DHEW

Digital Health Ecosystem Wales

Artificial Intelligence, Machine Learning and Robotics

Summaries of the presentations given at the Digital Health Ecosystem Wales event

September 2018

GIG CYMRU NHS WALES
Gwasanaeth Gwybodeg
Informatics Service

Hwb Gwyddorau Bywyd
Life Sciences Hub
Cymru
Wales

Artificial Intelligence, Machine Learning and Robotics

We are delighted to bring you the first in a series of publications from our unique Digital Health Ecosystem Wales (DHEW) programme.

Delivered in partnership by Life Sciences Hub Wales and NHS Wales Informatics Service, DHEW convenes and connects developers and companies offering innovative digital health solutions, with the NHS in Wales.

Funded through the Welsh Government's Efficiency Through Technology Programme, the programme is transforming the way that engagement and co-operation takes place between NHS Wales and industry for the adoption of digital solutions.

Our September 2018 event highlighted the ground-breaking health and care innovation currently taking place with health across Wales, the UK and Europe using Artificial Intelligence and Robotics, providing valuable learning and inspiration to our Eco-system partners.

We hope that you will join us in driving forward and supporting collaboration to effect significant and sustainable improvements to the health and wellbeing of families across Wales.

Content overview

What role could Artificial Intelligence, Machine Learning and Robotics have in helping to address the challenges faced by heath systems around the world?

This is the question posed at the September 2018 DHEW event, which brought together an audience of innovators, clinicians, NHS and industry. The speakers outlined a range of examples where Artificial Intelligence (AI) is already in use in healthcare environments and explored the benefits and challenges posed by these applications.

Professor Hamish Laing, Professor of Enhanced Innovation, Engagement and Outcomes at the School of Management, Swansea University hosted the event. His own presentation posed the possibility of an 'extinction event' if the challenges facing Western healthcare systems were not addressed. He acknowledged high levels of distrust of AI among the UK public even though it is already in use in the NHS and asks whether we need to better educate the public.

Director Digital Health at the Innovation Agency, Alan Davies introduced the State of the Nation Report on the use of AI in healthcare. Published by the Academic Health Science Network (AHSN), the survey saw 131 organisations feedback about their own AI adoption and revealed widespread concerns about trust, privacy and ethics. He suggests next steps include the development of an AI directory to share who is doing what with AI across the UK to better support each other.

Dr Phil Webb, Associate Director of Innovation, Velindre University NHS Trust shared a pilot that tested the use of AI chatbots for patient communication. RiTTA demonstrated a positive reception among cancer patients. The project is seen as a stepping stone towards more sophisticated patient-facing AI tools.

Nuno Forneas and Ricardo Gil Santos from the Portuguese provider of technology solutions for the healthcare sector, Glintt, showcased their company's offer. Glintt uses AI to help improve logistics, resource management and HR and was able to show real-life examples of a private company servicing both the public and the private sectors for the benefit of patients.

An outline of each of the presentations is available within this publication and on Life Sciences Hub Wales website. These include the key take-aways from each presentation as well as a note of the questions and answer session following each presentation.

Artificial Intelligence and Robotics

A presentation by Prof Hamish Laing, Professor of Enhanced Innovation, Engagement and Outcomes, School of Management, Swansea University

Headlines

- The developed world is facing five forces of disruption that affect healthcare
  - Changing age demographic
  - Rise of chronic disease
  - Increasing amounts of digital data
  - Increasingly sophisticated (and expensive) technology
  - Increasingly savvy patients/consumers

- Could or should Artificial Intelligence help us address some of these issues?
- Studies show a high level of distrust of AI among the UK public.
- AI is already successfully used in many UK healthcare applications. Do we need to better educate the public?

Five disruptive forces in combination

The challenges facing today's health systems are largely the same across the developed world. Five forces of disruptions are coming together and could be regarded has having the force of an extinction event if not addressed.

1. Greying patients (and providers).

Demographic changes means that there are now a great number of older patients, in terms of physical numbers as well as a greater percentage of the population. Healthcare professionals are also older as a group. This massive growth in the elderly demographic is placing a greater demand on health services.

2. Rise of chronic disease

25% of people now live into old age with chronic conditions. This can lead to complexity in treatments, such as managing patients with multiple co-morbidities who rely on an increasingly large cocktail of medication.

3. Information Revolution

From a world where information was scarce we are now creating a tsunami of data. How clinicians manage so much information about their patients and how we can make sense of it for them (context-specific, aligned with best evidence) will be key.

4. Blessing and curse of technology

Technological advances have undoubtedly had a massively positive impact on healthcare. But technology also comes at a price. How much is too much? How do we future-proof budgets in an age of increasingly advanced (and increasingly expensive) technology? How do we get best value from the technological advances?

5. New health and care consumer

Our patients are increasingly knowledgeable about their illnesses and can make informed decisions about their care. Should we think about them as patients or healthcare consumers?

Demographic shifts

Not only is the population ageing, the percentage predicted to live into very old age — beyond the age of 85 — is growing fast.

Rise in chronic conditions

Not only is the population growing in size and longevity of life, the number of people living into old age with chronic health conditions is increasing. By 2036 as much as 10% of patients will be living beyond the age of 85 with seven or eight chronic conditions.

Ageing beyond our ability to support

Our healthcare sector will need to stop being so labour-intensive. Our ageing population means there won't be the same percentage of people available to look after patients. We are already seeing staffing pressures today. For example NHS Wales has significant shortages in cellular pathology and diagnostic radiology, both specialisms thought to be able to benefit from augmented or artificial intelligence. In NHS Wales today, we're currently

short of 70+ radiologists. Could image recognition (ie normal / abnormal) help speed processes and help our specialists focus on where they add most value?

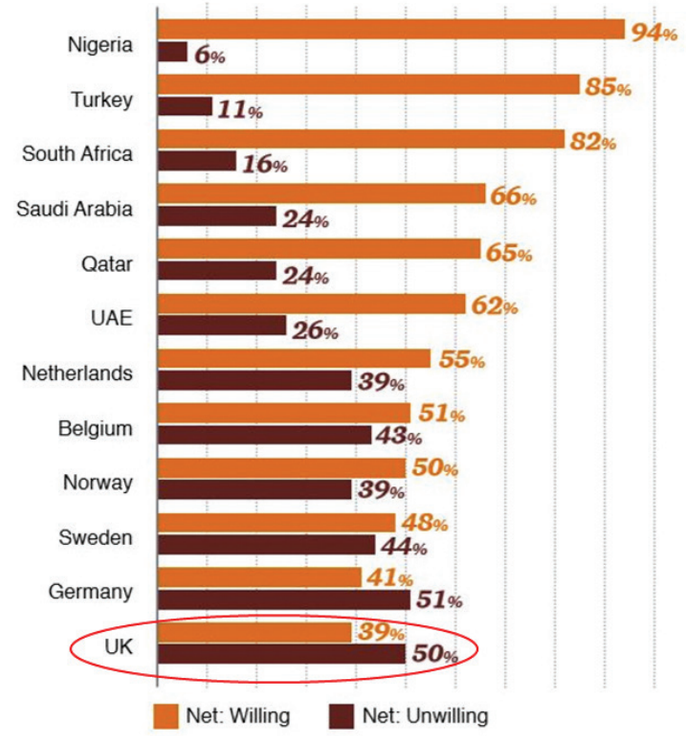
Are AI and robotics the answer?
The World Economic Forum produced maps of challenges facing healthcare delivery systems and the potential of artificial intelligence and robotics. These maps indicate several links and suggest a potential wide-ranging impact of interconnectivity.

What do people think about AI and Robotics?
A recent global survey by PwC revealed a wide range of views. A large percentage of people surveyed in the UK were not keen on the idea of using AI and robotics in healthcare.

Major variation in acceptability between nations

Significant concerns about AI/Robotics in the UK

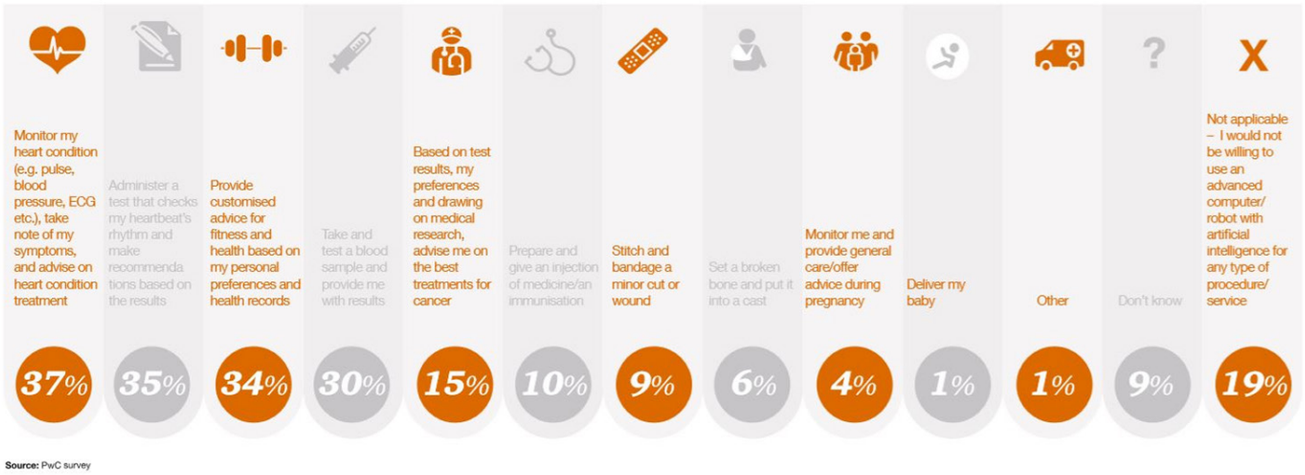
Figure 3: Percentage of respondents willing/unwilling to engage with AI and robotics for their healthcare needs (by country)



Source: PwC survey

Drilling deeper into the survey responses showed a split between the delivery and monitoring aspects of healthcare. A greater percentage of people were ok with the idea of care monitoring carried out by AI or a robot than the delivery of care.

Figure 7: Procedures respondents were most willing to receive from an AI/robot, when asked to rank three



Source: PwC survey

The UK's negative responses towards AI and robotics in healthcare do not reflect how much they are already in use in the NHS. It may be that the British public are unaware of how far this technology has been adopted.

Babylon Health
Babylon Health is one health provider offering an AI online platform that "thinks like a doctor".
https://www.babylonhealth.com/

DeepMind and Moorfields Eye Hospital
In collaboration with Moorfields Eye Hospital, a study has shown that DeepMind's AI can detect 50 eye diseases by looking at ultrasound 3D scans. The system employs machine learning and, as reported in the journal Nature Medicine, can produce a faster and more reliable diagnosis than clinicians.
https://deepmind.com/applied/deepmind-health/working-partners/health-research-tomorrow/moorfields-eye-hospital-nhs-foundation-trust/

University of Surrey and Surrey and Borders Partnership NHS Foundation Trust
The Surrey and Borders Partnership NHS Foundation Trust has recently been awarded £1million funding to research how machine learning can be applied to an Internet of Things network in the homes of people with dementia. A refined alerting process is helping to minimise false alerts while monitoring is helping to pick up health issues before they become problems. Early findings indicate that individuals involved in the trial demonstrated lower levels of depression, agitation, anxiety and irritability and were hospitalised less often.
https://www.sabp.nhs.uk/tihm

Accelerating Artificial Intelligence in health and care:
results from a state of the nation survey

A presentation by Alan Davies, Director, Digital Health Innovation Agency

Headlines

- The AHSN Network has published a new state of the nation report on the use of AI in health care. Access it online http://www.ahsnnetwork.com/ai-in-health-and-care/
  The survey saw 131 organisations feed back about their own AI developments /adoption.
- Most early AI adoption uses the lowest complexity of AI.
- The greatest AI impact can be found in the unlocking of value in data analytics and diagnostics.
- Key issues include trust, privacy and ethics. A robust code of conduct may be the best way to address privacy issues and build trust and adoption.
- Engagement with healthcare professionals is key in the development of AI.
- Next steps include the development of an AI directory to share who is doing what with AI across the UK and develop an ecosystem to better support each other.

Academic Health Science Networks (AHSNs) and the Innovation Agency

There are 15 AHSNs located around UK tasked with supporting the NHS with increased adoption and spread of innovation including digital technologies. The Innovation Agency is one of the 15, covering South Cumbria, Lancashire, Merseyside and Cheshire, with a population of 4.1 million people.

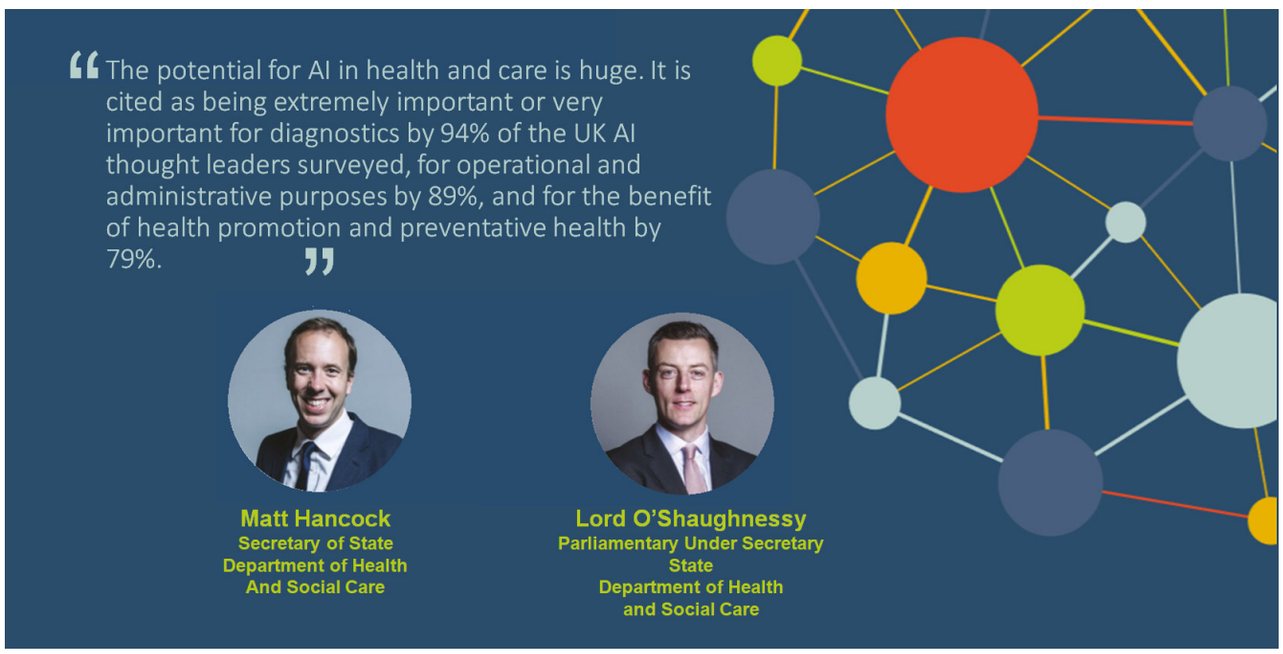
The AHSNs have been re-licenced following the first five year licence and in this second five year period they are commissioned by NHS England, NHS Improvement and the Office for Life Sciences. They are working closely together to deliver national programmes of work to achieve rapid uptake of innovations proved to have an impact, across the country. Their role is to try and understand the best of what is available today and what can be put in place for tomorrow.

State of the nation report on the use of AI in health and care

Accelerating Artificial Intelligence in health and care is a survey published this autumn by the AHSNs: http://www.ahsnnetwork.com/ai-in-health-and-care/

The survey report looks at what we mean by AI in heath and care, presents the results of the 2018 survey, provides feasibility analysis and proposes next steps.

Part of our role is to understand and unlock the potential that AI presents to healthcare. The Department of Health has expressed an explicit interest in doing this.

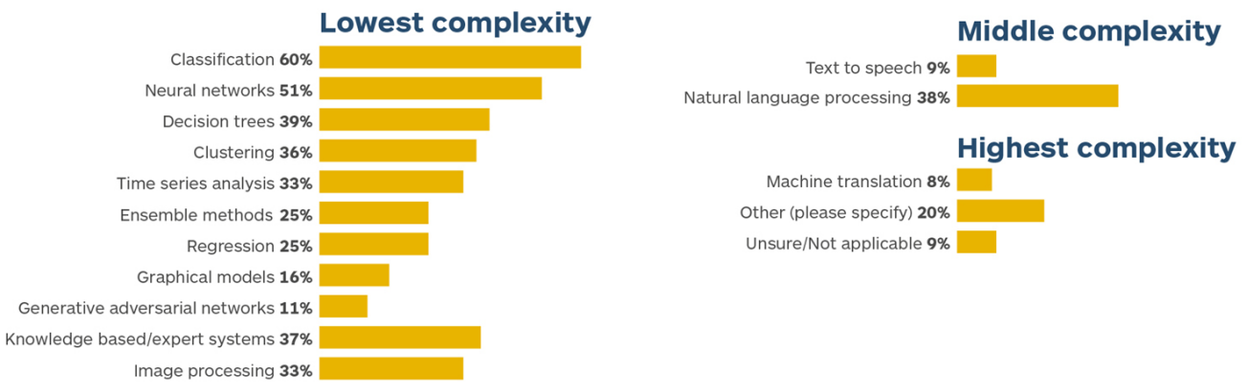


What is artificial intelligence?
But what do we mean by AI? There's isn't an agreed definition of AI, but it generally refers to machines that can learn from experience, supplement human intelligence (for example supporting a radiologist review of scans) or create 'smart' or responsive environments. It's worth noting that AI is already being used in many different ways in most of our lives, often without us really even noticing it is AI – a good example being SatNavs.

- Alder Hey Children's Hospital employs a chat bot called Ollie to enable patients and parents to ask questions about everything from what different treatments mean to the location of the toilets.
- The 111 triage solution is looking at ways to pick up calls in an automated way to release call handlers and to try to improve patient experience (and lessen the time they are 'on hold').

The Accelerating Artificial Intelligence in health and care survey saw 131 organisations across the UK feedback about their own AI adoption. We found that a lot of early AI adoption can be categorised in terms of lowest complexity. Most of it is used to speed up what humans can do. There was a much lower rate of adoption in the high complexity area. (By high complexity we mean something like autonomous vehicles).

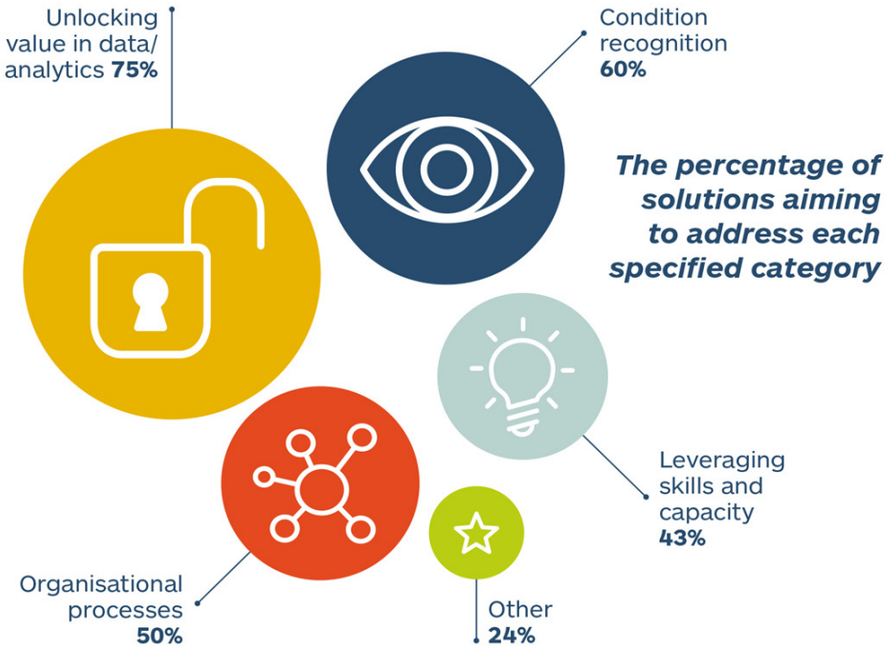
Most AI solutions delivering impact now are on the low complexity end of the spectrum



Key areas where AI is delivering impact
We live in an aging society. 50% of children born in 2018 are predicted to live to 105. How will they get around? Perhaps we do need to think about the adoption of autonomous vehicles for this group of people in the future?

Today the area experiencing the greatest impact of AI is in the unlocking of value in data analytics. Condition recognition also has a large percentage of AI solutions, particularly where AI is used to help find things (diagnostics support). Much of the AI in condition recognition has a learning system and the ability to cross-reference with case notes.

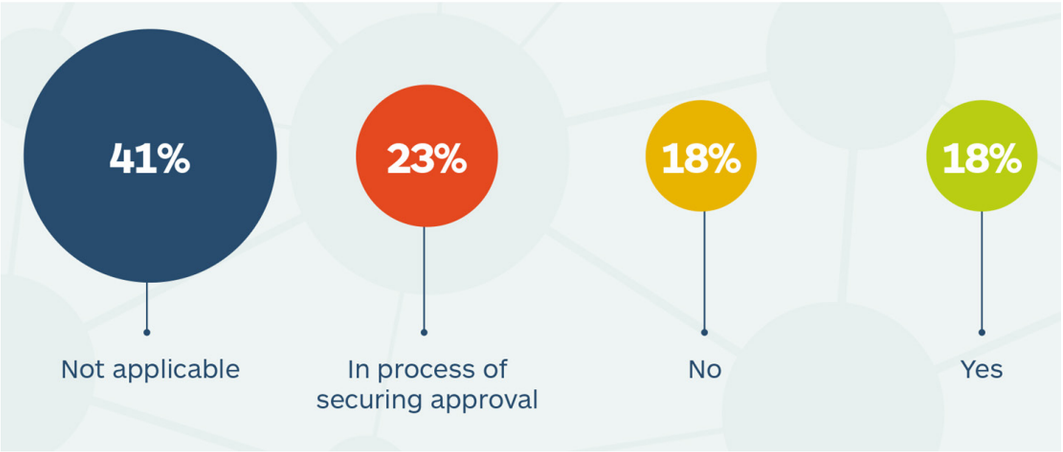
Key areas where AI is delivering impact



Most AI projects are at the research stage, or in very early stages of development. Below are some of the organisations that are currently involved in AI projects.

We are at the stage in the development of AI where funding and regulation are both key aspects to be considered. Many people have called for better regulation. This is a new area, which needs to be properly funded with regulations giving confidence and trust in what is delivered.

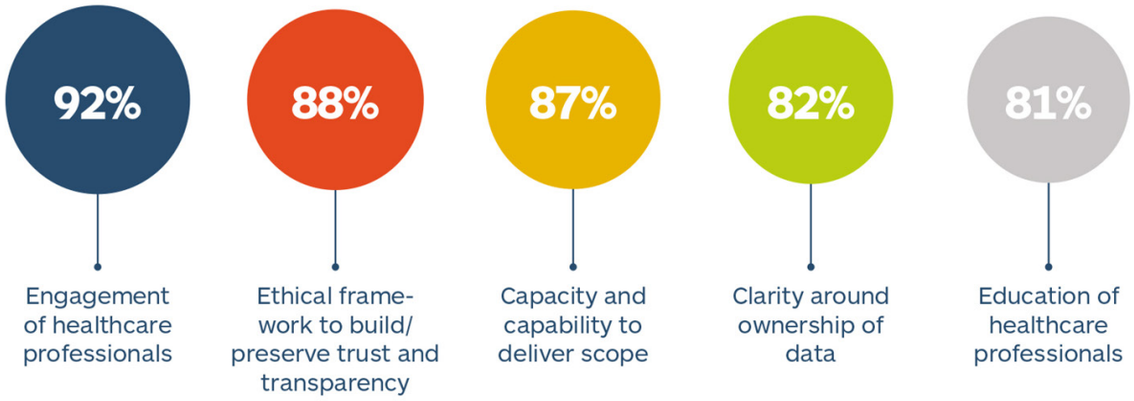
Most AI projects are at research stage, with a minority regulatory approved and/or commercially available:



AI and clinicians

Engagement with, and education of, healthcare professionals is important. For example, today most of us have cars with parking sensors. This is a form of AI and can be an analogy for much of the AI that would be useful for clinicians - ie healthcare AI that can be used as a useful warning tool for (but not a replacement of) healthcare professionals.

The full impact of AI requires attention to key enablers



What is the answer to the question: 'what are you doing with my data?'

Key issues highlighted in the survey included trust, privacy and ethics.

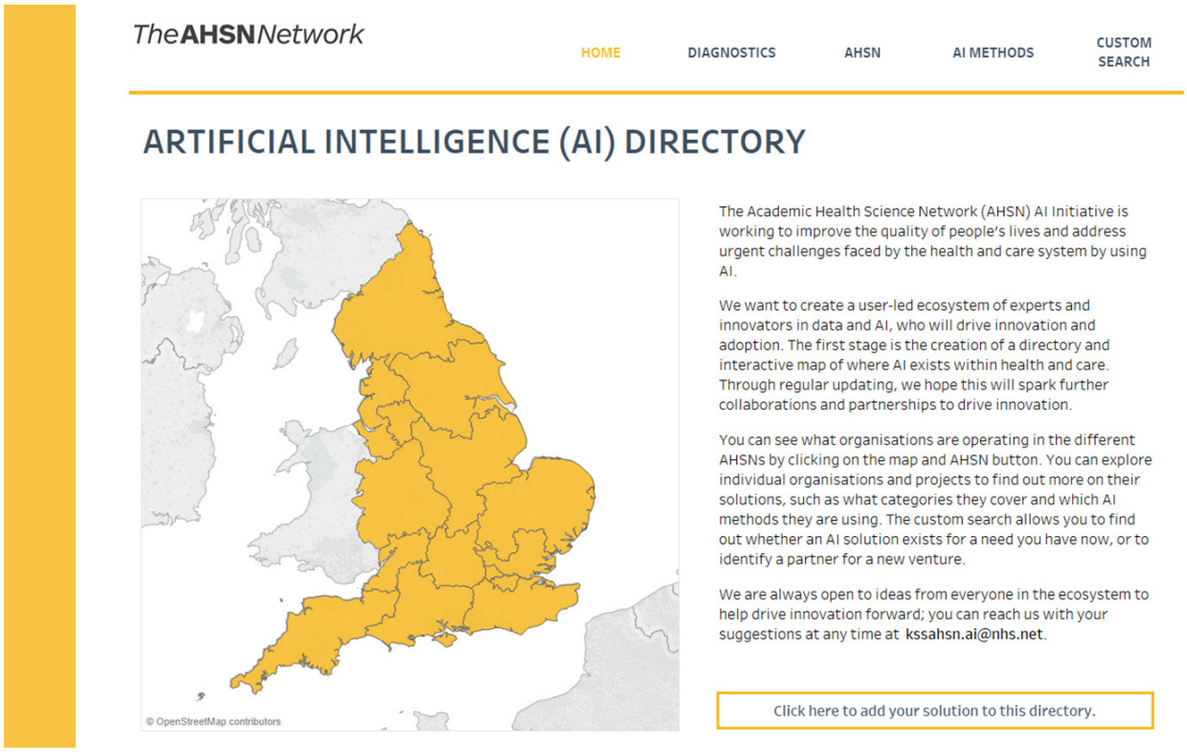
Trust privacy and ethics

	Engagement of healthcare professionals	Ethical framework to build/preserve trust and transparency
Extremely important	58%	61%
Very important	33%	26%
Quite important	8%	9%
Somewhat important	0%	3%
Not at all important	1%	0%

	Education of healthcare professionals	Education of public
Extremely important	50%	37%
Very important	31%	28%
Quite important	17%	25%
Somewhat important	2%	10%
Not at all important	0%	0%

Where next?

Next steps for the AHSN Network includes the creation of an AI ecosystem. This includes a directory and map of where AI exists in health and care around the UK. This can be used to create and build connections across the ecosystem as well as provide easy identification of emerging and mature technology.



Q1: Why is it hard to get what society already uses into healthcare? How do we get acceptance?

A: A prime driver to help reduce hesitancy is a robust code of conduct. If we provide some regulation for AI solutions and have a clear ethical position, we can better support both patients and healthcare providers in understanding the offering and making an informed choice. The idea is to give us a frame of reference by which we can accelerate what's going on. We need to find a balance between patient safety and improvement to outcomes. There is a tension between the old way and new ways of doing things. The old way currently works, but it might not in the future due to change in our country's demographic.

Q2. Could the adoption of AI be driven by a business case?

A: Technology can help leverage existing staff and thereby help maximise scarce human resources. We could potentially freeup staff to focus on higher value care needs.

Q3: How can we avoid excluding older people? The low level of digital literacy for older people is frustrating – more attention needs to be paid to that.

A: There are some initiatives. For example, Pathways charity is giving mobile phones to homeless people as a way of keeping in contact for their health & social care needs. Turning Point, a charity is helping find blended options for people who do not engage in digital. Empowering people to support their own self-care is important – and we need to be talking to a mixture of people from all ages.

That said, one of the biggest barriers to technology adoption is clinicians. It is important to support clinicians and help them become comfortable in the use of AI. One way we can address that is through co-development. Engaging clinicians in the development process helps to address real healthcare issues and makes it easier to win the hearts and minds of the people who need to use the technology. The AHSN's working with local and national partners such as HEE and Local Workforce Development Boards to engage the healthcare workforce with digital technologies including AI, and working with local training organisations. In many digital areas outside of AI, the technology is proven, but the barriers to adoption are similarly all about culture change.

Realtime Information Technology Towards Activation (RiTTa)

A presentation by Dr Phil Webb, Associate Director of Innovation at Velindre University NHS Trust

Headlines

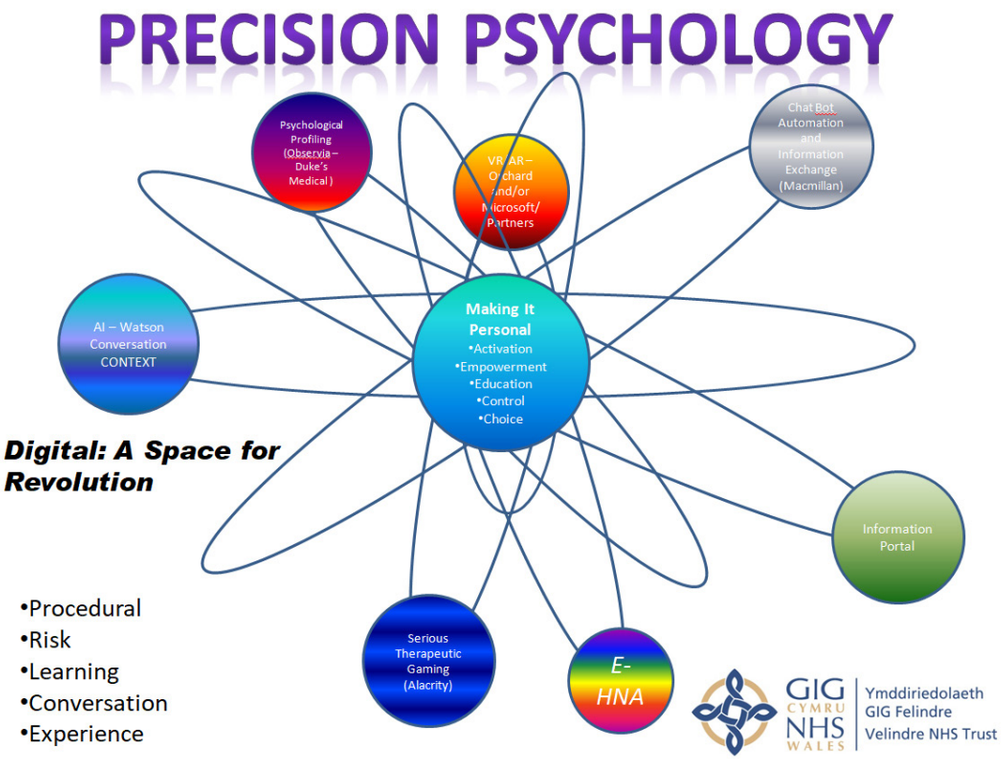
- Velindre University NHS Trust has been working on its cancer strategy, identifying what matters most to its patients. Survey results show:
  - We talk outcomes, but patients talk about choice and value communication.
  - Emotional health and well-being is valued by many cancer patients as highly as physical health.
- Velindre piloted a virtual assistant RiTTA to help answer patient questions about their care. The prototype was well-received by patients and it can be seen as a positive step forward in the development of patient-facing technology.

Cancer strategy – what matters to our patients?

As part of our commitment to improvement in care we looked closely at our cancer centre and identified a disconnect between what we did (activities largely directed at improving physical health) and the care provided. We needed to write a new cancer strategy and needed to reconnect with people. We started by talking to the people we cared for and devoted 12 months talking to a range of patients. Our results showed that talk outcomes, but they talk about choice and we value communication. Many people told us that their emotional health was more important than their physical health.

We think we put the patient at the centre of their care, but is that true? Asking ourselves about patients' expectations and how to have a conversation about this led us to the concept of precision psychology.

Precision psychology

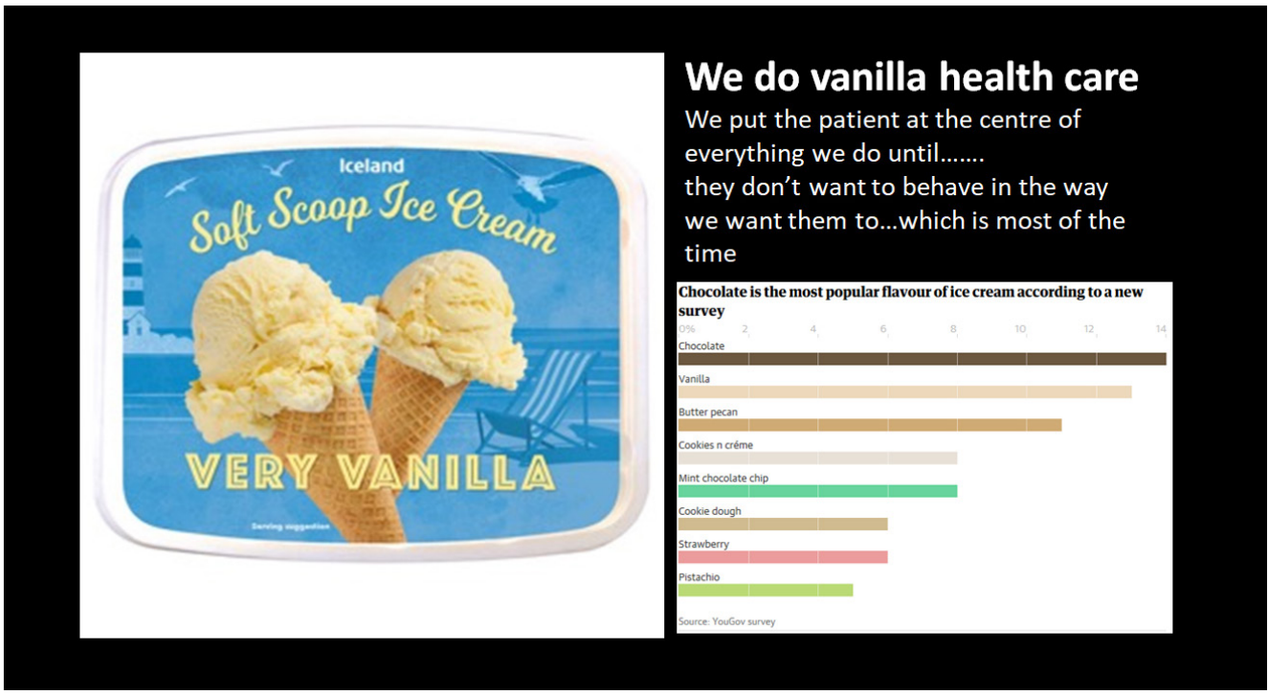


How do we get people to make decisions about their care?

We found we need to make it personal. Focusing on patient empowerment and education can lead to a better outcome for individuals.

What tools do we have to use for patient information and education?

Currently our patients have to rely on a 15 minute meeting with their oncology team in a busy hospital environment as the usual method for talking about their cancer care. This can be stressful for them and many told us that they had forgotten what they were told. Is there a better way to share information with people outside of the ways that they currently get it? We found that we were offering vanilla health care by assuming that what we had done in the past in delivering information and knowledge still applies today. We were not recognising that people are different – that there are many flavours beyond vanilla. Does a vanilla approach put our patients at the centre? Not really.



Our challenge to healthcare organisations is to put the people you serve at the centre of your planning. We need to engineer better outcomes within an environment of no money and no people to deliver them, using technology to improve the experience for the people we serve.

RiTTA

At Velindre University NHS Trust cancer care, our version of helping people have better conversations is Rita. Kind, friendly and knowledgeable, Rita answers between 900 and 1,100 calls a day. Questions range from "are opioids addictive" to "can I drink on while on chemotherapy?"

We looked at ways we could embed the knowledge and experience of a real helpdesk person, Rita, into an AI version, RiTTA: Realtime Information Technology Towards Activation.

Built on patient need at Velindre, RiTTA is the next iteration of IBM's virtual assistant, and built on the experience of Alder Hey's chatbot Ollie. She is being trialled with breast cancer patients and we are pushing our partners at IBM to find solutions for complex problems. For example, we have asked whether RiTTA can respond appropriately to the patient's emotional state. We also asked for a holographic image of RiTTA, Apparently no one has asked IBM if their virtual chatbot can have a holographic image before! We're enjoying exploring the options and pushing boundaries with our partners. Ultimately we hope that we will create a domino effect and help this whole area of technology move forward for the benefit of patients.

Q1. How did you include the learning from the real helpdesk Rita?
A. We took recordings of real conversations – and the way that Rita talked to people was taken on board. In addition Rita worked with us, giving us advice about how she responds to her callers' different emotional states.

Q2. Is RiTTA only for cancer patients?
A. We hope RiTTA will be one tile in a line of dominos. Once you build something like this, you can make it amenable for any application and any conversation.

Q3. Can RiTTA also work as a point of care device – eg blood tests?
A. RiTTA is a player of many parts and is not just limited to talking. Any IOT (Internet of Things) internet enabled device can have interoperability. We simply need to open this up to make RiTTA compatible with other applications. There are issues, so will need permission from patients and need to make it secure. But RiTTA can read any API so we just need to accept this technology as a society to move forward.

Q4. Is there any personalisation of RiTTA? Does she have any context or knowledge of who I am and where my journey has been so that I don't have to repeat information each time I access her?
A. To comply with GDPR, RiTTA currently forgets what you told her unless you specifically direct her to remember your details, which would allow her to carry on where you left off. That said, people are asking us why they can't do things that they can do with online banking for example. I think in 5 to 10 years time consumers will make choices and functionality will have expanded. But we have to go one step at a time and need to get products out for people to use before we can go forward. As a consequence of problems such as these, there are not many RiTTAs out there.

Q6. Is RiTTA vulnerable to exploitation – such as in cyber crime? Surely confidentiality in patient discussions is important?
A. Yes and yes. RiTTA is effectively supervised AI (and works like a member of staff on the helpdesk). As with her human colleagues, she is only as good as her training. It is our responsibility to set up a

system with transparent algorithms (ie has RiTTA said the right thing?) But the same standards and governance apply as with people. In terms of cyber security, nothing is non-hackable. We have to do our best to mitigate risk and to inform patients of the risks, as we do in all aspects of healthcare.

It is also worth bearing in mind that every day we're giving our data to commercial enterprises (Facebook, Amazon, health & fitness apps), but not the NHS. We need to have these conversations – we should have these more often – because the speed of technological change happening outside the NHS could kill the NHS. Further, the problems may lie beyond the sharing of data with the NHS. For example, if you reveal your details to an IBM chatbot employed by the NHS, where does the data get stored? With the NHS or IBM? Data storing etc needs to be properly set up and regulated.

MARIO Project

A presentation by Professor Dympna Casey, National University of Ireland Galway

Headlines

- Project MARIO was a research project funded by EU H2020 looking at how robots could be used as social companions for people living with dementia. The pilot operated across three countries and three settings: a hospital, a care home and a community centre.
- MARIO is a humanoid robot employing apps to engage with people living with dementia. The most popular apps were:
    - My music – a playlist of the patients' favourite songs
    - My memories – a photo album and commentary
- MARIO was most successful with people living with less severe dementia who saw the potential it offered for them to maintain their independence for longer.
- Patients with the most severe dementia needed support in accessing the apps, but many of these – painting, music etc – demonstrated successful outcomes.
- Social robots have real potential for use in dementia care.

Why Project Mario?

Estimates show that as many as 1/3rd of people with dementia in Britain are lonely. Project MARIO focused on psycho-social interventions to help address social isolation. Could robots have a positive impact, promote social engagement and help create a better quality of life? I was sceptical at the outset as regards to whether older people living wwith dementia would be accepting of this technology and of the notion of having a robot as a companion but their reactions were overwhelmingly positive towards the idea . We had 3 pilot sites - Italy (hospital), Stockport (community), Ireland (care home).

Why a robot – why not an iPad?

We found that iPads and smartphones may be too complex for older people living with dementia to access and use. Having a disembodied voice as with an IPad may also be quite distressing for older people living with dementia rather than an embodied presence as in a humanoid robot. Many people in the Irish pilot site had severe enough symptoms which meant that they were not always able to interact with MARIO directly, but carers or family members were able to provide support and help them when needed to work with MARIO.

Human vs robot

Our key message when working with staff, users or family was that MARIO was an adjunct, not a replacement. Human interaction is key, but with resources stretched and public services not able to provide this level of support then a companion robot may be an acceptable alternative.

MARIO's design

Our design process was user-led. We started by identifying the key requirements people would like to have, such as appearance - what was more acceptable? We interviewed people with dementia, as well as their carers and clinicians. The functions most requested were:

- Remind people of events, telephone numbers
- 'Remind me' (remind me that people have visited me, remind me to eat or drink)
- Access favourite music, books
- Provide interactive and stimulating games
- Access family on Skype
- User face recognition (no need to remember passwords)
- Direct me to the bathroom
- Have a human voice

The concerns raised during the design process included:

- Will it replace my nurse?
- Storing of private information – how secure is information?
- I want to relate to a machine with human characteristics

Technology is still at an early stage, so we could not build a magic wand. We built MARIO applications around 4 four principles

1. **Individuality – it needed to be personal**
2. **Person with dementia must be given choices (too often these can be eroded)**
3. **Prompts - to help people retain memory**
4. **Simple intuitive to use**

We developed and tested MARIO with 91 people all in the real world, not the lab. The project was 3 years in duration and testing and development ensued until toward the end of the project when we had a 2 month evaluation phase at each pilot site.

Successes and challenges
It was a challenging process – our key challenge wasn't always the technology! Engineers and nurses use different languages and abbreviations to communicate eg nurses use medical jargon and engineers use engineering jargon, which can make communication difficult; expectations of the technology can also differ.

Research testing and initial results
- Quantitative testing showed no discernible changes, but that was expected as the testing period was only 8 weeks.
- Qualitative evidence was based on interviews and provided very interesting results. There was an enthusiastic response, overwhelmingingly positive response from people living with dementia across all sites who were keen to have MARIO to help them stay independent for as long as possible.
- There was also evidence of increased cognitive engagement – especially focused on using the apps. One older person living with dementia often became quite agitated and exhibited frequent challenging behaviours. He found the painting app – and was able to stay focused for quite some time, one evening he spend a full 40 mins using this app . His carers reported that his concentration levels meant he had never been able to do that before.
- The stage of dementia of the user was critical in terms of how much MARIO could be used.
- The most popular functions were My Music and My Memories. My Memories was a collated album of family photographs and events, supported by reminiscence texts built with the user and their family. My Music was a playlist loaded into MARIO based on end users preferences and the second most popular app – many users with severe dementia responded really well to the music. Painting was also a popular app.
- Voice recognition was a challenge – outside noise and people's ability to speak clearly affected how well this worked.
- People preferred to use a stylus – especially those not used to touch screen technology.
- The primary concern of staff had been that they would lose their jobs. When they saw MARIO in operation, they realised that MARIO could not plan or deliver care. Their jobs were still important. A secondary concern revolved around the digital fluency of staff – some were concerned about their own ability to operate MARIO. A few carers argued that resources should go to more nurses or occupational therapists.

This was one of the largest studies completed to date but was still small – we wanted to test out a fully autonomous robot but the platform provider went out of business mid-trial. We feel there is need for suture studies with and more autonomous version of MARIO. We feel that social robots have a real potential use in dementia care.

Question and Answer session:

Q1. Are there plans to have robots that can detect if a patient has had a fall?

A. MARIO had no fall detection in this study. MARIO did have an alert button at the bottom of MARIO(ie accessible from the ground) but we did not use it in this study.

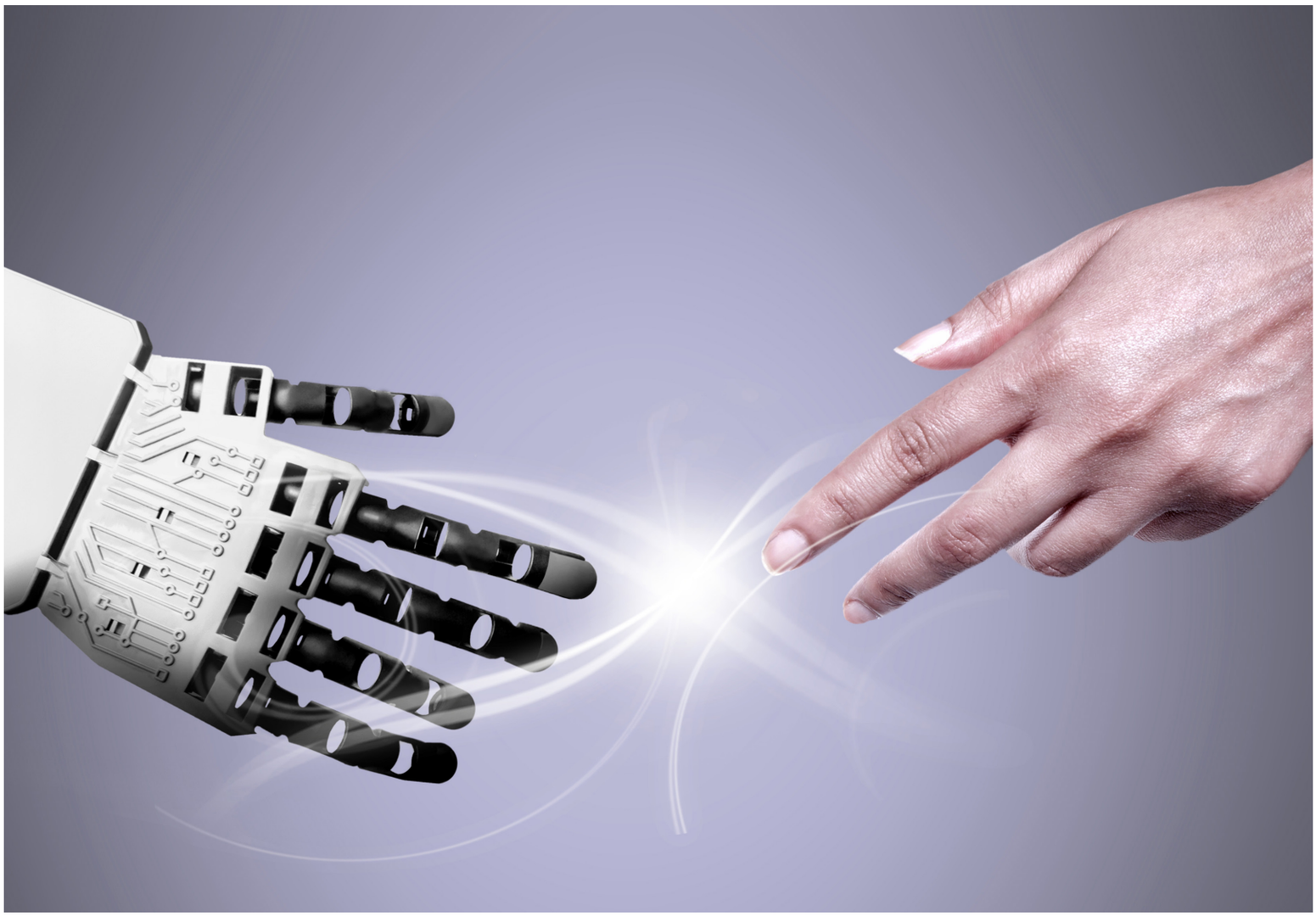
Q2. Commercial aspect – what is the price to the patient and would it be a barrier?

A. A robot like MARIO could cost £15-20,000 when in mass-production (but is not currently commercially available).

Comment: *There are currently several other pilots and studies similar to Mario, such as avatars that collect memories at the Universities of Portsmouth and Kent. Accenture has been working with Amazon and Echo Voice interface. The technological changes that are happening right now are colossal. We need to share information, we need to better map who is doing what potentially though some kind of directory, although understanding the need for commercial sensitivity.*

Q3. Did people use MARIO independently or with carers?

A. It was not autonomous. It could be in the future, but not able to achieve that for this study. There is the scope to add further applications in future studies.



The 4Ps of Healthcare

A presentation from Nuno Fórneas and Ricardo Gil Santos, Glintt

Glintt are a Portuguese company creating and delivering software solutions in Portugal, Spain, Brazil, the UK and Angola. More than 10,000 clinicians are currently using Glintt software in their work.

Headlines

- Digital transformation is necessary for all organisations but not necessarily a pleasant experience to go through
- AI can help improve logistics, resource management and HR in a healthcare setting
- Better logistics support means clinicians can focus more time with patients, not wasting time on administration
- There is no one size fits all approach and technology solutions should be developed and applied to healthcare settings / providers according to individual need

Digital transformation

Nuno and Ricardo believe that there is no secret formula for digital transformation. It's not a 'good thing', more a 'necessary thing', a thing that has to be done. There are risks and not everyone will be successful.

1. We invest a lot in strategic projects (this can be scary, expensive) and we invest in R&D. This is not an option – we just have to do it and have to do it several times to achieve success in some investments.

2. People are the key ingredient – It's usually not technology enabling innovation but people; innovation has more to do with having the right mindset than having the right tools.

3. Our people combine a mix of skills including business, technology and empathy. The latter is difficult to achieve, but it is the key to success in all digital transformation. All innovation is made for people, so empathy is the glue between technology and business and the success factor.

The four weapons of digital transformation are:

1. Machine learning and AI (artificial intelligence)
2. IoT (Internet of Things) and Robotisation
3. Blockchain (trust)
4. 3D printing

Personalised care

We're not always happy to share our information, especially with companies – eg retailers would love to have access to all our history, needs and preferences.

As healthcare providers we have access to a lot of patient information – a lot more than we currently do anything with. We can use this data to improve our knowledge of patients and the care services we offer them. With better support and information, clinicians can better serve patients – have more accurate medical history, adapt care plans for the needs of individual patient and not waste time on double analysis.

Organisations that can inspire us to transform

Nuno and Ricardo highlighted the Johns Hopkins Lifeline programme, designed to make patient flow more efficient. Johns Hopkins explored a different approach to managing day-to-day operations and developed a Command Center. This made everything synchronised – when a patient needs surgery, all the requirements (beds, staff, materials) are identified and put in place to minimise wastage and maximise efficiency. Once AI was introduced into the decision making process, the decisions became more predictive and the gains were even bigger. Other organisations are taking similar approaches to John Hopkins but haven't gone as far – yet.

Artificial Intelligence

AI started more than 200 years ago, anchored in maths. In 1950 the mathematician Alan Turing developed the Turing Test – which at its essence is summarised by Turing's question: "Can machines think?" It can be demonstrated when an evaluator cannot distinguish the difference between a machine's answer and that of a human, or when a computer can persuade the evaluator that it is human. We haven't reached that stage yet, but Glintt have a lot of experience of where this partially works and tools that can apply bits of it.

Glintt AI Tools currently used in Portugal
1. Logistics – this is the most obvious one (how can we raise levels of service in stock optimisations etc)
2. Resources that are scarce – we use AI to schedule them in a better way. This is not just about how much time the surgery will take, but uses data such as the skill mix needed, size of the hospital and the team size as additional factors so support planning
3. HR allocation – labour scheduling. This is about creating a schedule that is feasible and complies with regulations. We have identified the constraints and the available staff, identifying if the right skills mix is available. We use an optimisation tool to save money and balance what we ask of the physicians. By transforming the paradigm, and making it transparent (ie everyone can see the parameters applied to the scheduling formula), the resulting schedule is fairer and avoids the same person working every Sunday etc.

There is no secret formula – so why is there not more AI adoption?
There are many reasons why AI implementation can be difficult. Lessons that Glintt as learned the hard way:
1. Assumptions = screw ups – user centred design is essential to make sure that design doesn't rely on assumptions.
2. Team and knowledge diversity is crucial. Its important to involve legal and accounting teams not just clinicians or IT.
3. Beware of the negativity of others. We have had to be resilient against naysayers.
4. It always happens later than planned but rolls out faster - adopted later than expected, but the moment gets on the mainstream it goes really fast
5. Ideas are infinite, bandwidth and money are not – make sure you take the right steps to maximize the chances of success of the opportunities you find.

Glintt have used this experience to develop a framework based on the 4 Ps of Healthcare that guide its innovation efforts:

1. Preventive – how do we help prevent people getting ill?
2. Personalised – not one size fits all, the more personalised the better
3. Point of care – not always in hospital (hospital is not the centre of world for patient, also what is the role for hospital after patient has gone home?)
4. Perfecting – solutions that take advantage of AI and improve in time, rather than becoming obsolete

These vectors help Glintt decide on innovation paths and new solutions to explore – and understanding your needs and choosing the right amount of either each of these vectors or others you value helps identify the appropriate solutions. It's the mix of rare that makes it unique.

Final advice - Think about terminology. People don't want 'artificial healthcare' any more than they want artificial food. Maybe we should be talking about Augmented Intelligence, in a way that AI extends human capacities and, rather than replacing, supports humans in their ambitions.

Questions and Answers
Q1. In a recent OECD survey, 2 out of 3 said Portugal is best place in world to be ill. In scheduling systems we know using AI would improve efficiency – but do people accept that machine learning is better than people?
A. Our focus has been to build a solid business case to use technology to solve operational problems. It's a clearer case than where life or death decisions need to be taken. There is money to be saved by hospitals now using technology for things such as scheduling – but people on the ground have to be involved. Human factors have to be understood and integrated in order for things to be improved. It is important to build emotional intelligence – and interact with right people once we have the right data to build the algorithms.
We know its key that we talk to people on ground and show how we aren't replacing people but helping them achieve more in their jobs.

Q2. Isn't it true that the Johns Hopkins Lifeline programme crashed at consultant level as it didn't enable consultants to own it?
A. The potential for derailing is so strong if people aren't involved from the start – we learnt from John Hopkins' experience that we've got to get the clinicians on board to get things off the ground.

Q3. How much effort do you put into the redesign of existing processes?

A. Hospital A is different to hospital B and we have to create solutions with individual organisations that are right for them. When we start engaging with medical organisations we start with mapping existing processes and then build new processes with those existing owners. Then people ask us for stuff. If we tried to put in a tool that was not efficient and well-designed, we would be out of business! Our focus is not on our tools, but on the processes. There is an advantage in that we have done it before, we have experience and understanding in this arena – but drill down into each project and you'll see that none of them are the same.

Q4. How do you get over the challenge of bespoke solutions vs tweaked solutions (data sharing) in Portugal?

A. We have APIs in place for a common structure of information.

We invite you to join our
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