
Digital Vision for Health

Global opinion paper - March 2019

Trusted partner for your **Digital Journey**



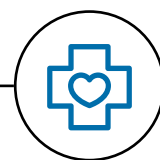
Atos

Atos Digital Vision series aims to provide a thoughtful and informed view of the opportunities brought about by digital services. It demonstrates how these opportunities are being harnessed by governments, markets and businesses to help deliver innovative solutions that benefit their customers and citizens, today and into the future. This opinion paper features contributions from Atos global experts and from leading thinkers from other major industry organizations and leadership bodies.



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Foreword: toward predictive and personalized care



Thierry Breton
Atos Chairman & CEO

Today's healthcare ecosystem is facing disruptive changes. The prospect of innovation has never been so bright, with new technologies such as immunotherapy and genomics promising to revolutionize medicine and life extending therapies.

At the same time, exploding MedTech costs and demographics trends have put the sustainability of healthcare systems at risk like never before.

New technologies are changing the game today and providing answers to these challenges. The theme of tomorrow's healthcare will move toward population health and precision medicine. This not only creates multiple opportunities but also means all stakeholders need to fundamentally rethink the way they interact with patients, conduct their operations, structure their business models and guarantee medical safety and compliance.

To step forward to a predictive, preventive, personalized, participatory care, it is essential to transform the siloed structure and enhance the interaction with patients using an end-to-end approach.

At Atos, we leverage current disruptive technologies to design and operate digital healthcare platforms to provide better outcomes for patients, clinicians, and society.



Ruud van der Loo
Vice President Global Healthcare, Atos

Half the children born in 2019 will live to 100. Longer life means increases in chronic conditions, healthcare costs and complex quality of life.

I'm optimistic digital technologies will bring exciting healthcare breakthroughs, such as genomics revealing the risk of developing diseases, robotics, simulation and augmented reality training surgeons or even delivering care.

Digital healthcare transformation is facing three shockwaves:

1. Rationalizing and streamlining existing systems.
2. Interconnecting and increasing collaboration between ecosystem players through collaboration, telemedicine and virtual care solutions.
3. Leveraging advances in genomics analysis and HPC to enable precision medicine.

The real revolution will come from combining existing and new data to improve patient services and increase people and patients' engagement in their healthcare. To succeed, healthcare players must seamlessly integrate, orchestrate and manage new technologies to accelerate time-to-value while reducing digital healthcare transformation costs and risks.



 **>65%**

healthcare facilities will be accessible by mobile in 2019

 **x4**

specialty drug costs will quadruple by 2020

 **22%**

of OECD GDP may be dedicated to Healthcare in 2020

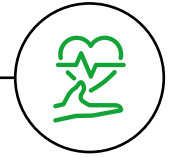
 **5 years**

should be added to life expectancy in the next 10 years

Real-time clinical delivery & electronic health records

Transforming legacy healthcare IT systems to open communities of Health. Integrating technologies between healthcare facilities to improve staff, patient and visitor experience.





The digital mission for healthcare: value-based care

Healthcare costs continue to rise, far outpacing the growth of both national economies and household incomes, representing 18% GDP in advanced countries such as the US & with a growth trend toward more than 22% in 2020. It is one of the biggest challenges of our lifetime.

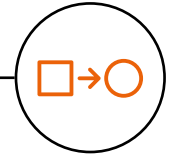
In many countries worldwide, health provision is one of the most dominant and polarising political conversations. How to pay, who will pay and how to future-proof care is front and center of discussion and politics across the world.

Although at times controversial, a value-based health care (VBHC) approach is essential—one that organizes healthcare systems around a more encompassing metric. The goal of VBHC is not to minimize costs but to maximize “value”, defined as patient outcomes divided by costs (Porter 2006). In the struggle to manage health care costs, clinicians and policy makers are increasingly focused on value-based care. Leading health systems worldwide are documenting variations in health outcomes and in clinical practice, which allows clinicians to identify best practices and steer resources toward the clinical interventions that achieve the best results.

Value-based health care delivers higher-quality patient outcomes at the same or lower total cost for a given condition. Important steps in the process include a detailed analysis of existing outcomes data; identification of best practices; and the widespread dissemination of those practices to reduce variations in clinical practice and improve overall health outcomes.

In the process difficult decisions often need to be made about types of care and pharmaceuticals that can be offered, which is why a detailed, scientific, evidence-based approach is essential.

This is where the digital health industry can make a vital contribution. In its pursuit of quality over quantity, value-based health care relies heavily on data and data analytics, and while healthcare providers can generate an enormous amount of raw data, they are ill-equipped to marshal that data in all of the ways that a value-based health care system demands. Companies in the digital health space, by contrast, are so equipped; they are able to fill this gap by gathering volumes of information from disparate sources, aggregating it, and meaningfully analysing it in order to generate the clinical, quality and payment insights required to foster the growth of value-based health care.



Digital dilemmas in healthcare

The digital transformation in healthcare is influencing every aspect of care delivery- from the bench to the bedside and into homes. Technology continues to be an important enabler across the entire spectrum of healthcare spanning genomics, clinical guidelines and social determinants of health. The intersection of healthcare and technology will play a central role in driving the value of health globally.

The digital transformation in healthcare is influencing every aspect of care delivery - from the bench to the bedside and into the homes of healthcare consumers. Technology continues to be an important enabler across the entire spectrum of healthcare spanning genomics, clinical guidelines and social determinants of health. The intersection of healthcare and technology will play a central role in driving the value of health globally.

Today, artificial intelligence is being utilized to improve diagnoses, treatments and care management. This progress enables better insights around the role technology can play in improving health and longevity.

While we understand the potential value this technology can bring, it brings significant disruption to current healthcare processes and must be thoughtfully integrated and maintained over time. Acknowledging these challenges and tensions allows us to plan for both the value and challenges of technology in healthcare.

As we consider the next decade of digital transformation, we can imagine the value of quantum simulation for personalized medicine. This replaces 'one-size-fits-all' medicine with an approach that is much more targeted to individual patients. The intersection of these two disciplines- quantum simulation and personalized medicine- could dramatically increase longevity and quality of life. Yet, the ethical, biological and technical considerations must be carefully weighed and will create barriers to achieving the ultimate goal- improved health.

The success of precision medicine is strongly dependent on the ability to turn data into clinical insights. This data spans electronic health records, medical imaging, laboratory tests encompassing genomics profiling, pharmacy, administrative data, sensors, wearable devices, and more. We must consider the many forces at work as we push for this innovation and progress around personalized medicine.

Both today and into the future, digital transformation will drive innovation, insights, and disruption in healthcare, but our charge is to ensure it drives the value of health globally.

Creating a truly paperless hospital

Many organizations have an aspiration to become paperless. There are huge benefits – for the environment, for efficiency and, of course, for service users themselves. While healthcare services need to be delivered cost-effectively, becoming paperless is much more than that. It's about delivering better care in the face of complex demands, enhancing the patient experience, and improving day-to-day working for hospital staff.

Rising demand

Whilst the technology already exists for hospitals to become paperless, making the vision a reality has been a complex challenge for many. Yet today there are reasons to believe that hospitals are now on the way to becoming paperless.

- There is user demand. Increasingly, patients want to book appointments and communicate with clinicians using digital tools.
- There's also growing appetite among clinicians – especially digital natives.
- With wearables, analytics and other digital solutions, hospitals can achieve so much more proactive patient management, reducing hospital admissions and lengths of stay.
- As cyberthreats evolve, safeguarding patient data with modern, secure systems is high on hospitals' agendas.

So, what's next on the journey to paperless hospitals?

Insights from Marina Salud Hospital

Exploring the question with Vicent Moncho Mas, Chief Information Officer at Marina Salud [1] in Spain - the hospital leading Europe in the paperless hospital quest - for which we provide the IT infrastructure, he talked through the transformation programme that the hospital has implemented to become paperless.

Marina Salud had the benefit of opening a new hospital in 2009. Leadership commitment from day one was to be paperless wherever possible, with a plan to eliminate all paper over time. Now, the only papers are consent forms, which we are now helping to digitize using digital patient signatures. Vicent talked through the hospital's journey:

- The road to defining requirements for different specialities,
- Progressing with an integrated solution across primary and secondary care,

- Achieving process standardization,
- And delivering change in an agile way.

Implementation included a network of 'super-user' nurses in the early stage, then a transformation office with a support center for clinicians, and now a series of truly agile projects.

Key milestones were:

- The adoption of Electronic Medical Records as a central pillar;
- Establishing and embedding the nursing workflow electronically;
- And the use of templates for clinicians on the electronic health records to speed up progress.

Key lessons

The learning from Marina Salud? Firstly, a paperless hospital is achievable. I also took away the huge importance of clinical buy-in and the hospital's effectiveness in achieving this, the vital role of collaboration to understand requirements and get the right training in place, and the critical part that strong leadership and a clear vision played in the hospital's success.

So, where are the main focus for hospitals now?

Collaboration, investment and buy-in

There's now a critical need to share learning and solutions between hospitals who are all on the same journey – supported by ongoing investment in core IT infrastructure and inter-operability so that technologies can function optimally. Success also depends on strong clinical, technical and operational leadership in combination; like any other digital change, becoming paperless is less about technology and much more about gaining buy-in and managing the change in high-pressure, fast-moving hospital environments.



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The reality is that paper is proven to introduce major potential for risk, delays and inefficiencies. Becoming paperless demands significant cultural and organizational change, but it is vital for modern and effective healthcare services.

Elaine Bennett,
Head of health, business and platform solutions, Atos UK&I

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Electronic health records: adoption or implementation?

The benefits for patients and clinicians of introducing electronic health records (EHR) into healthcare organizations are now well acknowledged. Having ready access to complete, accurate and up-to-date patient information can make major contributions to improving patient safety and quality of care while increasing efficiency and improving day-to-day workflow.

Yet, while many organizations prepare thoroughly to make sure these systems are introduced on time and to budget, once the go-live date has passed, there is less focus on gaining full value from the functionality they offer. In short, when it comes to EHR, too many organizations focus solely on implementing new software and fail to ensure that the benefits are fully delivered.

Without sufficient effort post-go-live, the value of EHR systems and any subsequent upgrades may be eroded over time. For example, if user training and adoption are not sustained, existing users may fall back on workarounds and ineffective workflows and new users may receive insufficient training.

In many ways, the real effort only begins at go-live; processes to ensure long-term adoption require a very different set of disciplines to launch. What's needed is a plan for how changes and improvements will be sustained.

An EHR sustainment plan must address two important areas.

- How the organization will support end users' ongoing needs, including communication, education and maintenance of materials and resources
- How and when metrics will be collected to assess end user adoption and performance.

Power of metrics

One of the differences between a highly effective sustainment plan and a mediocre one is the use of metrics. Consistently measuring users' knowledge about and confidence in the system creates a barometer for proficiency levels and best practice. Performance metrics are powerful indicators of whether users are improving, maintaining or regressing in their adoption of a new system and of any reversion to old behaviors.

Metrics also keep organizations on track if, for any reason, performance does not meet expectations. If these warning signs come early, then organizations can react quickly and proactively to address the problems and ensure the promised benefits of EHR are realized.

Healthcare organizations' management teams need to keep in mind that adoption is never static; it is continually either improving or degrading. Let's consider two different scenarios. In both scenarios, go-live was successful, but specific performance metrics are not meeting expectations.

- In the first scenario, the system is being used inefficiently. This may be due to inadequate training and subsequently lower user proficiency. Measuring this proficiency enables the organization to identify 'pockets' of low proficiency among certain users or departments and ensure they receive the education they need. Once users are proficient, the organization can keep monitoring the performance metrics.
- The second scenario is less common and more difficult to diagnose: metrics show that users are proficient, but specific performance measurements are still not meeting expectations. In this case, the specific metric needs to be analyzed. Is the right question being asked? Is the right data being collected? Are these relatively small changes or rare occurrences? More time might be needed to achieve certain metrics; throwing quick fixes at a problem too early (instead of staying the course and having confidence that the expected performance will eventually emerge) could be damaging.

An effective sustainment plan requires time, resources and funding – ideally identified during the initial planning and budgeting for EHR. To ensure sustained adoption of EHR, it takes relentless focus on improving quality of care, patient safety and financial outcomes. While investment is certainly required, the returns on that investment will be compelling.



Interoperability is vital in lowering healthcare costs and improving value

Three of the biggest names in American business – Amazon, Berkshire Hathaway and JPMorgan Chase, in 2018, announced a new joint venture to provide better, cheaper healthcare for their employees. They said the new venture's initial focus would be on technology but failed to give details.

They are right to focus on technology, it is the primary way to save on healthcare costs and improve health value. Investing in new digital services that support the patient process by breaking down health silos is the place to start. This means investing in telehealth services, personal health records or apps, virtual diagnostic services, perhaps also dashboards that show the hidden costs of medical services. Important for these new digital services is the need for seamless integration between healthcare providers, pharmacy chains, life sciences and insurers. It's no secret that Amazon is eyeing up the pharmaceutical distribution market and received a number of wholesale pharmacy licenses, so those plans may be enveloped into this new initiative.

However, creating such a promising personal healthcare ecosystem will require interoperability. This is going to be an important issue to tackle in order to see sustainable long-term improvements in healthcare.

The internet already enables patients to seek online consultations when and where it suits them. You can take over-the-counter tests to analyze your blood, sequence your genome and check on the bacteria in your gut. Yet radical change demands a shift in emphasis, from providers to patients and from doctors to data. That shift is happening. Technologies such as the smartphone allow people to monitor their own health. The possibilities multiply when you add the crucial missing ingredients—access to your own medical records and the ability to easily share information with those you trust. That allows you to reduce inefficiencies in your own treatment and also to provide data to help train medical algorithms. You can enhance your own care and everyone else's, too.

Improved healthcare interoperability is a top priority for providers, policymakers, and patients in 2018. The public and private sectors are working across the industry to facilitate seamless health data exchange between a multitude of health IT systems to coordinate care across various health settings. Years of healthcare interoperability initiatives, health data exchange frameworks, and health IT standards have yielded considerable improvements in proliferating efficient information exchange.

However, several challenges still bar stakeholders from achieving true interoperability for optimal care delivery and improved patient health outcomes. These include developing a national patient identifier, improving standardization and collaboration across the industry and ending information blocking and data sharing issues.

This announcement, however, brings hope as well as industry muscle to overcome these challenges and make real gains in the healthcare market by creating new personal healthcare ecosystems and new digital health services.



Data protection in the healthcare sector

There's always been an element of trust needed between the healthcare industry and patients - the trust that the right care will be given and that there will be confidentiality between both parties, which is of course underpinned by the patient-doctor relationship.

Recent cyberattacks means this trust must now extend far beyond just patient and doctor - the whole organization has to earn it too.

To understand how best to gain - and retain - their trust, Atos surveyed over 3,000 British citizens to understand their attitudes to cybercrime and what they expect from organizations when it comes to keeping their data safe.

Regaining trust

Over a third (36%) of the people surveyed stated they value their medical details the most. That's unsurprising - our medical history is amongst our most sensitive personal information, aspects of which many of us would divulge only to a highly trusted GP or medical professional.

It's alarming then that when asked which organizations are most able to protect themselves from a cyberattack, 52% of citizens ranked healthcare as high risk (over 7 out of ten). Clearly, the health sector has a huge job to do if it is to regain its patients' trust and demonstrate that it has the appropriate security protocols in place to protect their medical data.

The priority must be finding ways to reassure patients; and the stakes are high. If diminishing trust in situations involving private medical information means that patients are growing reluctant to share their full details, the risk goes way beyond a damaged doctor-patient relationship - it could affect the accuracy of diagnoses too.

This is true of several apps that have faced adoption issues because of data concerns - both within the healthcare and private sector. Despite citizens clearly seeing the benefit to new technologies such as wearables, trust quickly diminishes when data is not used or stored as expected.

Digitization in the health sector

When faced with a mounting threat from increasingly sophisticated criminals, this is no easy task. Digital transformation in the sector is a huge factor, with paperless systems becoming widely adopted by organizations looking to benefit from easier access and exchange of patient information to increase efficiently.

But if you look beyond this it's also about being able to provide a level of service they have come to expect from private companies. This might include instant access to their personal records, or being able to book an appointment and see a virtual doctor through an app.

This is a double-edged sword, with the increase in the level of patient data being stored online making health services a more vulnerable, and more appealing, target to potential hackers.

Patients too are wising up to the implications of having more and more of their information digitized and the risks posed by this. Half of the people we spoke to said that they expect healthcare organizations to have data encryption in place, and more than one third would expect to come across PIN managers when divulging their personal information.

These may only be small steps in ensuring healthcare organizations have the level of resilience required to face up to future cybersecurity threats to the sector, but they are important ones. Our research shows that citizens are willing to sacrifice some level of user experience, such as a speed of services (66%) and complexity of the login process (59%) for a more secure service.

It's important that health services are putting systems in place to provide that all-important peace of mind - that the sector can protect not only our physical health, but our personal information, too.



It is a cleaning agent for use on...

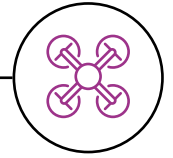
Caution: Take special care if you are pregnant or nursing. This product contains salicylic acid which may be absorbed through the skin.

Warnings: Avoid using pregnant and breastfeeding women. Apply to the affected area only. Do not use on the face or on the scalp. For full directions, see your pharmacist or doctor.

How to Use: Apply a small amount of the product to the affected area. Rub gently with the use of the product. For full directions, see your pharmacist.

Keep out of the reach of children. Do not use if the seal is broken or the product is expired. Your pharmacist will provide you with a full list of ingredients.

Ingredients: Emulsifying Detergent, Salicylic Acid, Sodium Lauryl Sulfate, and Purified Water.



Drones and cobots: the digital highways of tomorrow's healthcare?

Healthcare costs continue to rise; it is one of the biggest challenges of our lifetime. This is why many hospitals and governments around the world are looking for a value-based healthcare (VBHC) approach to minimize costs whilst maximizing value. To do this they are looking to emerging technologies to help. Drones and collaborative robots (cobots) are one of these technologies. They can drive value in the area of medical deliveries, reduce paper and administrative costs with an automated supply chain and free up doctor and nurse time.

Already started

Some transport operators have already carried out trials of drones in the health sector. They have been used to deliver medicines from mainland distribution centres out to islands that are hard to reach. Another example in Africa has seen drones being used to deliver blood and medical supplies to remote areas.

Moving beyond these early proofs of concept and making drones and cobots a reality in healthcare will require an overall vision combined with a reinvention of global logistics and supply chains and the support of information systems to ensure optimal efficiency. However, their potential benefits are multiple.

Benefits of drones and cobots for patients

Given that the patient's primary need is to receive effective care, having healthcare products and equipment available in the right place at the right time, including in an emergency is essential. Being able to avoid road traffic speeds up the supply of equipment and improves planning and efficiency. The second benefit for patients is that an optimized and responsive logistics and supply chain helps to free-up healthcare staff's time for direct patient care.

Benefits of drones and cobots for hospitals

For hospitals, a key issue that drones and cobots can help with is the security and accuracy of medical processes. Automating the supply chain is particularly useful in the handling of medical supplies which need to be monitored or kept at certain temperatures. Another major issue is cost-effectiveness. Making logistics and supply chains more reliable, responsive and efficient means that hospitals can order stock when it is needed, 'just in time', rather than requiring expensive storage facilities on site.

For all these reasons, optimizing logistics - including through the use of drones and cobots - is an important objective for hospital groups. Logistics management for just one hospital can equate to around 60 million euros of budget every year. It therefore makes sense that reducing lead times and optimizing and managing inventories more efficiently will make a significant difference to the bottom line.





Is this the beginning of a real disruption in healthcare?

81% of c-level executives of healthcare providers agree that Google, Amazon and Apple will be the most 'disruptive' tech forces in healthcare, according to a Reaction Data report. While the entry of these tech giants into the sector may not be relished by some hospital leaders, physicians and health tech vendors, it's likely to be welcomed by many consumers, especially those under 40.

First forays

Google, for example, is applying its artificial intelligence (AI) capabilities to detect disease and identify effective disease/lifestyle management, combatting cancer, heart disease, Parkinson's disease and multiple sclerosis among others. It is considering AI products such as Google Home to explore the feasibility of patient-facing health assessments and has partnered with Johnson & Johnson to build a surgery platform that brings together robotics, data analytics and visualization.

Amazon too has started to insert itself into the market, setting up partnerships with organizations to reduce the cost of employee healthcare by providing a technological platform for administering healthcare. Longer term, the company could enter the healthcare distribution chain by selling medical devices and, perhaps eventually, becoming an online pharmacy.

Apple is also stealing a march, and recently unveiled a Health Records app for collecting personal data related to health and wellbeing categories such as allergies, lab results, medications, conditions, and vital signs - even if the data comes from different sources. There's plenty of potential for other tailored apps, such as medication tracking or diabetes management, delivering even more personalized experiences using all the biometric data that citizens collect on their personal devices.

Patient demand

Some naysayers feel it is not possible for outsiders, no matter how large and accomplished, to make a big dent in this \$3 trillion industry. There are complex interactions between insurers, consumers and health providers that don't occur in other sectors. There are also billion-dollar EHR vendors and thousands of other incumbent healthcare technology companies with specialized knowledge, experience and multi-year contracts.

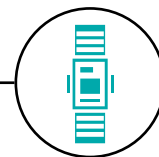
Still, patients are fed up with rising costs, clunky access to caregivers, few patient care improvements, unhelpful portals, and a severe lack of interoperability that translates into duplicate testing, repeatedly filling out the same old paper forms and, worst case, critical delays in receiving the right medical care.

These are the same consumers who are accustomed to instantly and easily doing almost anything online - banking, shopping, bill-paying, researching, reading, news-checking, making reservations and getting auto-routed to destinations. While today's multitude of digital business and social conveniences are an extraordinary new phenomenon to pre-millennials (roughly those over 40), they are a given for anyone younger.

Taking the next step

These younger generations expect and demand fast, sophisticated online services and products, and guess who is already providing it to them? Google, Amazon and Apple. Yet who is running the majority of traditional healthcare organizations and vendors? Pre-millennials. Many, including C-suite hospital leaders, have trouble just keeping up with their smartphone upgrades. Their millennial children are using Apple Pay for mocha lattes. Some major hospital systems - including the best of the best - are already taking due note of the potential sea change ahead and signing on for Apple's Health Records solution.

Instead of shrugging off the idea that one of these consumer-led companies could start reshaping healthcare delivery, why not get inspired? Maybe a good start would be a little IT re-prioritization with a significant investment in patient experience and the pesky problem of interoperability.



A millennial's view: The future of healthcare



My wearables have been measuring my sleep, temperature, heart rate as well as my eating habits and exercise performance. Through comparing this data against the available health data base and my past performance, it has noticed a downward trend and a slight temperature increase. When I wake up in the morning, my phone suggests that I could be coming down with an illness and so it opens my health dashboard app and asks me some questions on other symptoms; are you suffering from a headache? Are you finding it difficult to concentrate? From this, my phone can now say with a reasonable amount of certainty I am going to be ill. In fact, some of the answers I have given suggest it could be more serious than just the flu.

My phone automatically books me in with a specialist in the particular illness it believes I have, sends my health information that has been tracked over a number of weeks and my responses to the earlier

questions so that the doctor is as informed as possible. It then gives its own intermediate recommendation of paracetamol and rest. A few minutes later, my phone rings on video call and I answer to the specialist who already knows all my details, history and current stats. The specialist is able to make a very quick diagnostic and signs off on the prescription, I then pay via fingerprint identification on my phone and it will arrive by drone to my drop box within a few hours.

I am not yet feeling many symptoms but I have the correct treatment to pre-empt my illness. I haven't yet had a call from my manager to ask where I am as my phone has already blocked out my diary and informed my work, which is now verified with a digital doctors note. I haven't needed to fill a GP waiting room, and I haven't let a minor illness become chronic.

Collaboration, telehealth and remote monitoring

Enabling remote healthcare monitoring, diagnostic and treatment. Enabling digital prescriptions, digital approvals, connected devices and digitized patient records.



Building next-generation platform to succeed in healthcare ecosystems

As one of the most vital domains for human living, Healthcare has always received great attention from research and pioneered advanced technologies such as DNA recombination, medical robots, transplants and artificial organs.

Bringing legacy tech into the digital era

At the same time, the very complex nature of living things, the multiplicity of specialties needed to handle all kinds of pathology and the scarcity of resources has led to a very siloed approach, per affliction type or place of treatment. This complexity has been increased by the breadth of healthcare value chains themselves, including life science corporations, research institutes, health providers, payers and regulations authorities.

Preparing for a paradigm shift

By fully interconnecting people, business and things anytime anywhere, the latest digital technologies can now not only help healthcare institutions better manage their operations; they can now enable all MedTech players to provide, at last, a holistic care experience. To fully leverage this opportunity, Healthcare must be ready to make a quantum leap:

- Become wholly patient-centric, federating all players across a 360° personalized patient journey, from healthy living and prevention up to diagnosis, treatment, recovery and home care.
- Provide intelligent data-driven orchestration so all stakeholders can collaborate around value-based care and precision medicine.
- Adopt open platform foundations and real-time process automation to provide the best care services at the lowest cost.

More disruptive technologies will emerge. While some may only appear as dots on the horizon today, they will turn out to be transformational in the years to come.

The road ahead

To thrive, healthcare players will need to create the right partnerships and convene the largest ecosystems. Modernizing legacy and fully embracing the latest Cloud, automation, Big Data, API platforms and IoT technologies is only the start of the journey.

Next-generation architecture for future-ready healthcare players

PATIENT-CENTRICITY



360°, LIFE-LONG PATIENT EXPERIENCE

360° patient care and healthcare personnel engagement



COGNITIVE ANALYTICS

Smart care orchestrator for P4 medicine



BUSINESS ACCELERATORS

Real-time care services: EHR, Clinical Systems, ERP,...



HYBRID CLOUD

Software-defined infrastructures, microservices and DevOps

INTELLIGENT DATA-DRIVEN ORCHESTRATION

OPEN PLATFORM FOUNDATIONS



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With complex healthcare stakeholder ecosystems and billions of patients and connected devices overall, healthcare (lc) will be a very data-intensive field. More than in any other vertical, data management, cloud services, artificial intelligence and the IoT will be the core technologies needed to succeed.

Santiago Ristol Jorba,
Director of the Mobile Competence Center,
Worldline and member of the Atos Scientific Community

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The role of the patient in value-based healthcare: a patient-centric approach

Due to financial and population pressures the way we deliver healthcare must change. We must find more efficient ways to deliver better healthcare outcomes. Alongside this, given our ageing population, we need to keep people healthier longer.

For this reason, everything must change in healthcare delivery including the patient. We must all adopt a self-care approach and take more responsibility for managing our long-term health. This is an enormous shift in mind-set from where we are today.

Home care

One way that we can help promote self-care is using wearables and connected devices – the technology we can access on our person or at home, such as bracelets, blood-pressure readers, scales, glucometers and so on. The adoption of these devices could have multiple benefits.

Healthier longer

The first benefit is, obviously, better health outcomes through:

- The detection of minor changes from one day to another might help in the prevention area by detecting earlier any potential health concerns.
- Helping identify and respond to deterioration in health and well-being by monitoring physical activity, well-being, fatigue and stress levels.
- Engaging with patients so that they can become proactive with self-managing their life-long condition in a community care setting with alarms for medication reminders and other alerts on exercise, diet and lifestyle.
- Connecting with care professionals, family and other community supports, so that they can help provide better care.

Data driven healthcare

The second benefit is in the area of data collection, analysis and improving outcomes. This additional data stream could provide vital information on ways of improving outcomes. The data could show which drug regimens work best for a particular demographic, which environmental factors influence outcomes and the best ways to manage particular health conditions.

This wealth of data could provide an exciting stream of information for Government Health bodies to inform their health policy decision making and drug buying.

Assistance network

A further benefit is in allowing a patient's caregivers – both formal and informal – access to information they may not otherwise routinely have. A caregiver may be able to see if the person they're caring for has been eating regularly or is managing to take their medication at the right time. This also means that handovers of information when a patient moves from one caregiver to another can be seamless. Errors in care can be dramatically reduced with all the information available, electronically, in one place.

Cost efficiency

The final benefit is cost. Promoting preventative health measures and self-care by citizens can have a positive impact on the cost of healthcare long-term. By transferring some of the responsibility to citizens, people can be cared for better in the community.

So what are the barriers to uptake?

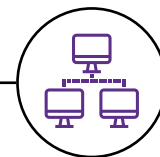
Not all wearables are medically certified. For this reason it can be hard for a health organization to endorse a particular product.

Secondly, an infrastructure is needed around wearables to control and manage the data – keeping it secure and ensuring patients can access all their information in one place is part of the challenge. The other part is anonymizing and being able to use the data collected to improve health outcomes, which must be the goal for value-based healthcare.

A final barrier, and perhaps the hardest, is culture. Our health practitioners and health organizations need to embrace this change. That can mean shifting mind-sets from treatment to prevention.

But the biggest change needs to come from the citizen. We all must be encouraged and equipped to take an active role in our own health. Wearables and connected devices can provide fantastic assistance but only the wearer can make the real difference!





Digital collaboration at the heart of the digital health revolution

The pressures facing the healthcare sector globally are well known – the population is growing, living longer and with more long term, comorbid conditions than ever before, yet patients as service consumers expect far more than they did in the past.

To compound this budgets and workforce pressures in all aspects of healthcare management and delivery are under increasing pressure which means simply delivering more of the same is no longer a feasible solution. Having worked in the industry for many years as a CIO and in other related roles in many hospitals I have found myself able to effect more positive change by targeting the patient and staff experience than any other business change projects.

Currently in many health economies the focus is on the “Patient Experience” as it has the potential to reduce cost and improve quality outcomes. Governments are even driving this by penalizing providers for delivering a negative experience. For example, the HCAHPS initiative in the US has resulted in \$1m in fines being imposed, and in the UK similar measures can result in hospital departments being closed or placed into special measures. It is the industry’s equivalent to the established measure of CSAT (Customer Satisfaction).

“Why do we always talk about hospital patients, what about all the other patients?” That’s easy, acute care (secondary or hospital care) is the single largest cost in any health system, typically accounting for 70% of the spend for around 20% of the total patient number.

Secondly, why patient experience? Again, there is a simple reason why a good experience is less stressful and more positive in terms of outcome. Medical studies have proven stress to inhibit healthy recovery. Less stress means quicker recovery and a consequent reduction in ‘length of stay’ and therefore a cost saving.

But this goes much further - by involving the patient in their care they are much more likely to engage in managing their own wellness, thereby reducing the burden on the professional care giver. If you look outside healthcare this is most evident in the airline industry where we are now perfectly happy and accustomed to ‘Check in’ to our flight. We own the process but the airlines achieve their cost reduction targets by making it part of our overall (hopefully) positive experience!

So, let’s look at some areas where we can improve the patient experience and how that in turn improves quality outcomes, while helping to drive down the cost of care.

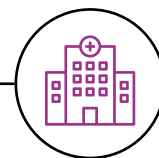
One simple way is to de-stress the whole patient journey. As we have seen, many studies have shown a happy, relaxed person heals quicker, so by creating and maintaining the best customer experience we can, an inevitably stressful time is now made less stressful.

Advanced communication and collaboration tools fit perfectly here as they have been designed explicitly to improve customer and staff experiences. Take a simple thing such as a glass of water. A patient will ring the buzzer, a nurse responds and then acts on the request. Great you think – but look deeper. A skilled resource is now occupied with an unskilled task just because the only buzzer available was the nurse call solution. Let’s change that to providing a patient focused digital desktop located on a bedside terminal – the patient touches the ‘Glass of Water’ button that communicates directly with an auxiliary who responds to the request – the experience is good, the patient is receiving great service quicker. Most importantly the skilled resource has more time to focus on the specialist tasks.

Expanding this concept out further into the hospital environment, we see how the same approach can drive efficiencies and costs down while still improving those experiences. The first trick is keep it simple – by using what you have and what you know. Now digitalization can enable some incredible changes to the way we deliver acute care.

Using data as the instigator (instead of the Patient’s finger) think of a high-risk patient attending the emergency department. We apply the same principle except the call is to a specialist alerting them of the patient’s arrival. Now they can intervene as they know all about a totally unrelated issue which reduces the risk of clinical complication. A pregnant woman in early term (so visually nothing obvious), has been involved in a Road Traffic Accident. Now maternity can be immediately on hand informing the accepting emergency consultant of the pregnancy. With the right collaboration tools this can be done remotely, with the collaboration between the two specialists created in seconds without human intervention – at its best.





Streamlining clinical decision

Birmingham Children's Hospital provides a wide range of children's health services for young patients from Birmingham, the West Midlands and beyond, with over 240,000 patient visits every year. The city-centre specialist hospital is home to the largest single paediatric intensive care unit (PICU) in the UK and cares for over 1,000 critically ill babies, children and young people every year.

The Kids Intensive Care and Decision Support (KIDS) service operates from the hospital and provides urgently needed assistance to clinicians in hospitals across the West Midlands who are treating critically ill babies, children and young people.

As the KIDS advice and transport service grew it moved to a new location adjacent to the hospital and took the opportunity to redesign its communications infrastructure. KIDS runs a 24-hour operations centre and requires an efficient and reliable system that would enhance logistical and clinical decision making for the KIDS team, bringing together the right doctors and nurses and other specialists in a timely manner.

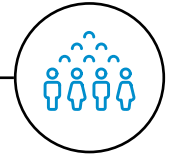
OpenScape Xpert has been installed in the main hub of the KIDS service and it is the first European healthcare deployment of its kind. The system which has been two years in production, has been designed to improve logistical and clinical decision making for the KIDS team. It has been the result of a successful collaborative partnership between clinical and IT staff.

All incoming calls to KIDS are received via a 24/7 Freephone number and are triaged by the KIDS consultant (a paediatric intensivist). The Xpert system successfully brings together the right doctors, nurses and other specialists for the 1,600 acute referrals which are received each year. The system also facilitates timely dispatch of the transport team and allows efficient communication between the team, the KIDS Consultant and other specialists involved in the case. This is vital to improving the delivery of remote expertise and timely solutions to critically ill babies, children and young people across the West Midlands.

The Xpert system has been in service since February 2014 and the staff notice the benefits of improved call management for paediatric intensive care advice and transport. The system allows more callers within a single conference than was previously possible and multiple cases can be handled simultaneously. By improving referral call management and conference call efficiency, KIDS is streamlining the decision making process and transport coordination for critically ill babies, children and young people across the region.

"This solution not only benefits Birmingham Children's Hospital but allows the referring hospitals who ring the KIDS service to benefit from more efficient handling of emergency paediatric calls. We are incredibly well positioned for the future, and with Unify's next generation technologies Birmingham Children's Hospital is really setting the standard for other children's hospitals in the country to follow in terms of highly-responsive patient-care."

David Marshall, Head of IT at Birmingham Children's Hospital



Population Health Management

Three simple words, yet so much complexity.

POPULATION Health Management (PHM)

Wikipedia defines population as 'all the organisms of the same group or species, which live in a particular geographical area, and have the capability of interbreeding.'

Within the context of PHM, we create our populations using subsets of the big population. Possibilities are plentiful: 'attributed Medicare members,' 'patients diagnosed with congestive heart failure,' 'patients with diabetes and obesity,' 'members of a self-insured health plan.'

With subsets established, we can then define our populations around two key elements: knowing who the patient is and have the appropriate data tied to that patient's record. We then use 'risk stratification' to develop our care delivery and patient engagement models with two goals in mind - improving health outcomes and lowering costs of care.

Understanding the numerous risk stratification models available is important. Having a strong data analytics strategy will put you in a better position to stratify risk across populations, then design, manage and measure your care programs and the outcomes for your populations.

Population HEALTH Management

If we look at what healthy means to each person, it's different. Eat right. Exercise. Take your meds. Manage your stress. Don't smoke. Wear sunscreen.

It's an individual decision to be healthy, but some people need help. The healthcare system needs to make it easier to be healthy.

Changing behaviors and improving the health of populations requires us to share data about medications and understand the full scope of care along with a patient's social determinants of health.

We should leverage data already available, and understand its impact on the care solutions and approaches that aim to change a person's behavior and promote a healthy lifestyle. Using and sharing data across the continuum of care is essential, as is exploring creative care models to address high-risk populations. Outcomes include improved care, an engaged patient and lower costs.

Population Health MANAGEMENT

MANAGING the health of a population requires the right organizational foundation for designing and deploying transformative models of care. But many organizations operate in a siloed, loosely governed environment, void of physician leadership in operational and informatics roles. They must move toward aligned leadership that includes engaged physician leaders across the continuum of care, along with a patient-centric view of processes and data.

From here, leaders can develop care models and leverage evolving technologies to manage population health. Possible approaches include telehealth/telemedicine, remote patient monitoring and evolving staffing models associated with different levels of health risk.

These all require a high-performing organizational culture where leaders can understand their costs and outcomes and take on the financial risk associated with advanced value-based reimbursement models, with these models extending up to executive compensation incentives.

This diagram from AHIMA (American Health Information Management Association) clearly defines the many moving parts associated with population health management. Note the aligned, innovative organization at its center and its two key areas of engagement: provider and patient.

Making the most of the relationship and interaction between physician and patient is about giving the provider the data, tools and processes they need to engage with their patients in a meaningful way that maximizes their health; a way that improves their health while minimizing the impact of an acute episode of care and/or chronic health condition.

This engagement lies at the very heart of managing the health of a population - of Population Health Management.

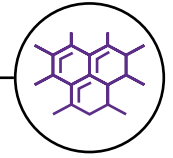
Precision medicine



New high-throughput technologies coupled with digital pathology and medical imaging are producing an unprecedented understanding of the molecular, cellular and organ processes that govern health and disease.

As a result, research and healthcare - two complementary yet traditionally parallel areas of knowledge - are now converging.





Precision medicine: the future of health

As science and technologies advance and demand continues to grow, healthcare systems have to evolve into a more sustainable model that maintains people's wellness rather than just treating illness once it has occurred.

Through a combination of proactive human interventions and decisions – supported and enabled by rich data and intelligence – that model will be more effective by being much more precisely directed at the individual.

Precision medicine is based on four key pillars of care: predictive, preventive, personalized and participatory. A good illustration of how these four pillars work is the story of Dr Martinez, based on the case for personalized medicine, personalized medicine coalition, 3rd edition.

- Dr Martinez is sitting down with his laptop. On the website that he uses to manage his practice, an alert pops up warning him that several new mutations found in 10 percent of people have been discovered to be associated with the likelihood that they might convert to type 2 diabetes. All of his patients have had their entire genome sequenced and entered into their electronic medical record. He conducts a quick search of this 2,000-patient database and finds about 80 who are at risk (**Predictive** care).
- To half of those patients, he sends a strong reminder and advice on diet and lifestyle choices they can take to avoid the disease (**Preventive** care).
- For the other half, whose medical records reveal pre-diabetic symptoms, he sets up appointments to consider more proactive treatment with drugs that can prevent the onset of the disease (**Personalized** care).
- Patients can download an app certified by the healthcare system that will allow Dr Martinez to remotely monitor their glucose blood levels (**Participatory** care).









As that example shows, precision medicine depends on clinicians and citizens being proactive and working together to look after health and wellbeing. The success of that partnership relies on the healthcare system's ability to transfer breakthroughs in data analysis across into healthcare settings – 'from the bench to the bedside'. Massive volumes of raw, complex and heterogeneous data have to be acquired, validated, stored, processed and analysed using high performance computing systems. They then need to be interpreted and presented (through dashboards and reports) in meaningful ways to clinicians. Individual citizens can become more proactive in starting specific preventive treatments, or make lifestyle changes that prevent the onset of the disease or minimize its impact.

In this democratization of medicine, genomic testing plays a very relevant role. DNA sequencing technologies are being adopted as part of routine practice as a powerful tool for early diagnosis and for personalized treatment. Getting access to the molecular profile of patients and correlating this data with phenotypic information (the expression of specific traits, such as stature or blood type, based on genetic and environmental influences) is an enormous cultural shift. This fast-evolving, immensely powerful new diagnostic tool is revolutionizing healthcare and supporting clinicians, citizens, carers and society to work together in new ways to make predictive, preventive, personalized, participatory health and social care a reality for all.








A patient's journey

Let's look at an example of how the blend between big data analytics capabilities together with high performance computing systems could bring important outcomes in the healthcare setting.

-  Alison is a 45-year-old British citizen worried about her father's death last year due to a heart attack.
-  She makes an appointment with her doctor, who offers to perform whole genome sequencing with previous informed consent.
-  The doctor carries out real time sequencing by introducing Alison's blood drop into a mini sequencing portable device that plugs directly into the USB port of her laptop.
-  Processing of the genomics data (filtering, mapping and variant calling) is carried out in the mini-High Performance Computer embedded into the sequencing device.
-  Anonymized and encrypted, Alison's processed genomics data is sent to a Big Data computing platform where the analysis of the genomics variants is made.
-  The platform counts also as a repository where the healthcare data gathered through different clinical pathways for every patient in the healthcare system is stored. This platform is hosted in an healthcare Data Centre and has been implemented by putting in place cutting-edge cloud, security and cybersecurity technologies that are fully compliant with all valid European laws. These technologies ensure the privacy of the data at rest and in movement. The data stored in this platform can only be accessed by authorized medical doctors and healthcare authorities to decide the better treatment options for the patient or to design preventive measures based on stratification. There is a strict audit programme monitoring this platform that keeps track of all the processes launched on it.
-  The doctor relies on a decision support system (DSS) that can infer an accurate diagnosis from the bulk of scientific, imaging, medical, clinical, omics, research and social data available. Cognitive computing is the mainstay of the system.
-  Unfortunately, Alison carries three variants that are related to cardiovascular diseases: the same as her father.



-  After validating the diagnosis, the doctor executes another module of the DSS to find the most suitable treatment for her patient based on her clinical (arterial hypertension), social (single and no family support) and genomic profile (three cardiovascular risk variants). The doctor is advised by the DSS to prescribe a medication that has been tested in 100,000 patients with identical genomic profile with good results. She also recommends a diet to control her blood pressure.
-  She suggests the use of a T-shirt that enables monitoring of Alison's electrophysiological heart activity in real time. The T-shirt is connected to a mobile application that sends the data (electrocardiogram and symptoms as requested) to a trained system that can predict any possible anomalous event.
-  Alison stays asymptomatic until the age of 61 when the system alerts her doctor about the risk of arrhythmias. After performing a TT Echocardiogram, an aortic valvulopathy is detected and she programs an aortic valve replacement. The valve is printed on a 3D printer based on the images taken from TT Echocardiogram.
-  The doctor requests the help of a cardiovascular surgery expert in US who proposes robot-assisted surgery with augmented reality.
-  The surgery is successful and Alison is now enjoying a healthy life.



Machine learning for health

Since 2009, there has been a quiet revolution in machine learning. It's working behind the scenes in our everyday lives, most obviously on our smartphones' voice recognition and translation tools. Much of this advance is being driven by the Tech Giants, who have been rapidly acquiring niche companies and recruiting from academia to accelerate technologies and applications.

The implications of machine learning for healthcare are huge; computers use algorithms to make instant classifications and find ground-breaking insights without being specifically programmed to do so. These decisions and breakthroughs are based on massive amounts of complex, diverse and sometimes ill-defined data that would take humans years of experience to make sense of.

Where the machine's 'decision' involves complex data yet is a binary one, it's relatively easy to see the case for automation. Google has been experimenting with machine learning intensively for the past few years. Its machine learning has been applied to diabetic screening, making a yes/no classification of an image based on features that are difficult to define and hard for a human to classify. Successes like these herald a future where all kinds of screening decisions (mammography, lung CT, chest X-ray) could be completely automated.

The more data you can expose the computer to, the more effective the machine learning algorithms will become. It's therefore easy to foresee computers outperforming humans on certain tasks. Computers can calculate the risk of adverse events, and the impact on risk of a certain genetic make-up, behaviour or exposure for individuals.

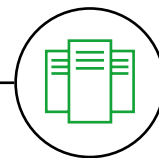
So could machine learning replace humans? I don't believe so. Firstly, even for tasks like image analysis, many of the decisions that need to be made are more complicated than in screening; and although some cognitively demanding tasks could be completely automated and disappear, jobs will not. With powerful machine learning available, there's little point asking a radiologist to carry out relatively simple pattern recognition which, while it requires a great deal of experience, doesn't require the intelligence or the broader training that we give to doctors. Yet interventional radiology, engaging with colleagues, collaborating on treatment and using a more holistic understanding of the person, is something for which we need a human being. It's also hard to imagine machine learning in general practice, where a GP is in a more human, more socially complicated dynamic. And in

surgery, automation will carry out many standard procedures, but surgeons will be needed to oversee these. There's a similarity to the airline industry: much of piloting is automated, but the crew are still critical in safeguarding and intervening in abnormal situations.

Building trust

As citizens, we trust our clinicians to navigate the complexities. Yet as the algorithms become ever more sophisticated and opaque, does this create a problem of trust? What do clinicians feel that they need to know about the computing? Having good, clear statistics on performance will be important. Some mental picture or theory of the algorithm is also useful. Yet as the technologies advance, this may not always be possible. Today's clinicians trust an MRI scanner even though they may not know in detail how it works. It will be the same for machine learning. We need to have our eyes open to issues around trust. The EU Data Protection Regulation gives certain rights to people who are subject to a decision made by an algorithm: so, for example, the algorithm will need to be explained. There is also a duty on those using such algorithms to check that the algorithm is fair; and if machine learning is used in conjunction with a dataset that reflects an inherent bias in society, the algorithm may be demonstrably unfair.

The next decade is full of opportunities and challenges for clinicians to navigate a transition in which some of their capabilities are removed. Naturally, it's easier to embrace a system that we see as enabling us than it is to take on a technology that might undermine, replace or overtake us. Getting the balance right is complex: removing a task completely and doing it by machine is more straightforward than having machines to help the human do the job better. Yet clinicians have always embraced and integrated new technologies into their practice. And as Google and many others are proving in fantastically innovative and exciting ways, the immense power and possibility of machine learning can be enormously useful if we are to meet today's healthcare challenges and advance research.



Sequencing and supercomputers

CNAG conducts large-scale DNA sequencing and analysis, ensuring Spain's competitiveness in the strategic field of genomics.

Spain's National Center of Genomic Analysis (CNAG) is involved in large scale sequencing projects in areas as diverse as cancer genetics, rare diseases, host-pathogen interactions, preservation of endangered species, evolutionary studies, and the improvement of agriculturally useful species.

Its mission is to deliver research and results that help make citizens' lives better.

The work that CNAG does has huge potential across a wide range of disciplines. The main challenge in reaching this potential is scale. In every genome of 3.2 billion bases, there are many base variations that are potentially responsible for diseases, making them challenging and time consuming to spot. "At the moment we're able to identify some of these variations, but the aim is to be able to locate and accurately predict the effect of every one of them in whichever genome we're looking at," says Ivo Gut, Director of the National Center of Genomic Analysis.

"This will enable us to make big-picture predictions about, say, how a specific type of cancer is likely to respond to a given combination of medication. Once we get to this stage - and it's not far off- we'll be able to put the findings to use in a clinical environment and have an impact on how many diseases are treated."

With such complex analytics, a powerful computing platform is essential. Analysis of each genomic sequence may take hundreds of CPU hours, which limits the number of projects that can be carried out, and makes repeating an analysis difficult. "This is fine for one-off research projects, but we want to be able to offer sequence analysis on an industrial scale, with the ability to repeat one analysis a number of times if required," says Gut.

When CNAG built its sequencing and analytics environment, it issued a tender and identified Atos as its solution provider of choice. Gut explains: "It was not only about increasing the sequencing capacity by procuring new equipment, but designing from scratch the appropriate computer infrastructure, with the assistance of a technological leader with expertise in the field of genomics. Choosing a flexible core infrastructure enabling limitless growth, together with genomics projects, was also essential".

CNAG's supercomputing capabilities must meet the scalability and performance needs to support this continued up-scaling is in place. Specialized sequencers feed the genomic sequence data to the high-performance data analytics platform that provides granular and varied insights to its end users. For instance, hospitals will be able to use its genomic research in different ways to combat different types of diseases. "When treating a rare disease, physicians may never have seen such a case in their whole career," explains Gut. "But we can provide them with phenotype information that could help them make an identification and diagnosis faster. In many cases, this can lead to quick and effective treatment - such as putting the patient on a course of vitamin supplements. On the other hand, in the oncology unit, diagnosis is not so much of an issue. Here, it's more about identifying the right medication or combination of treatments to achieve the greatest results against a given type of tumor - and this is where the phenotype data will come in use."

CNAG is constantly reinforcing its sequencing capacity that goes hand in hand with the expansion of its supercomputing systems. This will not only help develop its sequencing capacity, but also the scope of its research. This will also help CNAG maintain its position as a centre of international reference in genomic research, thus strengthening Spain's leading positioning in the strategic field of genomics.



How to meet the challenge of augmented medicine

The potential for the implementation of AI in the healthcare sector is very real and raises a great deal of hope, but also many criticisms of its potential dangers.

To date, many research projects are under study, but in the end, there are relatively few examples of industrially finalized, operational solutions.

Major obstacles to the transfer of innovation are:

- the questioning of medical practice, with challenges pertaining to decision making and training;
- a legislative hindrance that calls for political, legal and ethical reflection on the liability of algorithms.

In a fast changing environment governed by security, reliability and quality aspects, the success of a project related to healthcare AI applications is eventually correlated to the quality of its management and the agility of its organization.

To promote the quick, efficient transition from academic research to technological innovation and then medical practice, we recommend the implementation of the following approach:

- complementary to existing initiatives, to capitalize on past investments and existing services, notably local, regional and national data warehouses;
- global, to break down the barriers between disciplines, practices and professions and meet the scientific challenges pertaining to data and their accessibility, security and integrity; the technological challenges, as well as the ethical and legal challenges;
- modular and agile, to gradually and incrementally address the various steps from primary research to the operational implementation of the different research projects;
- unifying, to stimulate the contribution of all the academic and industrial stakeholders, and of data producers/hosters;
- open, to help generalize the access to health data, a process which Europe has firmly committed to; and to promote sharing and exchanges in accordance with the law in force;

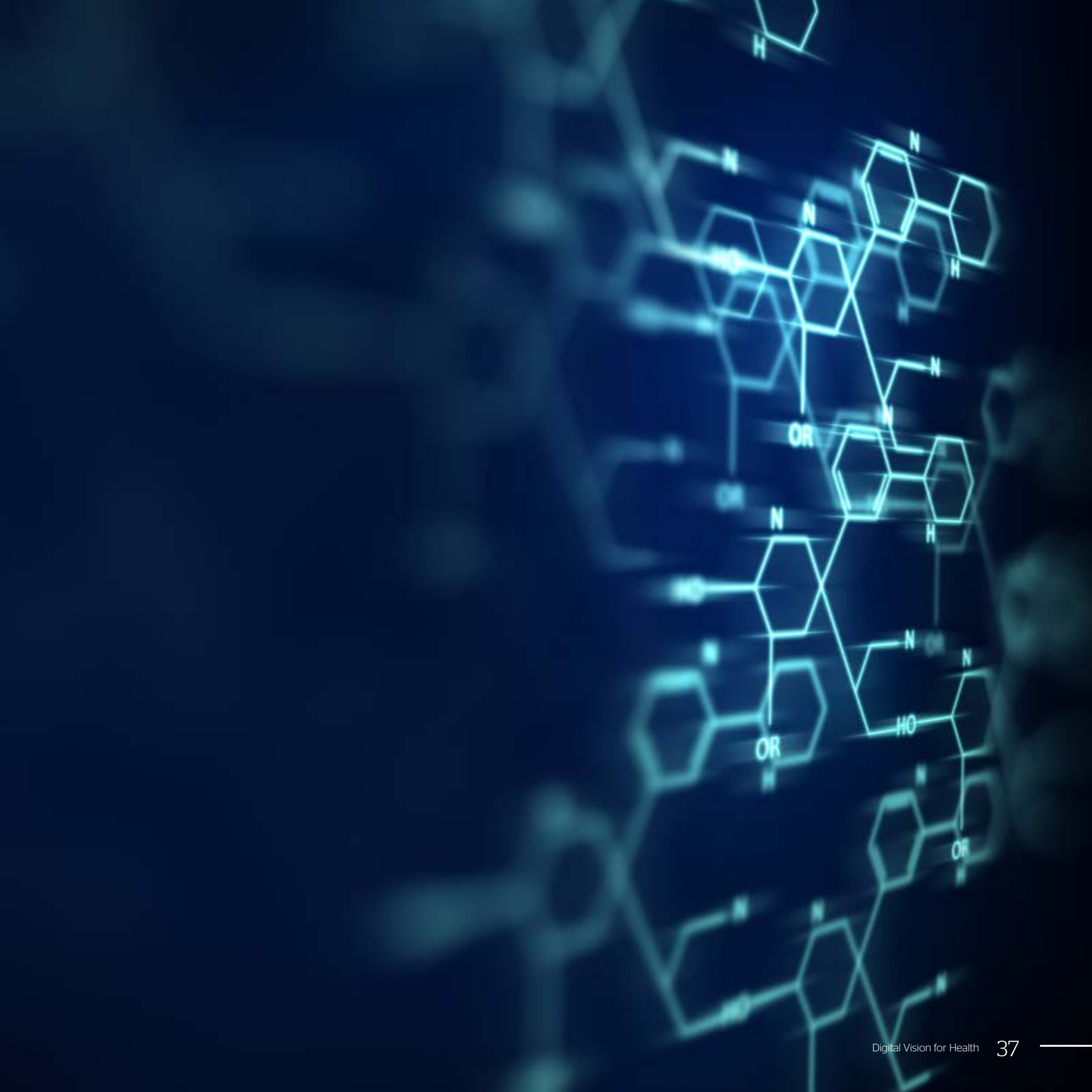
- secure, to ensure that the data is used in a minimalistic, targeted way, for duly declared, traceable purposes, in accordance with patients' informed consent;
- respectful of patients, for ethical reasons but also to secure their engagement;
- patient-centric, to achieve the real medical and economic value added of healthcare AI;
- equipped with technical tools based on a sovereign European cloud system including infrastructure and software components, with appropriate service levels.

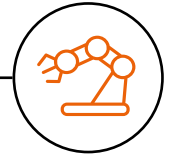
This integrated approach must result in the iterative, agile implementation of use cases enabling operational services for the healthcare journey stakeholders, for the benefit of patients. In other words, the needs expressed by doctors and patients must be placed at the heart of the process.

Adapting the training of healthcare players

The emergence of new fields of knowledge and expertise makes the dialogue between research, industry and the medical sector vital. New professions will emerge to respond to specific, interdisciplinary needs.

Tomorrow healthcare players must be trained according to these scientific and technological changes. Such transformations will only be possible with the informed engagement of the relevant academics, doctors, and industrial players. The trust of citizens, patients and healthcare professionals is essential to obtain the full access and use of the data needed to evaluate and validate algorithms and to improve medical practice. The promise of augmented medicine can only be achieved within a framework enabling patients to give consent deliberately.





How AI will change our experience of healthcare?

Uses of artificial intelligence (AI) in healthcare are fascinating, with machines now able to sense, analyze, diagnose and help with everyday clinical and administrative tasks.

Let's look at some examples.

Helping patients at every step

AI can scan medical records and help diagnose disease, eliminating potential for human error. It can then prioritize cases in real-time, precisely analyzing actions and predicting risks associated with clinical procedures. AI can also help to deliver personalized services based on patient data and moods. In fact, an AI app can recommend the best next step and/or doctor based on medical records.

Reaching new heights in research

Collecting data about all patients in a hospital and applying big data and deep learning capabilities can identify patterns for diseases or individuals. AI also helps to make genetics more precise and understand the connections between drug and disease at the root level, resulting in more effective medications and treatments.

Helping hospitals with marketing and operations

In need of a business strategy based on a detailed understanding of your target market? AI can help with modeling competitive pricing, analyzing market risk and structuring market data into meaningful insights. Operationally, Robotic Process Automation hugely increases the efficiency of repetitive or back-office tasks.

Virtual nurses and healthcare bots

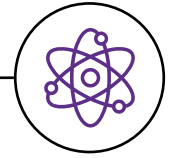
If a patient needs a diagnosis or second opinion, AI can provide digital consultations in the comfort of their home. If a patient needs help keeping track of their medicines and food, virtual nurses are on their way. Or if patients and their families need to choose the best diagnostic center or understand the side effects of a medication, healthcare bots will assist.

Evolving role of doctors

In the near future, AI will operate in the background, with the greatest gains coming from accelerating workflows, supporting clinicians in their decision-making and freeing-up valuable time. Clinicians' role will remain central and will simply evolve, supported by AI.

It's similar to Google Maps, which offers information depending on the place you click: opening hours for a library, or a restaurant menu. In both cases, technology doesn't replace people, it enables them to achieve their goals more efficiently. For example, we all know how frustrating it can be for hospital patients to have to wait. Clinicians also lose a lot of time waiting for patients or lab results. AI can help reduce hospital waiting times by optimizing schedules, so hospitals can plan more efficiently and scheduling systems can take account of patient risk profiles.

The rise of AI won't be confined to hospitals; over time, it will become embedded into mobile and wearable devices. Gartner recently predicted that by 2025, 50% of the population will rely on 'virtual personal health assistants' for their routine primary care needs. And this is just the start of the AI journey, helping humans to save lives and stay healthy across the spectrum of health and care.



A quantum leap for healthcare

With recent advances in data and analytics, automation and artificial intelligence, the capacity even of today's most advanced supercomputers will start to reach its limits. The good news is that a new computing power is emerging that will bring remarkable changes to many sectors, including healthcare. Quantum computing is opening up possibilities that will transform the way in which human beings process information by offering vast improvements over traditional computing in computation time, quality, cost and energy usage.

What is quantum computing?

Based on quantum physics, quantum computing - unlike traditional computing - is non-binary. This means it doesn't provide a definite answer; instead, it averages the right answer over multiple identical iterations and works with multiple states at the same time.

Even now, there are some processes and tasks that have been difficult, if not impossible, to achieve using traditional computing because of their size and complexity. Quantum computing changes this, altering the way we can approach major scientific and technological hurdles and making research and industrial processes faster, better and cheaper.

Applications of quantum in healthcare

In healthcare, quantum computing will help to meet the opportunities and challenges arising from the explosion of data. The power of quantum computing will enable researchers and healthcare professionals to discover, pioneer and deliver more precise and more personalized diagnoses, treatments and medications.

Here are just three examples.

- **Electronic health records.** The ability of quantum computing to process very large amounts of complex, variable data from many different sources will transform what is possible using patients' electronic health records, with data from connected objects and third parties. What's more, quantum computing offers new and different levels of encryption (called quantum cryptography) to safeguard electronic patients record from cyberattack, even as cyberthreats evolve.
- **Genomic research and personalized medicine.** One of the most significant ways in which quantum computing transforms the ability to process and use big data is genomics. Using the power of quantum computing, it will be possible to massively speed up genomic

sequencing, at a volume and cost that is not possible with existing supercomputing. As a result, clinicians will be able to deliver more personalized medicine, based on an individual's unique genetic make-up, which currently maybe too costly or time-consuming to justify investment at an individual level.

- **New ways to develop drug and new drugs.** Again, using the power of this new kind of computing, researchers and scientists will be able to harness big data to analyze disease patterns to discover and develop new drugs, to treat both disease and individuals. High performance computing processes to advance research will be much simpler, faster and accurate. Perhaps one of the largest, eventual, impacts on healthcare will be the ability to carry out iterative drug design by, for example, analyzing the structure of a virus and, using quantum computing capabilities to simulate different biological reactions in order to formulate effective medications.

Making quantum a reality for healthcare

In healthcare, we're likely to see applications of quantum computing entering the mainstream in the next 10-15 years. To make this realizable, research and development into quantum computing today is critical. That's why Atos has already embraced quantum computing as one of the game-changing innovations of our time.

The Atos Quantum program is our response and is the first quantum computing industry program in Europe. As part of this, we are developing a quantum simulation platform to enable researchers to test, algorithms and software for future quantum computers - together with a portfolio of quantum applications, including quantum cryptography.

While there is much to be done, these are very exciting times as quantum technologists all over the world prepare for this truly revolutionary and awe-inspiring technology to enter the mainstream.

About Atos

Atos is a global leader in digital transformation with 120,000 employees in 73 countries and annual revenue of € 13 billion.

European number one in Cloud, Cybersecurity and High-Performance Computing, the Group provides end-to-end Orchestrated Hybrid Cloud, Big Data, Business Applications and Digital Workplace solutions through its Digital Transformation Factory, as well as transactional services through Worldline, the European leader in the payment industry. With its cutting-edge technologies and industry knowledge, Atos supports the digital transformation of its clients across all business sectors. The Group is the Worldwide Information Technology Partner for the Olympic & Paralympic Games and operates under the brands Atos, Atos Syntel, Unify and Worldline. Atos is listed on the CAC40 Paris stock index.

Find out more about us

atos.net

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Let's start a discussion together



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