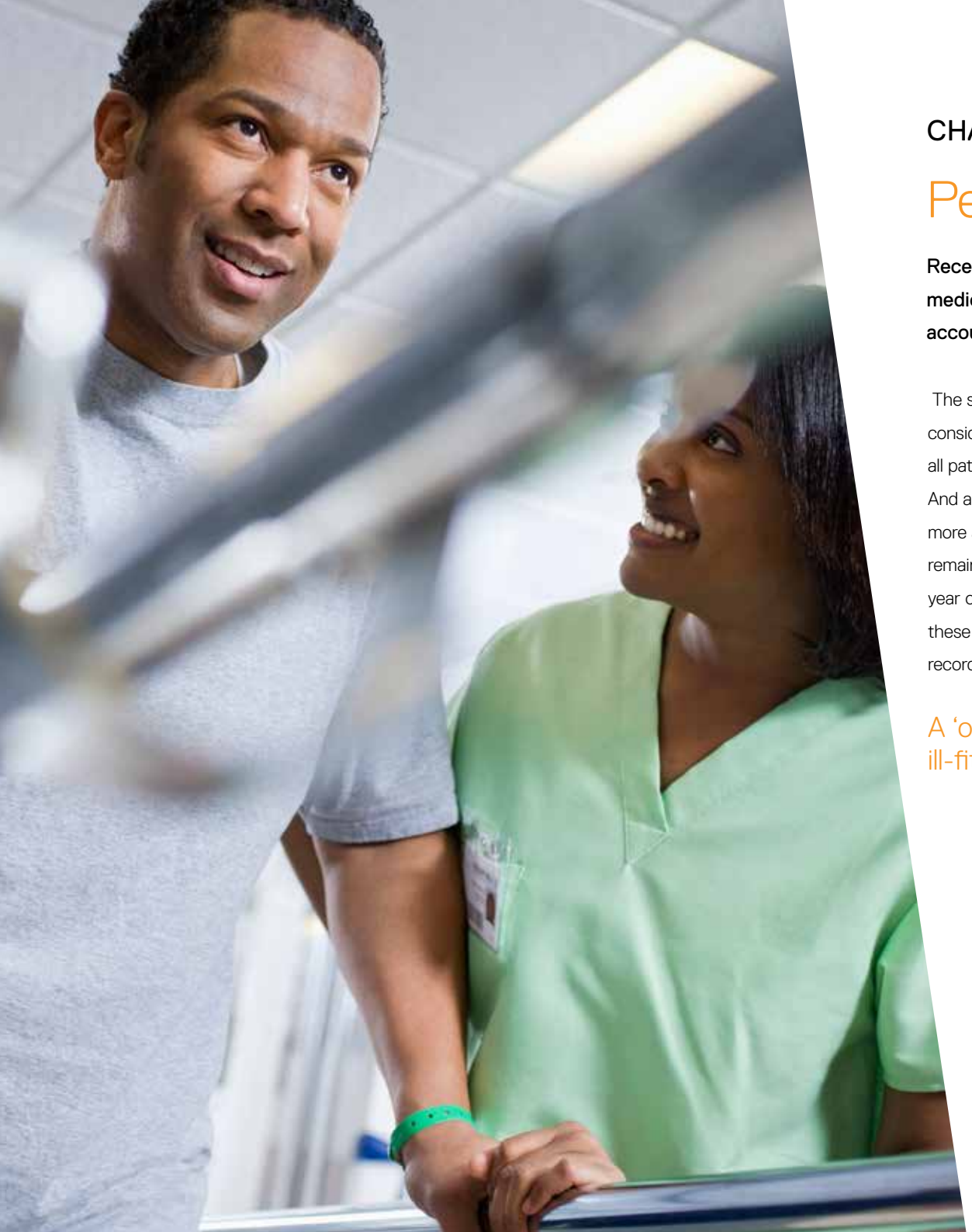
$127 billion

THE PROJECTED ORPHAN DRUG MARKET VALUE BY 2018. THIS WOULD ACCOUNT FOR 16% OF ALL PRESCRIPTION DRUG SALES. FOR MANY BIG PHARMA COMPANIES, ORPHAN DRUGS ARE KEY IN SURVIVING THE PATENT CLIFFS FOR THEIR BLOCKBUSTER DRUGS.

Source: fiercepharma.com

KEY TAKEAWAYS ON PREVENTIVE CARE

- Lifestyle diseases burden the healthcare budgets of governments
- Preventive care can create efficiency gains, but the responsibility of individuals can only be stretched so far
- As technology continues to evolve and *the cost for genomic sequencing decreases*, more becomes possible
- New reimbursement models are likely to gain ground as well and pave the way further



CHAPTER 4

Personalized care

Recent advancements in genome typing are making personalized care and medicine a reality. This can ultimately replace the old blockbuster drug model for an accountable care model.

The still dominant 'one-size-fits-all' approach is increasingly considered too limited. This blockbuster approach does not help all patients equally well and is, to some, even life-threatening. And although electronic health records are being implemented more and more, connecting all data and making sense of it, remains challenging to many. While the UK spends £1.2 billion a year on chemotherapy it is, in fact, unclear just how adequate these treatments are. The outcomes are simply too poorly recorded to make sensible statements about this!

A 'one-size-fits-all' approach is an ill-fit for many patients.

6%

... OF HOSPITAL ADMISSIONS IN THE UK ARE DUE TO ADVERSE REACTIONS TO DRUGS. ALSO, A GREAT MANY READMISSIONS COULD BE PREVENTED IF PATIENTS RECEIVED THE RIGHT KIND OF FOLLOW-UP.

Source: Sustaining universal healthcare in the UK: making better use of information. Volterra, 2014

"By 2020, the strategy of singlehandedly placing big bets on a few molecules, marketing them heavily and turning them into blockbusters will not suffice."

The 'Pharma 2020: Challenging business models' report, PricewaterhouseCoopers

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ON PRECISION MEDICINE

= "an emerging approach to disease management and prevention that takes in to account individual variability of genes, environment and lifestyle for each person. Precision medicine looks to move the needle from reactive medicine to proactive medicine. It's a clear move away from drugs and treatments for the broad population to a more precise, individualized treatment plan."

Source: InsideBIGDATA - Guide to Healthcare & Life Sciences, report

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ON PERSONALIZED CARE

Personalized care broadens the **personalized medicine** paradigm, and often starts from an individual's **genetic analysis**. Instead of targeting large groups with a one-size-fits-all approach, medical treatments are tailored to the specific needs of an individual patient.

The long-term ideal is to replace the traditional 'trial and error' approach towards large groups of patients with laser-sharp **precision medicine towards individual patients.**

Source: InsideBIGDATA - Guide to Healthcare & Life Sciences, report

30%

PATIENTS THAT FOLLOW A MORE PRECISE / MORE PERSONALIZED TREATMENT PLAN INDICATE TO EXPERIENCE 30% MORE IMPROVED WELLNESS PERIODS COMPARED TO PATIENTS ADHERING TO A NON-PRECISION MEDICINE TREATMENT.

Source: InsideBIGDATA - Guide to Healthcare & Life Sciences, report

Genomic sequencing

Technical improvements in **high-performance computing** (HPC) have dramatically accelerated genomic analysis. The newest HPC systems for genomics provide organizations of different sizes with a highly flexible, end-to-end solution that includes storage, networking and analysis capabilities that were before only attainable with a **supercomputer.**

*Genomic applications are typically **I/O or disk intensive**, rather than compute intensive. These applications often process large numbers of files (15–200GB in size) in a specific sequence. So from a genomic research perspective, what matters is how many genomes a solution can process in a day, and how many kilowatts are needed to process one genome.*

*Tests show that genomic workloads run faster on **HPC clusters** with denser, bare-metal architectures and that larger processors often remain underutilized during genomic analysis. As a result, solid HPC systems for genomics include numerous midsize processors as well as large amounts of memory so that researchers get the fast performance they need to support both I/O- and disk-intensive workloads.*

What to look for in a HPC system for genomics:

- High-speed processing
- Energy efficiency
- Reliability, flexibility and scalability
- Accelerated data transfers
- Plug-and-play versus customization options

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ON HIGH PERFORMANCE COMPUTING (HPC)

"The practice of aggregating computing power in a way that delivers much higher performance than one could get out of a typical desktop computer or workstation in order to solve large, complex problems in science, engineering or business."

Source: InsideHPC.com

Virtual care

An increasing part of personalized healthcare will be delivered virtually: patient and healthcare provider interaction will increasingly become **detached from the physical presence** and will in many cases be replaced by information and communication technologies. A trend which is fuelled by ...

- Ageing populations and demographic changes
- Increasing digital savviness of healthcare consumers
- Further digitization of healthcare in general
- Governmental efforts to reduce healthcare expenditures
- An ongoing shortage of skilled healthcare staff to manage all patients face-to-face.

Patients play a role in this by using **at-home-devices** as well as through ongoing data collection (e.g. through wearables and apps). Physicians and other care providers can set to work with the data collected and provide personalized advice through video-conferencing and telemedicine.
And although lots can be virtualized, at this stage, actual human interaction is still key in many instances.

Human interaction can't be reduced entirely to just bits and bytes.

But healthcare is expected to shift increasingly towards more virtual versus in-person care.
To make that happen healthcare will have to become increasingly integrated and collaborative, both from a human and a technology point of view.

400 +

THE NUMBER OF NEW HOSPITALS BUILT IN CHINA EVERY YEAR.

Source: economist.com

12.9 million

THE WHO EXPECTS THERE TO BE A SHORTAGE OF 12.9 MILLION CLINICIANS BY 2025.

Source: WHO

5.4 million

MARKET RESEARCH FIRM IHS MARKIT ESTIMATES THAT GPs WILL CONDUCT AROUND 5.4 MILLION VIDEO CONSULTATIONS A YEAR BY 2020.

85%

UK-BASED BABYLON HEALTH – A START-UP THAT DEVELOPED A CHATBOT THAT MIXES ARTIFICIAL INTELLIGENCE (AI) AND VIDEO AND TEXT CONSULTATIONS WITH DOCTORS AND SPECIALISTS – RECKONS THAT 85% OF CONSULTATIONS DON'T HAVE TO BE IN PERSON.

?

DID YOU KNOW THAT...

... Philips has developed **a mobile ultrasound scanner**, called Lumify? With Lumify, high-quality portable ultrasound is available almost anywhere. Healthcare professionals can subscribe to it, download the Lumify app and plug the transducer into their smartphone or tablet. Scans are immediately shown on the HCP's mobile device. Faster diagnosis now becomes possible at the point-of-care.

10%

... OF CARE IN WESTERN EUROPE WILL BE DELIVERED VIRTUALLY.

Source: Gartner, Transforming Care Delivery Through the Use of Virtual Care and Telemedicine, 2016

"We provide a virtual clinic between 5 p.m. and 8 p.m. using Lync. So if a family is having an issue with a baby crying or not eating, they can quickly contact one of our team for support."

Jim Barwick
Executive Director of Transformation,
Locala Community Partnerships

DELL EMC

A CLOSER LOOK – DELL EMC CUSTOMER CASE
LOCALA COMMUNITY PARTNERSHIPS, UK

1 **The situation** – Locala Community Partnerships provides healthcare services such as district nursing, health visiting, school nursing and community dentistry in and around Kirklees in West Yorkshire. Clinicians on the move could call up patient records, but not much more. They had to make multiple trips to their offices to access other healthcare-related documents.

2 **The challenge** – Locala wanted to integrate technology more deeply into the provision of healthcare services. Key goals were

1. boosting caregiver access to real-time patient data while being active in the field,

2. provide better services to patients and

3. concentrate home visits where they are most needed.

3 **The approach** – Locala and DellEMC co-created a private cloud environment that keeps patient and healthcare data highly accessible and secure at all times. The solution was based on Dell PowerEdge servers, Dell PowerVault storage, Dell Networking switches and Dell SonicWALL firewall technology. With Microsoft® Lync™, staff can now make use of web and video conferencing on their client devices.

All in all, the solution combined cloud computing and services, mobile computing, unified communications and managed services (a single service desk from Dell).

4 **The result** – The overall service towards the patients has drastically improved because:

- Personnel at Locala now have constant, real-time access to clinical records and related patient data.
- Residents can register their interest for e-consultations and speak to a GP via Lync at times when the clinics are closed.

Some quantifiable effects:

- Patient-facing time has increased by 5%.
- Virtual contact is set to rise by 20%.
- Staff efficiency gains have helped to lower costs by 5%.

DELL EMC

A CLOSER LOOK – DELL EMC CUSTOMER CASE
TGEN'S CENTER FOR RARE CHILDHOOD DISORDERS

1 **The situation** – TGen's Center for Rare Childhood Disorders (C4RCD) harnesses the latest technological leaps in genome sequencing to pinpoint the causes of rare childhood disorders that largely remain a mystery to modern medicine. Often, there are just a few children, or even a single child, with a particular set of symptoms. However, according to the National Institutes of Health, there are close to 7,000 rare diseases and about 25 million people in the U.S. have one. Children that enrol in the C4RCD are clinically evaluated and have their genome tested, including the use of whole genome sequencing, spelling out the entire 3 billion letters of each individual's DNA genetic code. A single genome measures up to 4 terabytes, and sequencing that genome could take weeks to complete.

Every day, TGen bioinformaticians, geneticists and clinicians perform genetic sequencing in an effort to identify diseases and help more people survive them. To accurately diagnose disorders, TGen needs the right high-performance computing (HPC) systems to quickly run extremely complex algorithms that analyse multiple terabytes of genetic and molecular data on a patient.

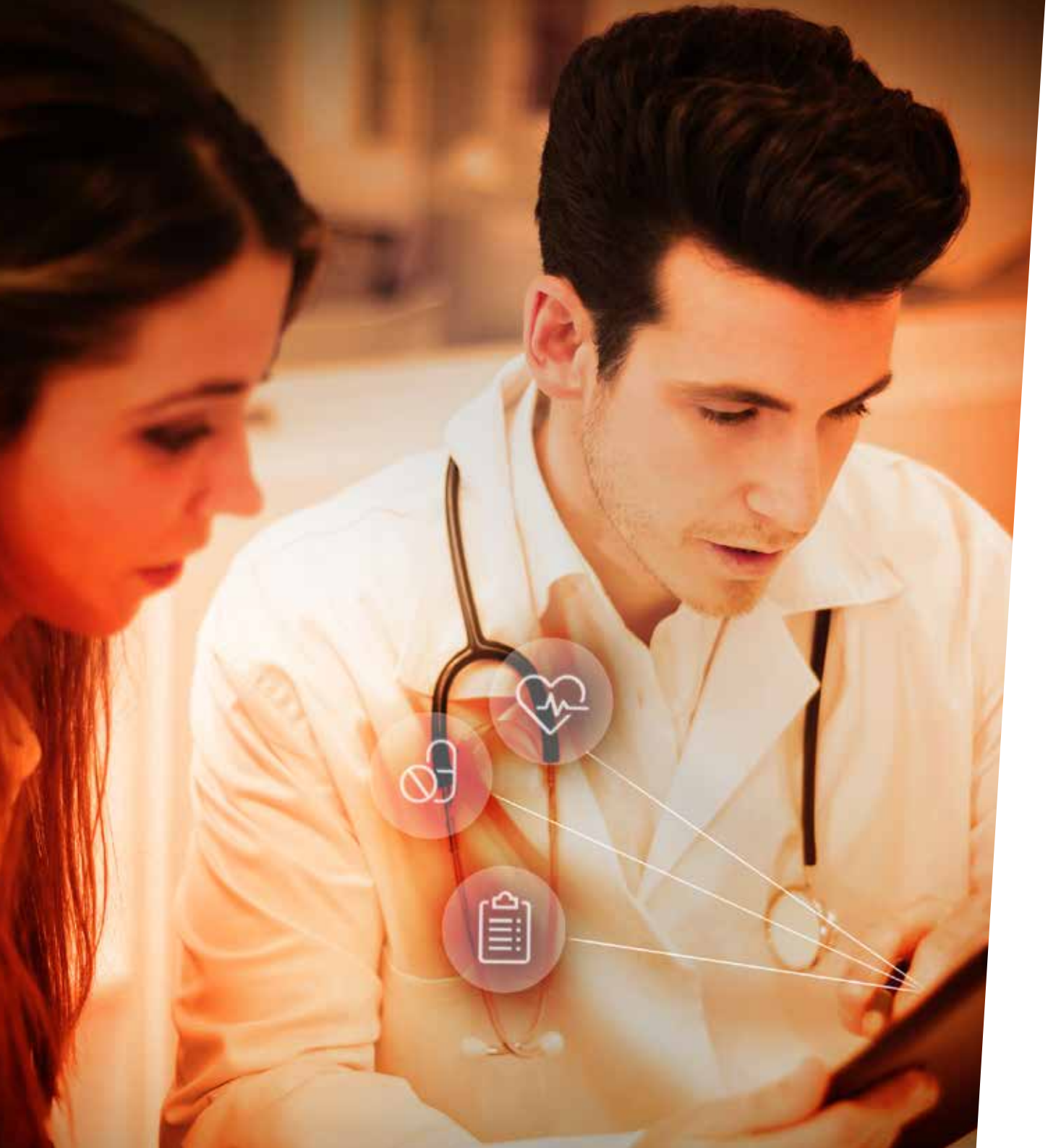
2 **The challenge** – Speed up the discovery of gene mutations by using a faster, more powerful technology platform for genetic sequencing.

3 **The approach** – The Dell EMC Genomic Data Analysis Platform was installed.

4 **The result** – Both the volume and speed of research have increased dramatically. **1 million CPU hours per month** are now logged on the cluster. As a result, scientists and doctors can come to conclusions faster by processing more data in a shorter time frame. TGen researchers are now able to develop custom treatments at least **one week faster** than before. For example, conventional genome mapping for a personalized treatment for neuroblastoma can take up to 6 months. With DellEMC's Genomic Data Analysis Platform, this period was reduced to **less than 4 hours.**

KEY TAKEAWAYS ON PERSONALIZED CARE

- A one-size-fits-all approach is losing ground
- Genomic sequencing is democratized thanks to technological advancements, bringing the personal genomic ID within reach of many more people
- Care is expected to become more virtual: fuelled by staff shortages and increases in digital savviness from HCPs and patients alike



CHAPTER 5

A holistic view

Much can be gained from connecting many more stakeholders throughout the healthcare ecosystem. Nonetheless, some big hurdles still have to be overcome to fully reap the benefits.

Imagine an electronic health record (EHR) that continually keeps track of your health. That collects data from your smartphone, wearables and, at some point in the future, implanted body sensors. A health record that starts from your unique genomic composition and that is refined as you walk through life.

Consider the possibilities if this health record would be connected to a centralized system that enables healthcare providers to monitor your health. A record that you, as an individual, can access as well. From which you can decide to share your anonymized data with other organisations (pharma companies, universities, etc.) to advance our understanding of human health.

Envisage this for millions of people worldwide, combined with the computing power needed to make sense of it all. In such a world, our understanding of our own health and of human health in general would multiply manifold.

We're on the right track

Before we get there, there's much we still need to achieve. But the building blocks being laid now, already offer a glimpse of things to come. Our first steps towards a more holistic view is already delivering benefits in the fields of...

- **Prevention, risk reduction and lifestyle changes.** Connected data can help identify possible risky behaviour and smart technologies can suggest (or nudge us towards) healthier lifestyle choices.
- **Early diagnosis.** By continually capturing more data, health problems can be identified sooner, in some cases, even before symptoms are experienced. Treatments can be initiated sooner, which would be beneficial not only for the individual patient, but also to the overall healthcare budget.
- **Treatment outcomes.** Smarter data analytics can greatly improve the treatment outcomes for patients. More connected data from across the complete healthcare landscape could help physicians to make better diagnoses and prescribe more personalized treatments with better outcomes.

$136billion

THE PROJECTED IOT HEALTHCARE MARKET VALUE BY 2021.

Source: World Internet of Things (IoT) Healthcare Market – Opportunities and Forecasts, 2014-2021, by Allied Market Research

The impact of connected data

More connected data initiates a whole series of related events.

Connected data reduces administration time and improves **healthcare staff efficiency** → it reduces the time needed to find patient records → it frees up time that can be used to provide higher quality care to patients or see more patients.

Adherence improvements → patients can be better informed about when to take their medicine → HCPs gain more insights on the actual adherence to treatments → studies have shown time and again that improved adherence has a major impact on the total cost of healthcare expenditures.

Improved treatment outcomes → connected data can lead to more accurate diagnoses → better integrated and more holistic treatment models become possible → more effective programmes lead to more patients receiving better treatment.

Beyond medicine

Healthcare is increasingly expected to move beyond the treatment. Just like R&D is expected to move beyond the lab and the hospital is expected to move beyond its secondary or tertiary care role.

As data becomes more intertwined, so too will the roles across the complete value chain become more intertwined.

The pharma industry is making some headway here. 'Business model' and 'open innovation' have been on its agenda for many years now. Many in the industry are moving away from the fully integrated model (e.g. the pharma company doing everything itself) towards other, more federated or virtual models (get some – sometimes even the majority of activities – done by others). The outsourcing model stretches far, from research and development to marketing and beyond.

The general premise being that 'do it all yourself' is no longer viable in today's competitive market.

Collaboration with others is needed to make the move away from purely producing medicines to managing outcomes. And the economic rationale for doing so is sane.

Source: The 'Pharma 2020: Challenging business models' report, PricewaterhouseCoopers

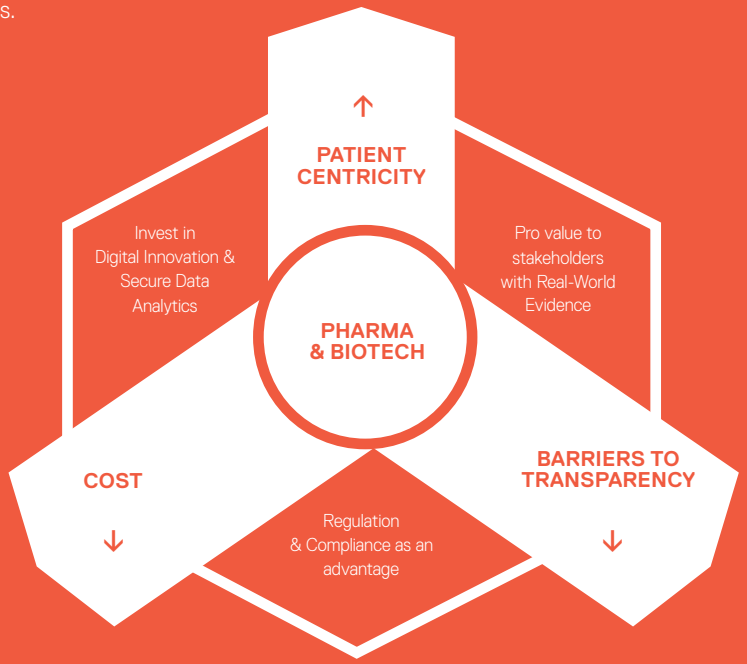
"Collaboration becomes the key theme in 2017 – collaboration within the health-care ecosystem, with patients, or internally."

Deloitte, Perspectives – Life Sciences Industry Outlook 2017

5 RESEARCH IMPERATIVES

From a research and development point of view, pharma companies – and especially their scientific staff and data scientists – face five imperatives to boost efficiencies, reduce costs and innovate faster:

1. Fail fast in R&D → it's better to generate insightful results from a fast failure then to continue down a losing street.
2. Access quality data → to improve decision-making, the most accurate, recent and complete data is crucial at all times.
3. Meet compliancy requirements → be sure to meet the FDA and EMA compliancy standards.
4. Reconcile lab and real-world performance → make sure to quickly detect anomalies and differences between lab and real-world outcomes in drug trials.
5. Real-time analysis → crunch vast sets of data in real time and be able to generate meaningful insights from this.



Breaking down silos

Management of data continues to give many a headache.

Poor integration and sharing of data and unsynchronized internal and external data flows persist in the industry.

Data stays stuck within silos. Only a limited number of people can access it. Different systems use different logics and ontologies. Data quality and provenance is often questionable. Data is not linked making comparing and collating of data extremely difficult and cumbersome. Legacy hardware and software create an inefficient mix. The challenges are many.

But technology can provide answers here. Data lakes or **federated search technologies** can bring together data. Semantic search and other big data technologies can make sense of the vast mountains of (un-)structured data.

Combined, these technologies can augment the human element. After all...

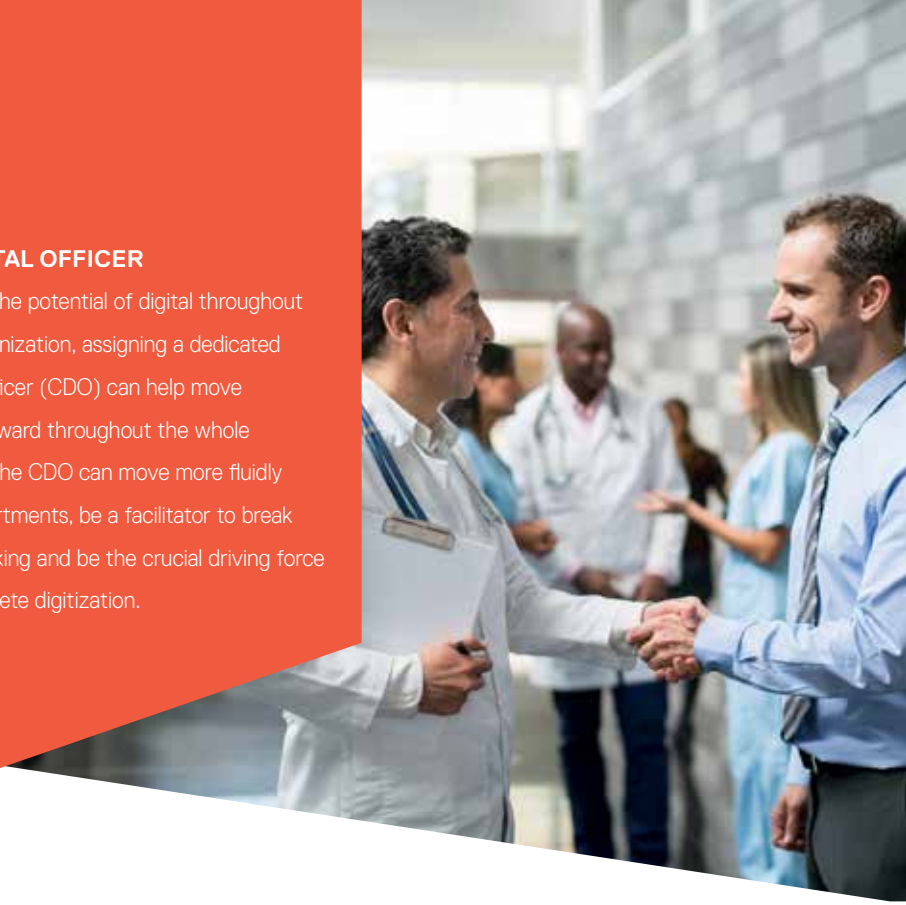
our abilities as humans to process data and make sense of it are limited.

So, in conclusion, digitization touches every part of the healthcare continuum. It's crucial to create synergy between all domains. Breaking down the data silos extends well beyond technological boundaries. Last but not least: redefining the roles and responsibilities of all those involved is equally important.

In an ideal world, a connected data system that can generate findings based on real-world data upon which strong partnerships with the industry, physicians, payers and patients can be built. This type of deep analytics will ultimately also play its part in the sales and marketing process.

CHIEF DIGITAL OFFICER

To fully grasp the potential of digital throughout the entire organization, assigning a dedicated chief digital officer (CDO) can help move digitization forward throughout the whole organization. The CDO can move more fluidly between departments, be a facilitator to break down silo-thinking and be the crucial driving force towards complete digitization.



264

THE NUMBER OF SCHOLARLY ARTICLES US SCIENTISTS AND SOCIAL SCIENTISTS READ PER YEAR (= 22 PER MONTH). AVERAGE READING TIME HAS PLATEAUED AT AROUND 30 MINUTES PER ARTICLE.

Source: Nature.com

1.8 million

THERE ARE AROUND 28,100 PEER-REVIEWED JOURNALS WORLDWIDE WHICH, BETWEEN THEM, PUBLISH AROUND 1.7 TO 1.8 MILLION ARTICLES A YEAR.

Source: stm-assoc.org

DELL EMC

A CLOSER LOOK – DELL EMC CUSTOMER CASE
ROYAL VICTORIA REGIONAL HEALTH CENTRE UPGRADES

1 **The situation** – Located in central Ontario (CA), north of Toronto, Royal Victoria Regional Health Centre (RVH) provides highly responsive healthcare to more than 450,000 residents across a large geographical area. RVH's team has more than 380 physicians and 2,500 staff members.

2 **The challenge** – The organisation needed to improve its health information system. Ultimately, the physicians and staff of RVH identified three key challenges:

- Create a consolidated view – To deliver patient care more efficiently, all data should be brought together in a single view for physicians and clinicians.
- Manage growing data volumes – The system must be able to keep up with the enormous increases in data and achieve exceptional performance to make the information readily accessible to those who require it.
- Eliminate costly migrations – A new platform must accommodate changing technologies over the long term, so that RVH can grow with the system and eliminate the need for expensive migrations on a regular basis.

3 **The approach** – RVH chose Dell EMC XtremIO for an always-on, in-line data optimization architecture. Data is now optimally compressed and deduplicated. Dell EMC Connectrix network switches guarantee maximum performance and scalability. RVH also relies on Dell EMC Data Domain DD4200 with Data Domain Boost for assured backup and recovery of its critical patient and business operations data.

4 **The result** –

The overall service towards the patients has drastically improved because:

- 60% to 80% performance gains on various applications and processes.
- Responses to complex queries reduced from 3–5 seconds to 1–2 seconds.
- Daily data repository runs now require just two hours, rather than taking more than a full 24-hour cycle as it had been before.
- The time needed to run reports has been reduced from as much as eight hours before to as little as 15 minutes now. RVH's analytics team is able to perform more data mining of the MEDITECH EHR and can run more frequent reports.
- Backup times have been reduced from eight hours to less than two hours daily.
- Security is enhanced thanks to flash backup copies of data.

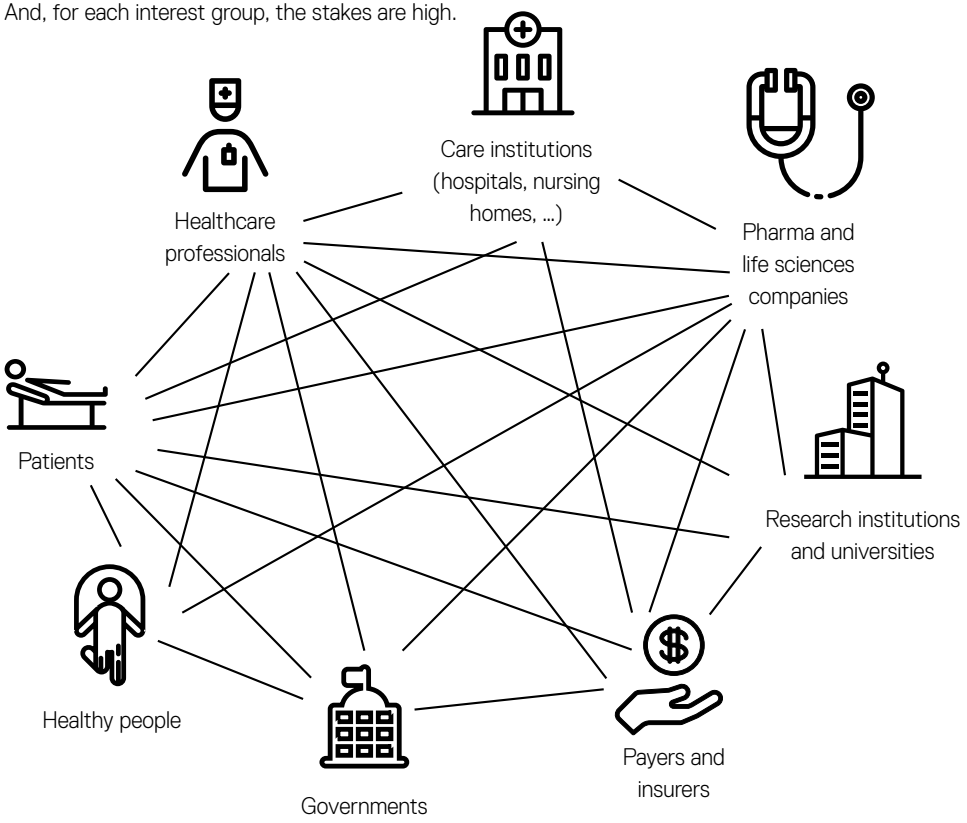
"Caring for patients is a 24x7 business. Any moment where our system is not available has the potential to impact patient care."

Pat Harkins
CTO – Informatics and Technology Services, Royal Victoria Regional Health Centre

THE CONNECTED CARE ECO-SYSTEM

Few industries have so many different directly involved stakeholders.

And, for each interest group, the stakes are high.



CONNECTED HEALTH

Connect health is a web of intelligent communication and actionable information sharing with the intention of improving patient outcomes. It is enabled by a fabric of technology, in which people, processes and devices are all capable of working together.

Source: Dell – Connected Health | The path to better, more integrated care and health outcomes, white paper, 2016

The patient centricity paradigm

The life sciences industry has been typified by a product-centric paradigm, but this is now changing. Many of the aforementioned evolutions also impact how the industry approaches its ultimate end-customer: the patient.

The **patient centricity paradigm** has been on the radar for some time now. But, increasingly, patients demand this themselves. Today's impatient patient no longer sits idle. Nor does (s)he blindly accept the judgement of a healthcare professional. From GP to specialist, doctors are confronted with **empowered and knowledgeable patients**, often forcing them to better explain and substantiate treatment decisions.

Herein lie opportunities as well. The empowered patient, yearning for a more personalized approach, may also be willing to switch tactics to improve their (electronic) health record and grant more healthcare professionals better access to their data. **Wearables and health apps** can help to create a more complete 360° view on a specific patient while, at the same time, stimulating stronger adherence to treatments.

"It doesn't take an instant more, or cost a penny more, to be empathetic than it does to be indifferent."

Brian Lee
CEO Custom Learning Systems

TO CONCLUDE

Connected care

Smarter data improves the health of every individual on Earth. It makes all of us smarter about our own health while also yielding innovative new insights that, before, lay hidden somewhere in the massive piles of data we create daily.

Connected data holds the promise of a healthier life for all.

Let's now make it real with Dell EMC Digital Transformation.

KEY TAKEAWAYS ON THE HOLISTIC VIEW

- We hold the keys to be healthier than ever
- But there are still a lot of hurdles to overcome and silos to break down before we reach Connected Care bliss
- As an industry, we are already making headway in connecting the many stakeholders within the healthcare ecosystem
- All these paths are leading towards a new patient centricity paradigm
- Dell EMC is focused on enabling the Healthcare and Life Sciences Industry with end-to-end transformative technologies.

ABOUT **DELL**EMC

Dell EMC Health Care & Life Sciences solutions offer **pragmatic innovation** that addresses your toughest challenges. We bring players to the table with long-time healthcare and IT backgrounds. We assess your needs and opportunities and make solid recommendations designed to meet your specific business outcomes. And we know how to integrate our ideas into your current IT environment, connecting all applications and technologies required for a single solution deployment or an entire infrastructure build.

Let Dell EMC help realise your digital transformation

At the core we help you do more by transforming your IT platforms. We then surround this flexible, dynamic IT environment with streamlined processes and strategies that empower people to integrate Health IT into their daily routines for the betterment of care delivery. This approach builds the foundation for a healthcare system in which information is easily stored, analysed and shared. It also helps systematically reclaim resources from maintenance tasks and inefficient processes in order to fund much-needed innovation.

Rely on us, as a technology leader in healthcare—we've got the expertise and experience of dealing with small to large healthcare providers and life science organizations. Our leadership can be seen in some of the biggest and largest growth categories in the IT infrastructure business—converged infrastructure, storage, virtualized datacentres, secure laptops, cloud infrastructure and virtualization.

So where technology is concerned, we're clearly playing to win.

Dell EMC leadership in HCLS

1st
... FDA-approved, personalized medicine clinical trial for paediatric cancer

50%
... of US hospitals are using Dell desktops or laptops

7 of 10
... pharmaceutical companies are Dell EMC customers

41%
... of US hospitals use Dell EMC servers

+66%
... of US hospitals are Dell EMC customers

+6K
... hospitals worldwide work with Dell EMC

160B
... network security events processed daily by Dell SecureWorks

49%
... of storage infrastructure in US hospitals is run on Dell EMC

Health IT Transformation

Clinical Application Optimization

Advanced Medical Imaging

Healthcare Hybrid Cloud

Converged Infrastructure

Interoperability Solutions

ISV Solutions

Precision Medicine Transformation

Predictive Health Analytics

Population Health Management

High-performance Computing

Genomics and Life Sciences

Clinical Research Architecture

Connected Health Transformation

Patient Engagement

Innovative and Specialized Devices

Healthcare IoT

Telehealth

Enterprise Content Management

Virtual End-user compute (VDI)

Security Transformation

Advanced Data Protection

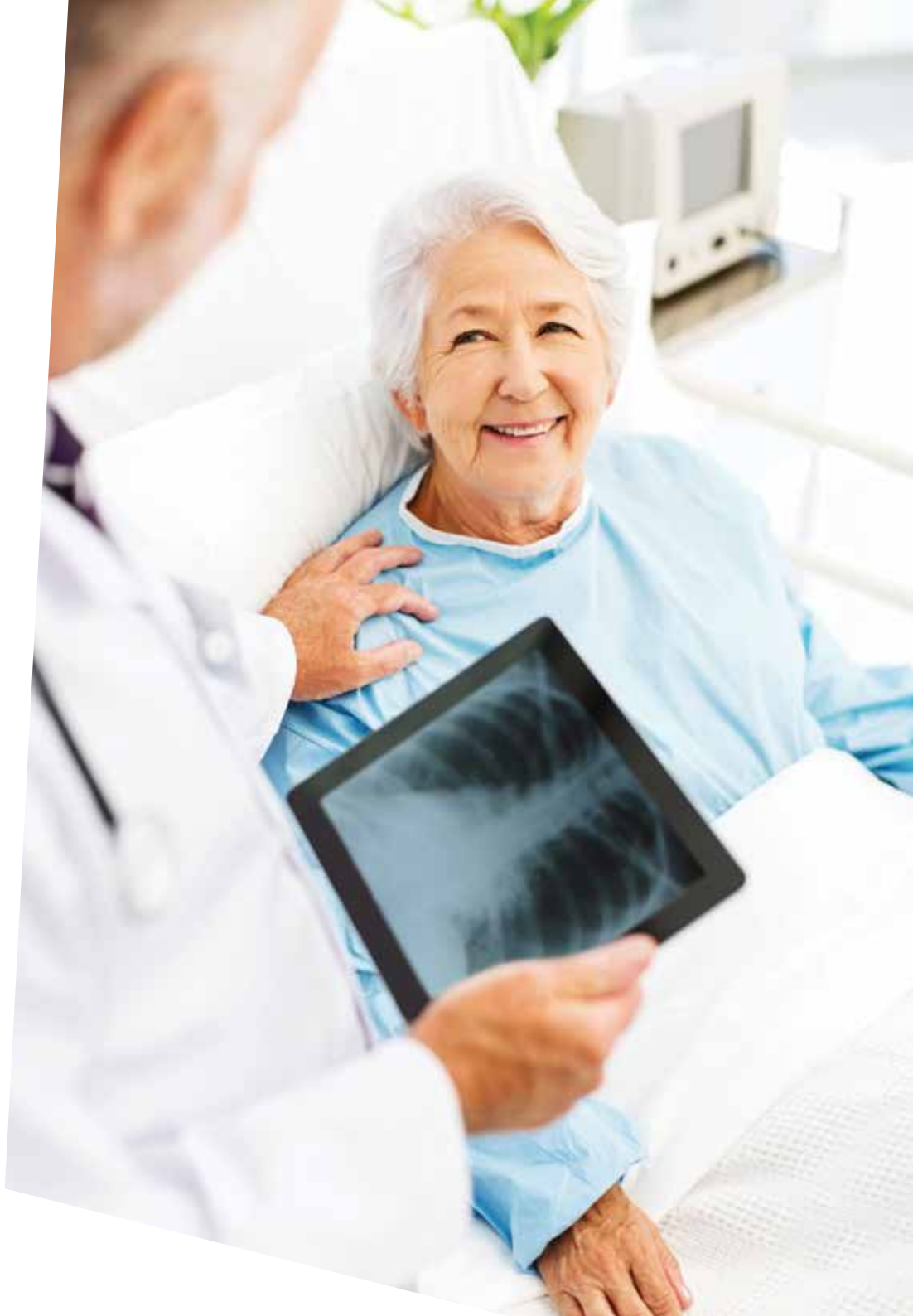
Endpoint security and encryption

Network monitoring and Response

Authentication and Access Control

Governance Risk Compliance

Managed Security Services



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