PATIENT AI

Towards a human-centred culture of technological innovation in the NHS

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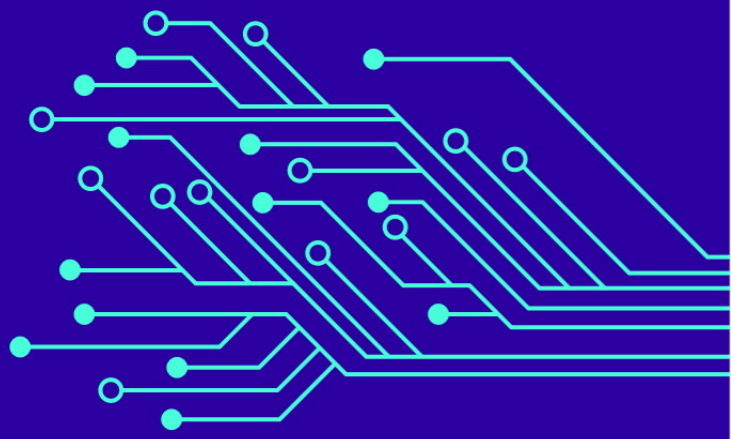

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About the RSA

The RSA (Royal Society for the encouragement of Arts, Manufactures and Commerce) believes in a world where everyone is able to participate in creating a better future. Through our ideas, research and a 30,000 strong Fellowship we are a global community of proactive problem solvers, sharing powerful ideas, carrying out cutting-edge research and building networks and opportunities for people to collaborate, influence and demonstrate practical solutions to realise change.

The RSA has been at the forefront of social change for over 260 years. Today our work focuses on supporting innovation in three major areas; creative learning and development, public services and communities, and economy, enterprise and manufacturing.

About the RSA Tech and Society Programme

Tech & Society is a programme of work that explores how to increase the agency that people have over the way that organisations design and employ technology. Through deliberative methodologies and innovative conversations, we seek to bring together programmers and citizens; technologists and regulators to place cutting-edge developments in service of the greater good.

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The RSA takes responsibility for the contents of this work; any mistakes contained herein are our own.

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Human-centred innovation

"I had one patient ask me: What if the radiologist goes against the AI system? Does the patient have a right to know that the radiologist has gone against the AI and, if so, why they went against it? And if so, and the AI is right and the doctor is wrong, what happens then? And vice versa, who is responsible?"

Response given by an NHS clinical chair to the RSA Tech and Society inquiry.

This short paper reflects on a collaboration between the RSA and NHSX which took place over the course of 2019 that sought to understand the ways in which radical technologies, such as AI and ADS, are influencing commissioning and clinical practice in the health system.

Defining Radical Technologies

AI (artificial intelligence): the field of computer science dedicated to solving cognitive problems commonly associated with human intelligence.
ADS (automated decision systems): computer systems that either inform or make a decision on a course of action to pursue about an individual or business that may or may not involve AI.

Why did NHSX come together with the RSA?

The RSA's flagship *Tech and Society* programme seeks to devise practical ways to involve citizens in complex questions around technology.

One of the methods, trialled by the RSA Forum for Ethical AI, is known as a *citizens' jury*.

1. A group of citizens are convened from a diverse range of backgrounds and perspectives: the 'citizens' jury'.
2. The jury is educated on the relevant issues around AI and ADS, and/or the specific application in question, and encouraged to engage in a deliberative dialogue with one another.
3. The views of the jury are fed back and recorded by the convenor and used to drive insight and reflection.

A large and growing body of evidence suggests that deliberation like this, in larger or leaner form, is key to surfacing ethical questions around technological take up and proliferation. The RSA and NHSX were inspired by this experience to explore the AI proposition in the health system further – and understand how we might create a human-centred culture of innovation that usefully integrates radical technologies in a way that enhances clinician experience and patient care.

The health context

Earlier RSA work dove deep into the proliferation of AI in health. We surfaced three principal uses of radical technological innovations across the health system:

- **Automating tasks.** For example, the NHS 111 system is experimenting with AI for patient triaging by using natural language processing to recognise words that indicate urgency and redirecting callers accordingly.
- **Analysing large datasets.** For example, AI is being used to review the 2.5 million scientific articles that are published each year in order to make recommendations that are specific to an individual's healthcare profession.
- **Predicting conditions through complex pattern recognition.** For example, emerging apps, like SkinVision, are identifying users' likely conditions and making related suggestions for redress.

AI is also assisting medical professionals by identifying existing drugs that could treat rare diseases (Helix), distinguishing cancerous tissue for surgeons to cut through (iKnife) and illuminating where tumours may be (Inner Eye).

Notably, uses of AI and ADS in healthcare in many of these examples were positively received by the RSA's citizens' jury. Citizens were impressed by the majority of examples, particularly iKnife and Inner Eye (although they were more sceptical of automated 111 triaging).

Citizens already have a high level of trust in the NHS and, as part of this, a large degree of faith in the existing regulatory system. There is also general awareness of the intense financial pressure and resourcing constraints within the NHS, which seemed to fuel greater sympathy for the use of ADS.

> *"If the NHS decides it is cheaper and more effective and efficient, it is better. It frees up doctors for other services."*
> Juror comment from RSA Forum for Ethical AI.

The scope of this study

Encouraged by this research, NHSX and RSA came together to understand, not only citizen response, but clinicians' and NHS management's response to the ingress of rational technologies in their professional spaces. Innovation is not just a set of technologies but an environment and

a culture and so we also wanted to understand the human story behind the cultural environment of the health system in which innovation takes place. The interface we chose that would yield these insights was the entry point of these technologies into the health system: at the point of procurement.

This study therefore aimed to:

1. Understand, through appreciative inquiry, commissioner, clinician and patient interactions with radical technologies.
2. Surface barriers and pain points and how we might overcome them.
3. Provide NHSX with ideas to improve the quality of adoption, the cultural environment in which adoption takes place and thus improve clinician experience and raise the quality of care.

Methodology

- Over the course of June and July 2019, the RSA conducted in-depth interviews (according to Chatham House rules) with a range of professionals developing, procuring and using data-driven technologies across the country. A sample of questions asked is included in Appendix 1.
- We spoke with 12 key people across the health system; each interview was approximately one hour in length.
- As well as the principal research questions above, we also posed several additional questions around topics such as safety and public challenge.
- The findings described in this report emerged from inductive analysis of the interview transcripts' key excerpts which are included throughout and in Appendix 2 at the end.

Summary findings

Even in this relatively small set of conversations, there was striking convergence on what needed to be done to smooth the ingress of radical technologies into the health system and create a genuine, human-centred culture of innovation around technological innovation in the NHS. Our summary findings and recommendations to NHSX, based on these conversations, are as follows.

- **Patient adoption is key** for the successful integration of radical technologies, such as AI, in the health system – and is key to creating a genuine culture of innovation in the NHS. Commissioners recognise that innovations and processes that gradually bring clinicians along with managers and integrate seamlessly into the clinical workflow are more likely to endure than 'big bang' interventions. All actors in the system, from commissioners to citizens, have an interest in fostering a culture of patient adoption. This involves consultative and deliberative processes that actively engage clinicians and citizens in conversations that surface ethical and practical considerations around the ingress of radical technologies and address training and cultural needs.

- **Evidence is essential.** Clinicians and patients alike trust interventions that build from a robust evidence base. Evidence, piloting and sandbox-style initiatives can help overcome multiple residual issues around implementation, from misalignment of financial incentives, to misalignment of corporate and clinical cultures and patient expectations.
- **Clinical champions.** A network of designated clinical AI champions should be platformed as an important part of the AI proposition. This would not be a network of hero-professionals; rather they would largely be system-focussed public entrepreneurs who work below the radar to help shift attitudes and practices and provide inspiration to others so as to collectively build a culture of innovation.

In the following sections we unpick these items in more detail. We include a more comprehensive ordered record of our conversations in Appendix 2 at the end of this document.

Patient adoption

Reasons to be optimistic

'We don't want people thinking that we're developing scary, monster type products.'
Response given by an NHS clinical chair.

There are, on the face of it, many reasons to be wary of the incursion of radical technologies into the health system. A proportion of patients and clinicians in our research maintained a residual suspicion that AI-based interventions are 'second class' or 'not real medicine'. On a human level it is easy to see why. Automatic digital diagnosis tools, for example, feel less personal than having a learned, personable doctor examine a patient's ailment.

We were, however, encouraged to learn that clinicians and patients in our sample were open to the proliferation of AI-related technologies in the health system, provided certain, eminently sound criteria are met.

Purpose

Much ill-health in our country is a result of poverty and systemic inequalities that affect physical and mental health; the question should be how technology can help the health system shift these underlying issues in concert with clinicians.

And yet we noted a perceived lack of clarity among our interviewees about where in the health system workflow digital technologies might be introduced, how this would be managed, and why said decision had been made. Instances of bad practice were raised.

We encountered embedded scepticism that technological adoption was not so much about patient care or improving quality of life and health, but to satisfy a political or commercial imperative.

Understanding and agreeing on the purposes of technological implementation is the starting point for a more constructive conversation.

'What's really important, if you're [...] trying to influence the way people think about this, is to bring the public with us, to be sure that the safeguards are in place…'
Response given by an NHS clinical chair.

Deliberation

We were encouraged by the appetite among the practitioner community for public conversation about technological adoption and transfer.

"…Everybody knows that it goes through an ethics committee, that there are huge protections for the data. One thing that is really important, is to tell the story such that we bring the public and patients with us."
Response given by an NHS clinical chair.

Telling the story and collectively crafting the story together are two different things, but both sentiments are part of the solution.

That deliberation is increasingly regarded as a sine qua non of good practice should not be a surprise. There is a growing awareness of the ethical issues around AI and other radical technologies among the public. Both patients and clinicians are becoming increasingly wary of adoption without evidence or public conversation. Each news story about malfunction or misuse of, say, facial recognition technology or data abuse adds further fuel to the fire.

"Whether it's the state working with a citizen, or a doctor working with a citizen on an individual basis, can we have a sufficiently robust conversation around consent that you can make a valid decision about whether you want to be involved in, and be in engaged in [sic], the use of AI as a part of your care, or for looking after your own health….What are the risks of doing it? What are the risks of not doing it? What are the risks with your data? And that's about explainability, the code of practice that's been developed. That's my litmus test, can we have a defensible consent conversation."
Response given by NHS Trust Chief Clinical Information Officer (CCIO).

The concern of many participants was that the NHS needs to do more work, not only on initiatives that invest in technological horsepower, but on convening the right sort of collective conversation to surface unanswered questions around radical technologies and put them to patients and clinicians.

Evidence is essential

The tests

Clinicians, therefore, value technologies that go with the grain of clinical care, rather than 'disrupt' (as Silicon Valley enthusiasts like to put it), unless disruption is absolutely necessary. This is not Ludditism; rather it is sensible practice standing firm athwart technological and political change.

Patient adoption is part of that picture, but so, also is evidence. Clinicians and patients alike value independent evaluations that clearly demonstrate the benefit of new tools above and beyond what is already in place. In this section we detail some of the ideas passed on by participants to meet the evidentiary test.

- **Residual challenges of taking AI from lab to scale must have been demonstrably overcome.** Both clinicians and commercial contractors were concerned that realistic expectations around new technologies are maintained and that 'belt-and-braces' work has been done to demonstrate operational utility.
- **A rigorous anti-bias test is fulfilled.** Just as AI can be used in the criminal justice system to increase stop and search of minorities, so bad procurement of AI (with minimal governance or from less reputable companies) in health can lead to, say, missed diagnoses against patients from certain communities. In so far as it is possible, bias must be mitigated and be shown to have been mitigated through research and testing.
- **Benefits are proven,** for example by deploying technology first at the back end rather than beginning at the front end. This was raised as an effective idea and a way to provide a relatively safe space for innovations to take root, both in terms of practical workflow and in the professional consciousness.
- **Evidence that models the impact of the innovation on clinical workflow** was consistently well received as a key part of the evidentiary picture that brokers goodwill – and is thus a key element of the 'patient AI' approach.
- **Making provision for continuous upskilling.** This was outlined by many participants as a key concern. Absent a plan for upskilling and reskilling, technological uptake was certain to be suboptimal.

"The super users, the early adopters tend to have more rigorous training, some that get more because of their background and requirements, but everyone should go through a basic level of training and understanding."
Response given by NHS England CCIO.

- **Sandboxing and piloting.** Pilots and sandboxes (controlled environments in which free experiments can take place) were raised as useful tools for substantiating the evidence base and satisfying the demands of the clinical community.

"So then we're procuring this sometimes incredibly expensive equipment or software, with unknown support demands for a potential non-existent financial benefit. That's another reason why we should have small pilot projects, so we can have well-defined project objectives that we're optimising that are quantifiable for finance."
Response given by Chair of NHS Trust.

Indeed, a positive commitment to both piloting and sandboxing, for example through the newly-announced NHSX AI Lab, would represent a positive organisation-wide principle around technological take-up.

"In complex new surgical techniques, there is a proposed level of success that the surgeon comes to a colleague with. There isn't an analogous thing for using this in AI technology...I don't know what mechanism that would be, but I think extending the ability to take a chance on something is what we need."
Response given by an Intelligence Analyst at a hospital in the Midlands.

Clinical champions

Getting the incentives right

Technology companies want to work with NHS clinicians and managers want to work with technology companies. Bringing these elements together requires skillful organisational leadership.

There remain structural barriers, from dysfunctional procurement models, to misaligned payment incentives and these need to be ironed out if the benefits of technological take up and innovation are to be truly realised. Perhaps even more important than financial alignment in this regard, however, is the need for cultural and conventional alignment.

> *"… I will be working on validating and testing some of this software, and basically trying to pinch time from doctors whenever I can. I've been building software for hospitals for the last 5 years and that's how it's done, it's about getting it done in whatever way you can to get the initial prototype working. You show it, and then start a conversation about seriously funding something. I imagine this is what the first year will be like, me and a doctor doing much of the legwork in our own free time perhaps to create a business case for a much larger, or significant, sustained investment."*
>
> Response given by Medical Physics digital lead from a London NHS Trust.

Clinical champions and public entrepreneurs

One of the key ideas that surfaced from the research was that a network of Patient AI clinical champions be established across the NHS.

This would not be a cadre of 'hero doctors and nurses'– but rather system changers – those working within who help break down internal barriers, and create space for entrants to come in.

> *"Where I've seen the most locally successful adoption of technology is because there has been strong sponsorship from a clinical leader. Absolutely true, but what it doesn't do is allow it to be scaled because what we aren't good at is understanding those conditions and replicating them. So how do you blueprint the charismatic leadership that takes people with you, that can acknowledge the risk for it to be comfortably held in a system. […] we have to systematically exploit them."*
>
> Response given by CCIO of an NHS Trust.

At the RSA, we refer to such systemic changemakers as public entrepreneurs. Public entrepreneurs work 'beneath the radar,' against the grain of the system to create change in its fabric. Their work may not result

in a single initiative or outcome or story but results in a broad cultural shift. Patient AI clinical champions would bring these actors together in a collaborative network.

> *"Consultants hold … sway. There's [currently] a governance hurdle [to innovation] as well, [but] a clinical lead or consultant is able to commission an audit, which allows us to use patient data for a research hypothesis."*
>
> Response given by an Intelligence Analyst at a hospital in the Midlands.

It is through cultural innovations like these – alongside major initiatives or incentive reform – that an environment in which technology is positively received and embedded at every interstice of the health system might be realised.

A culture of ever-improving care

> *"Some patient groups I work with want to know why the radiologist can't come and work through the scan with them. At the moment that's done in an outpatient clinic with a non-radiologist, so using (an innovative technological model) means maybe radiologists will become more patient facing.… Maybe that's a benefit to patients and radiologists…"*
> Response given by NHS Clinical Chair

We hope this short report has, at least in outline, demonstrated that patient AI is key to a better NHS – in every sense of the phrase. Patient introduction of radical technologies will result in better adoption and better patient care in the long-term rather than rapid introduction, which will likely lead to rejection.

At the RSA we are committed to helping foster an innovative culture in the NHS that puts patient care first. As such we welcome recent starter investment in AI by the NHS and the political rhetoric about modernisation and technology. But we also hope that the above study provides insight into the human-centered culture of innovation that is needed if we are to successfully integrate radical technologies into our health system.

AI companies are already engaging in the process of deliberating on the ethical implications of their wares. Our most treasured public institution must be part of that conversation, as must clinicians and patients. For, if not, a backlash against technological transformation may well be the consequence; a backlash that would help no one and miss crucial opportunities inaugurated by technology to improve patient care.

Appendix 1

List of questions asked to participants in the RSA-NHSX interviews

Questions to procurers	Questions to suppliers
Introductions ▪ Please could you give some back ground on your department/organisation and previous experience procuring medical technology with an AI component?	**Introductions** ▪ Please could you give some background on your organisation and describe your relationship with the NHS?

Pre-procurement
 	
▪ What initially makes you consider procuring new AI technology? (ie Is it from recognising a need internally and seeking solutions externally, or businesses approaching you with solutions? Please talk us through this process.)
  ▪ Follow up: How do staff suggestions play a role in this process?
	Pre-procurement/ desigining the product
	
	▪ Please talk us through the process of ideation to procurement of the AI technology by the NHS (ie where did the idea come from, did you already have a relationship with the NHS and know what they wanted, or did you approach them with a solution?)
	  ▪ Follow up: In what way were any staff or patients who would be using the technology involved within the design process?
	▪ What were the main challenges in developing the product the NHS wanted to procure from you? (ie guidance on standards ethical or otherwise, intellectual property rights)

Questions to procurers	Questions to suppliers
The procurement process ▪ What are the different types of procurement models (ie tender, co-production) you use for procuring AI technologies, and which ones have you found to be most effective? ▪ When procuring a new product, how does public opinion towards the company, sector or product and the role of the NHS as a public institution guide your thinking? (ie the company's governance structure or attitude towards intellectual property) ▪ What are the main barriers you face to procuring AI technologies? (ie types of evidence base, lack of staff knowledge, user research, financial, time pressures) ▪ How do you think these barriers may be overcome?	**The procurement process** ▪ What are the different types of procurement models (ie tender, co-production) or business agreements you have used with the NHS, and which ones have you found to be most effective? ▪ What were the main barriers you faced when trying to sell your product to the NHS? (ie data-sharing, IP issues, evidence base, lack of staff knowledge, financial, time pressures) ▪ How did you overcome these barriers?

Questions to procurers	Questions to suppliers

Deploying the product
 	
▪ Do you have a continuing relationship with the business once you've bought the product? If so, please describe.
  ▪ Follow up: Does the company provide ongoing support or trouble-shooting?
▪ What responsibilities do you think you have in ensuring AI technology is deployed in the way you intended?
▪ In what ways have you provided guidance or training to the staff using AI technology? How has it changed the way they work and what feedback have they given you?
  ▪ Follow up: How do they feel about overriding the technology?
▪ Do those using the AI technology check whether it is improving quality and/or safety of care? If so how? (ie research, evaluation, audit to assess the impacts)
  ▪ Follow up: How do you ensure those deploying the technology may seek redress or challenge an outcome?
 	
▪ As a commisioner how do you ensure accountability accountability for the system once it is in use, both in terms of the staff using it and the business you procured it from?
	Deploying the product
	
	▪ Do you have a continuing relationship with the NHS once they've bought the product? If so, please describe.
	  ▪ Follow up: Do you provide ongoing support or trouble-shooting?
	▪ In what ways have you provided guidance or training to the staff using AI technology? How has it changed the way they work and what feedback have they given you?
	  ▪ Follow up: How do they feel about overriding the technology?
	▪ What responsibilities do you think you have in ensuring AI technology is deployed in the way you intended?
	  ▪ Follow up: are you involved in testing and auditing the system, as well as ongoing monitoring? Do you know if there any standards in place for this?
	  ▪ Follow up: Are you interested in evaluations of the product when in use?
	▪ Have you considered accountability for the system in use – does it lie with you or the commissioner?
	  ▪ Follow up: How do you ensure those deploying the techonology may seek redress or challenge an outcome?

Appendix 2

Abridged interview quotes, ordered by subject area.

Through the interview process and inductive analysis, the RSA identified six categories of concern and opportunity. The following sections capture the most useful of these findings. We include this analysis for discussion and consideration by NHS practitioners and professionals:

2.1 Making the case for change
2.2 Patient implementation and clinical champions
2.3 Providing an evidence base: supplier side
2.4 Data
2.5 Communication
2.6 Standards

2.1 Making the case for change

2.1.1 Public scepticism in clinical settings

Patient needs come first, all our interviewees agreed. New technology is a means to an end, and not an end in itself.

But this message is often obscured by the way such interventions are staged and the way they enter the clinical workflow.

Indeed, the public were often noted to be sceptical. Radical digital technologies were often seen as "second class interventions" used to save time and money, while diminishing doctor-patient relationships.

Many interviewees expressed concern about these trends. They spoke of the need to involve the public and patients in research, design and use, so that the tools and services being deployed within the NHS are ones that people want, rather than what a commissioner thinks service users want.

> *"[It is] important that patient and public engagement is prioritised in the media. We don't want people thinking that we're developing scary, monster type products. What we're trying to do is really answer difficult clinical problems that will benefit patients. In our studies we always have a patient and carer representative, but those people are usually bought into the idea of research. What's really important, if you're [...] trying to influence the way people think about this, is to bring the public with us, to be sure that the safeguards are in place, everybody knows that it goes through an ethics committee, that there are huge protections for the data. One thing that is really important, is to tell the story such that we bring the public and patients with us."*

Response given by an NHS clinical chair in response to the question *"Is there anything else you'd like to share with us?"*.

"Whether it's the state working with a citizen, or a doctor working with a citizen on an individual basis, can we have a sufficiently robust conversation around consent that you can make a valid decision about whether you want to be involved in, and be in engaged in [sic], the use of AI as a part of your care, or for looking after your own health. So what are the fundamental building block of consent? What the thing you're being offered does? What are the risks of doing it? What are the risks of not doing it? What are the risks with your data? And that's about explainability, the code of practice that's been developed. That's my litmus test, can we have a defensible consent conversation."

Response given by NHS Trust CCIO in response to a follow up question on education and training (whether this was needed generally across the NHS or a set of highly educated individuals across the NHS?).

2.1.2 Scepticism is not purely borne of ignorance

Increasingly, NHS staff are being challenged by patients in complex and sophisticated ways to think about the ethics behind the use of certain tools. They suggested that more work could be done on unanswered questions that it would be helpful to have in formal guidance documents.

"I had one patient ask me: What if the radiologist goes against the AI system? Does the patient have a right to know that the radiologist has gone against the AI and, if so, why they went against it. And if so, and the AI is right and the doctor is wrong, what happens then? And vice versa, who is responsible?"

Response given by an NHS clinical chair in response to the question *"Is there anything else you'd like to share with us?"*

2.1.3 Staff are largely positive when engaged appropriately

Many interviewees spoke about positive attitudes among clinical staff towards new tools. For example, the potential of radical technologies to diminish 'admin drudgery' and allow for triaging of critical cases that would enable healthcare professionals to spend more time with priority patients was lauded. Some mentioned that technological innovation was requested by patients:

"Some patient groups I work with want to know why the radiologist can't come and work through the scan with them. At the moment that's done in an outpatient clinic with a non-radiologist, so using this concept means maybe radiologists will become more patient facing. Maybe that's a benefit to patients and radiologists…"

Response given by NHS Clinical Chair to a follow up question regarding relationships – *"What is the trust behind this, are [specialists in X] confident in the technology, and feelings around the hype?"*.

However, there are considerable challenges among the clinical community. Interviewees discussing technology in patient-facing roles suggested that their colleagues at times see digital interventions as second-class interventions in certain contexts.

The robustness of any or all interventions are often questioned. They also sometimes place clinicians in an uncomfortable position whereby

they question their roles as clinicians. These are two very different but equally considerable challenges.

There was notable resistance from one interviewee about how far their services should be expected to extend.

They were asked to develop a nuance within their service that would be particular to only three or four people in a region. The resistance here was on a mismatch of staff buy-in, that those NHS professionals the company was working with were trying to meet a specific need which should be addressed by clinicians, rather than understand the development of the solution in the round:

> *"The problem becomes when that is only 3 or 4 people. That's not available data is it? That's a stumbling block for us, we're developing things like this but you don't have to rely on the digital platform to implement for those 4 or 5 people. You should have a person do this. We feel uncomfortable doing some of this stuff, and maybe the line is crossed there. We're here to help support and maintain services, but not to replace one to one services. We augment current healthcare."*

Response given by CEO of health solutions company with focus on diabetes to follow up question on ongoing relationships with Clinical Commissioning Groups.

Other interviewees referred to recent examples of media backlash against collaborations that had resulted in misuse of data and said this had led them and colleagues to be fearful of taking risks or getting things wrong.

Everyone we interviewed emphasised awareness raising and training as a crucial need for staff buy-in and to ensure new tools are integrated and adopted safely. AI models are often generated in research environments but need patience and effort to transition into clinical practice.

2.2 Patient implementation and clinical champions

2.2.1 Evidence is key: evaluation, not arbitrary priorities, creates culture shift

Evidence matters. As one interviewee put it, *"showing credible positive evaluation of projects is an important part of winning the hearts and minds of doctors"*.

Many interviewees told us that colleagues wanted to know what best practice looks like and what kind of changes are required in implementing different technologies. The desired outcome of the evaluation for all suppliers interviewed is that it demonstrates the benefit of the new technology above and beyond what is already in place.

One interviewee suggested independent evaluations of digital projects were crucial to show credibility as internal evaluations could be criticised too easily.

However, another comment highlighted that there is some resistance to evaluations of public health applications of digital technologies as this falls under the remit of local councils who are too heavily involved in, and influenced by, a 'political agenda' - and where incentives to think across agencies are not aligned.

Clinicians value independent evaluations and peer review processes that clearly demonstrate the benefit of the new tool above and beyond what is already in place. In healthcare contexts, this is the basis of sound technological implementation.

2.2.2 Patient implementation, not 'big bangs'

A recurrent theme was what we refer to as patient implementation.

One way to build staff trust in new technologies is to gradually apply them to management or back-office type settings, where they do not need to go through such rigorous clinical validation procedures, but will have a visible role in improving processes. This will help build the evidence base and raise staff awareness without high levels of risk to begin with.

Several interviewees highlighted the need, in particularly difficult clinical working environments that an approach was needed which slowly, independently proved the benefits (by, for example, starting in back-end operational efficiency), modelling the impact on clinical workflow and upskilling first.

These interviewees went as far to say that this approach would likely be more successful. This suggests that in certain situations, slower introduction will result in better adoption in the long-term, rather than fast introduction which could lead to rejection.

2.2.3 Staff training and engagement

Interviewees frequently articulated the need for users to feel confident and comfortable with new tools, pointing to the need for training or modifications to the medical syllabus.

There were a spread of views on whether training should be focused on specialists using AI, those working alongside specialists using AI (in other words, playing a role upstream or downstream of where an AI solution is applied), or more generalist interventions in order to prepare for the longer term changes that would occur over the coming decade.

> *"General training and education across the entire NHS workforce […] because it's going to be ever present and incredibly important. In the same way that I'm a physicist, I hardly ever see patients but once a year I have to do hand hygiene training. It's going to be like that, whatever you do in a hospital, a ML algorithm is going to touch your work and understanding the impact of it on what you do or the impact it may have is very important."*

Response given by Medical Physics digital lead from a London NHS Trust to follow up question on type of education interventions that would be most effective.

> *"The super users, the early adopters tend to have more rigorous training, some that get more because of their background and requirements, but everyone should go through a basic level of training and understanding."*

Response given by NHS England CCIO level to question on staff needs.

One interviewee, who had worked on the Global Digital Exemplar (GDE) programme, told us that staff involvement at an early stage had been crucial in terms of the cultural shift and change management required, allowing staff to design the intervention with their expectations in mind rather than being a uniform standard pushed forward.

They mentioned making time for people to engage is also important because it allows for excitement around co-designing tools and the opportunity to become ambassadors or clinical champions:

"It's hard trying to get everyone involved, if you can demonstrate that it's coming from the top and it's important and we have the right clinicians on board then it becomes more engaging but engaging clinicians in general is very difficult. And we saw that time and time again, because they would say 'my job is to look after patients not to work on technology'."

Response given by CCIO of an NHS Trust in response on follow up question on building a culture for successful technology adoption.

2.2.4 Clinical champions

The clinical champions idea recurred throughout the interview process.

Clinical expertise is often needed to validate new tools. If there are clinicians excited about new technologies, they will be more likely to support that process and help introduce them into their workplaces.

There was a great deal of optimism for the idea, however, at least one interviewee highlighted the dangers of relying on individual personalities to push things through as it led to piecemeal procurement and adoption of different solutions across the NHS which did not necessarily scale.

"Where I've seen the most locally successful adoption of technology is because there has been strong sponsorship from a clinical leader. Absolutely true, but what it doesn't do is allow it to be scaled because what we aren't good at is understanding those conditions and replicating them. So how do you blueprint the charismatic leadership that takes people with you, that can acknowledge the risk for it to be comfortably held in a system. […] So let us understand what you've done, how do you speak to your team and how do you engage them, what are the stories and narratives you build, the sense of accountability and responsiveness. So absolutely we need them, but we can't just rely on them, we have to systematically exploit them."

Response given by CCIO of an NHS Trust (different to above) in response on follow up question on building a culture for successful technology adoption.

A co-ordinated network of clinical champions – rather than individuals working alone – would appear to be at least part of the solution to this challenge.

2.3 Providing an evidence base: supplier side

2.3.1 Evidence requirements remain onerous on suppliers: more pilots needed

Of those interviewed, four businesses running online platforms or apps were in the most comfortable position regarding evidence to inform the business case for product development or product deployment. We conducted in-depth conversations with them about their experiences of demonstrating their impact for the purposes of procurement.

They were largely positive; they had been able to collect enough data from people using their services over the past 5-10 years to ascertain how many patients they had served or how much money they were saving the NHS.

They maintained that this evidence was crucial for getting buy-in from the various Clinical Commissioning Groups (CCGs) that had procured

their products, and making sure they were providing a service that was in line with best practice. They also noted, however, that they had been fortunate in running services from which they could collect data, slowly building up the business case and confidence of those commissioning their solutions within the NHS. They recognised this was a key area that innovators struggled with.

On the negative side, the NHS's timeframes were referred to as being too slow for start-ups who struggle to maintain a steady cash flow.

> *"In order for AI companies to make their case more attractive, they need partner institutions to help make the case for them. A lot of the conversations we've had with suppliers have been on the basis of where they would work with us for free for 6 months or 1 year, or at a very minimal cost per patient, such as a dollar a scan. So that they can learn and we can learn, we realise that we both need to understand what is the clinical and operational impact of this technology. For us, so that it can inform future procurement; for them, to better inform their marketing, strategy and also their scientific efforts as well."*

Response given by Medical Physics digital lead from a London NHS Trust to follow up question on the pre-procurement conditions for ultimate success.

Some interviewees mentioned that there is scientific evidence of many tools, but not a lot of clinical evidence of them in use which means it is hard to build a business case for procurement:

> *"So then we're procuring this sometimes incredibly expensive equipment or software, with unknown support demands for a potential non-existent financial benefit. That's another reason why we should have small pilot projects, so we can have well-defined project objectives that we're optimising that are quantifiable for finance."*

2.3.2 Innovation and risk

Those developing new technologies often mentioned the 'chicken and egg' problem of having to demonstrate the benefit of something before gaining access to resources - staff time, finances or access to data - but being unable to produce the evidence without the resource. One interviewee suggested that the NHS could help new entrepreneurs by supporting them through something like an evidence generation accelerator, where the risks associated with innovation are shared.

Interviewees generally acknowledged that it was important to be cautious, but stated that with any innovation there is a level of risk and what is acceptable hasn't been defined for AI technologies:

> *"This is fine in complex new surgical techniques, there is a proposed level of success that the surgeon comes to a colleague with. There isn't an analogous thing for using this in AI technology...I don't know what mechanism that would be, but I think extending the ability to take a chance on something is what we need."*

Response given by an Intelligence Analyst at a hospital in the Midlands.

Some interviewees gave insights on this from the perspective of developing technologies for use from within the NHS. They described having a strong desire, along with colleagues, to develop new systems without having to procure them, but the way their time is accounted for at work makes it hard to justify time and space to develop their skills and build new tools. This was seen as something that could be overcome by greater voice and authority from key internal NHS champions:

> *"There would have to be a much harder push from any other staff group, consultants hold much more sway. There's also a governance hurdle as well, a clinical lead or consultant is able to commission an audit, which allows us to use patient data for a research hypothesis. Whereas the governance hurdles are set up to prevent "fishing expeditions" – to protect patient records. There has to be that fully specified clinical need and a prespecified way of addressing it."*
>
> Response given by an Intelligence Analyst at a hospital in the Midlands.

> *"The bit about funding is still a nebulous one, so how do we justify taking someone out of their job for whatever time it is? So initially of the pilot projects we have its initially my time that's funded, so with my PhD hat on, I will be working on validating and testing some of this software, and basically trying to pinch time from doctors whenever I can. I've been building software for hospitals for the last 5 years and that's how it's done, it's about getting it done in whatever way you can to get the initial prototype working. You show it, and then start a conversation about seriously funding something. I imagine this is what the first year will be like, me and a doctor doing much of the legwork in our own free time perhaps to create a business case for a much larger, or significant, sustained investment."*
>
> Response given by Medical Physics digital lead from a London NHS Trust to follow up question on whether funding was the critical factor for achieving success.

Some businesses reported that the most time-consuming part of getting their products approved were going through clinical approval. They appreciated the need for safety and regulation, but sometimes felt that 'patient safety' and clinical concerns were being used as an excuse not to experiment. Another interviewee also spoke about the lengthy process they had to go through to get their apps approved on the NHS apps library.

> *"What was really interesting from a broader perspective, we have apps on Amazon, Apple, Alexa, but none of these were approved because NHSD don't have the architecture to set these things up. So we get queries about these apps, and even though the actual programme has been approved, these apps don't get approved because they can't test them. So for us, real world evidence is generating way faster than the regulators can keep up with, so we need to switch those two. […] Engagement and uptake is*

really interesting, every CCG wants to do their own pilot. The politics was definitely the most painful part and inertia isn't just not understanding, it's not wanting to understand."

Response given by CEO of health solutions company with focus on diabetes to follow up question on ongoing relationships with Clinical Commissioning Groups.

2.3.3 IP issues

One interviewee specifically identified IP issues as something holding back wider benefits. Despite new tools and solutions having been developed within NHS trusts and the ideology that knowledge should be shared for the greater good, they were unable to share their code to an opensource platform as it conflicted with commercial interests of the trust:

"The NHS is siloed and fragmented, there needs to be more communication across departments and [sic] develop structure systems together we could get a lot more done, but there's no incentive for that in a market place where intellectual property is holding it back."

Response given by an Intelligence Analyst at a hospital in the Midlands on follow up questions on communication.

2.4 Data

While data access was not a core concern of this project – other studies have dealt with it in some depth - it recurred multiple times in relation to other key barriers, so we have included some insights from interviewee responses here for completeness.

Quantity and quality of data, and access to it, were identified as key blockages to creating generalisable tools, and were mainly raised by those within research roles. Those developing tools within the NHS recognised there is huge potential in the wealth of data the NHS has, but were sceptical about how soon they would be able to capitalise on it. They cited a poor data infrastructure and a history of initiatives promoting standards that do not necessarily correspond or translate across different trusts as barriers to scaling. Even knowing what and how to collect data was pointed out as basic fundamental that needed management:

"Collecting data in a way that can be used. Once you start having structured datasets and it's coordinated and it's having an impact, then some of these emerging technologies can start happening...and that's a big shift because often we like to collect everything but not everything is relevant. The needs management process to say what is some of the relevant stuff to collect and not collect it all."

Response given by NHS Trust CCIO in response to a follow up question on overcoming barriers.

2.4.1 Access

Several people spoke about having to justify access to data and the difficulties of making the case for this, again referring to the chicken and egg scenario, but also mentioning the impact GDPR had had:

"Didn't have a problem with this but now large number of studies held up, not by ethics, but by the hospital information governance department.

They're asking us how we're anonymising the scans, where are we storing them, how long we are keeping them, and we respond in the same way that we used to but somehow our responses are never enough. Ever since GDPR, there is a huge barrier and difficulty for the Caldicott Guardian and the information governance people to feel comfortable with data sharing. This has become my biggest problem. I have to search for databases that are maybe publicly available or all sorts."

Those involved in developing new tools spoke about new ways of working to avoid having to share data outside of hospital firewalls. Instead reaching distributed or federated agreements with other research or commercial organisations to test each other's computations on each other's data sets to see how their tools function and help validate each other's work. One person said they were trying to develop *"...a really good data sharing agreement, which can be reused so that people don't have to reinvent the wheel"*. They also explained that they were involved in setting up a whole research lab inside the NHS firewall with researchers given honorary NHS contracts so that they could work inside the firewall without the data having to leave the institution.

"There is still a big question around data. We haven't figured out where the data sits, who owns the data and what they do with data. There's still a constant friction point with technology companies. Haven't personally been involved with data sharing models. Have seen different kinds – often the technology company will say the data is yours, but if they end up doing anything with it or using it with your permission then it becomes our proprietary knowledge. Whether that's right or wrong I don't know - I think that's work in progress, needs to be determined at a national level to determine what the policy is. National strategy to know where the red lines are - becomes more and more the case. NHSX are figuring this out and building some propositions around this in terms of thinking about what's good and what's not."

Response given by NHS Trust CCIO in response to a follow up question on overcoming barriers.

2.4.2 Bias

The interviewees we spoke to developing public-facing tools like apps and online services told us that their motivations in building them is to enable people to manage their own healthcare in a way that is suited to their needs and allows personal choice. Several people highlighted the importance of user-centred design in building new tools and challenging the dominance of white middle-class use cases for technology. Without people from different backgrounds and ethnic groups using services it is impossible to collect data on them which therefore means technology is not built to best serve them. This connects to issues of bias within data sets, but also wider concerns of how to tackle health inequalities. If designed and implemented well digital technologies provide the opportunity to reach isolated groups currently not being served due to a variety of cultural or health issues. For example, one interviewee suggested that men would be more comfortable talking to a chatbot about their mental

health problems. Interviewees had differing experiences of accessing data of minority groups, some already having a wide platform of users to draw from while others mentioned lack of funding that prevented them from engaging with patient groups.

> *"One of the interesting challenges is challenging the white middle class use cases for technology. Reasserting the cultural diversity of other use cases that might be out there. Particularly in the context of a metropolitan city like London where you've got different concepts of mental health from the beginning, so how do you use the adaptability and responsiveness of technology to address that. A culturally sensitive chatbot understands the culture you come from and understands how to talk about mental health or mental health difficulties in such a way that you're able to engage with it. A human might be able to do that but whether you can get to the right human who is able to do that is another question."*
>
> Response given by a CCIO of a Foundation trust on a follow up question about bias and public trust.

One interviewee suggested that this could either be resolved with a data-driven technical argument, or through wider acknowledgment of inherent bias within society which needs to be tackled through awareness raising and public leadership. They put forward the idea that community leaders have a role to play in motivating their populations to engage with health services so that everyday use cases rather than critical or anomalous cases could be recorded and thus this data could better inform service design.

These points on data bias link back considerably to the earlier points made on public trust, and a growing awareness of the ethical issues with AI and that people are becoming increasingly wary of adoption when they do not feel as though there are appropriate mechanisms of responsibility and accountability for when decisions are made that could be based on inbuilt bias. This is echoed by the RSA's previous citizens' jury work where citizens have also wanted to see "explainability" at the heart of decisions made about them. If a clinician accepts or chooses not to accept the recommendations of an AI tool, citizens are keen to understand how those in-built technologies in their care journey may affect their health outcomes. For patients that are more aware of potential risks, they want more justification for the use of these technologies and public reassurance that the ethical considerations have been taken care of.

2.5 Communication

2.5.1 Communication matters

The need for communication and building close relationships between different sets of people was of high importance to everyone we spoke to, both internally and externally to the NHS. Some mentioned the need for communication between people within the NHS who have different skill sets or work in different departments (buyers and users; clinicians and data scientists), and others focused on the need to build up relationships between NHS staff and external suppliers. Interviewees gave a variety of reasons: to match different agendas and incentives staff have when

procuring a solution, to ensure adoption and ease of use, and to ensure feedback loops so that the technology is designed and delivered to meet intended outcomes.

> *"Yes – time and time again I hear that technology developers have a problem getting access to clinicians to really understand those user contexts, to shadow to work with, to understand the day in the life of a community psychiatric nurse so that they build an ecologically valid product that's going to work, versus building an algorithm in an abstract sandpit that doesn't reflect human nature."*

Response given by a CCIO of a Foundation trust on questions about communication.

> *"The teams that do this are professional procurement related individuals at any given trust. They could be buying anything at any one time, bandages, information systems, etc – their skills are around financial management, not technical skills. So we need advocates to make the case for something, and if it's a clinical thing an angry consultant jumping up and down gets things done. You have to get someone onside to get things done."*

Response given by an Intelligence Analyst at a hospital in the Midlands to follow up question on cultures for adoption and success.

2.5.2 Pilots vs scale

A common theme from many of the interviewees was on the approach needed to introduce a new solution, versus how a solution proven at a small scale could then be scaled up. It was felt that experiences on both of those could vary from institution to institution, but there was generally an appreciation that different vantage points meant there were different incentives at play.

> *"For a commissioner it's about prioritisation, the risks versus benefits, and thinking about what does it mean for my local population and why would I buy something like this. That's an interesting dynamic that needs to be explored more. Just because NHS England think it's the right thing to do, or everyone's making noise on why this matters - but actually there are lots of competing priorities. Often investing in innovative flashy things is not always a priority for those commissioners. It would be good to think about how we can socialise this to their priorities. We're not at the point where we're seeing examples that can be applied in a way that is scalable and in a clinical workflow. Lots of them are in the research stage and not in the real world."*

Response given by Medical Physics digital lead from a London NHS Trust to follow up question on whether funding was the critical factor for achieving success.

Many interviewees talked about the difficulties in engaging with different parts of the NHS that didn't seem to communicate very well across departments or levels. They said it caused problems in having to replicate similar evidence for each CCG wanting to commission services, and that the way funding streams work is a barrier to innovation.

"In Southampton, we wanted to do some research to publish a paper. So given we have peer review stuff and lots of outcomes, but that's not enough. Maybe I was naïve, because of being part of this accelerator, I thought we would get that badging and the apps been scrutinised, but it turns out every CCG wants to do its own pilot. And that is not only slow, but it is consuming from a logistics point of view."

Response given by CEO of health solutions company with focus on diabetes to follow up question on scaling up their product.

"The slight complication with some of the technology, is if when there is a cost, how do you disseminate that cost within the institution? The example of the emergency x-ray that needs to be reported by radiology. When radiology procures the solution, the benefit, essentially goes to the emergency directorate, the emergency department. And that internal model for how to charge for an AI-driven service is a bit unknown. Or do we procure together across departments, or directorates, so we recognise that while it will be deployed in radiology in medical imaging, the benefit might be realised downstream. So perhaps it's not that we charge the emergency department for a better service, but that we procure together."

Response given by Medical Physics digital lead from a London NHS Trust to follow up question on scaling up successfully implemented innovations.

One interviewee suggested that a lack of communicating their understanding of AI also means senior managers are not prioritising investment into the necessary skills amongst staff members:

"In my experience, when something is not well understood by people, they feel like they need to throw money at external consultants to provide. This sometimes bears fruit, but you should also invest in your team and developing skills – though this is impossible if you don't understand what you're training for...in most hospitals, they can't afford to have extra members of staff, or staff with extra skills in research roles, because they're already just making ends meet. It's difficult to make a case for someone who isn't directly producing roles. We want graduate data scientists in the NHS, but if we don't have an entry point for them, that's really hard."

Others argued that the NHS hadn't yet recognised itself as a digital organisation and is currently trying to deliver digital and healthcare as two separate goals. Instead they wanted to see multidisciplinary teams working together:

"We do that for patient care. For example, someone who has cancer, the best care is given by multidisciplinary teams, but that's not what we do around technology. We put the technology people in a room out on another site, in a different part of the hospital and the clinicians in different part. The challenge is how to break down some of those silos, bringing different groups together in multidisciplinary team. Get the technologists, the clinical transformation, quality improvement."

Response from CCIO at NHS Foundation Trust to question on communication across the NHS.

In terms of the procurement of new technologies, one interviewee told us that trusts are becoming more sophisticated in building in an ongoing relationship with suppliers as part of their contracts. Likewise, they said suppliers are beginning to offer better value propositions by opening up their network so that different sites across the country can share their experiences of the ongoing implementation of new tools.

The businesses we spoke to outlined that the key to their success with the NHS has been not only in providing the evidence to make a business case, but also in relationship building. One organisation said they had had an ongoing relationship with the NHS over the last decade, this helped them understand what the key issues the NHS want to tackle are and align with a specific strategic area. They all emphasised the importance of relationships and support from respected clinical experts in gaining buy-in from the wider NHS.

> *"Yes essentially, there needs to be almost like an AI project manager. Otherwise there's too much potential for conflicting opinions, especially when it comes to procuring because the interest can be very varied. One product can look good from a clinical perspective, but bad from an integration or operational perspective. If you have an IT person talking to a doctor and they have different priorities, then reaching consensus is impossible, you can get deadlock and then nothing happens."*
>
> Response given by Medical Physics Digital lead at a Hospital on open question if there was anything further they wanted to share in the interview.

Many interviewees suggested there needs to be new ways to communicate results, to share evidence and best practice with others. They pointed to scientific conferences but as one person said: "…they're attended by PhD students and Postdocs, not commissioners". They wanted new avenues to discuss what is happening in terms of service change within the NHS and one interviewee pointed to the GDE blueprint library as a good model:

> *"So that was pre-procurement all the way to deployment, very brief: what decisions they made, who were the decision makers and why they made those decisions. Something like that would be perfect: we had a problem with our reporting times, these are the people we included in discussions, we decided on this and this has been the outcome. There's no rubber stamping, no saying this is what you should do, just this is what we did. A platform like that would be perfect."*
>
> Response given by Medical Physics Digital lead at a Hospital on open question if there was anything further they wanted to share in the interview.

2.6 Standards

Several of the businesses we spoke to requested more guidance and structure; many of the products they are developing are creating new grey areas where the current standards for medical devices may not go as far as they might need. Whilst the interview structure did not go into standards at length, to address this one interviewee mentioned building on the seven

pillars framework for clinical governance to try and ensure the quality and safety of the clinical AI services they are providing, and others suggested they would like to collaborate with regulators to find ways forward.

> *"We have lots of algorithms we run and tell everyone we're running them, but aren't sharing the results. So for instance, our pancreatic cancer algorithm predicted 8 people it thought might have that and something. So there is something else up in their profile. We have sent that email out to eight people and three of those eight have emailed back to say they went to the doctor and that they had cancer. So the prediction was correct and maybe it was wrong for the others. But how do you validate something like that…Our biggest struggle is not scaring and telling people. But we need to do something. It's urgent but we don't want to scare you. It would be helpful to have guidance for that."*

Another interviewee who spoke to us about the Code of Conduct, said that the reception it had received from trusts was very positive:

> *"Many of them signed up to it, partly because it's the right thing to do, because the things around data security, privacy, being clear on the value proposition, being clear on the commercial model, what are the technologies being used for, is important. But also, partly because of some of public outcry towards the not so successful partnerships that we've seen – not that they were necessarily out in a malicious way to behave unethically, but partly because they didn't know what good was… Many of them have now set up clinical governance boards, many of them have quality assurance, infrastructure in place to question the ethics and to ensure things are achieved and delivered in an ethical way."*

2.6.1 Validation of tools

One interviewee working in a research environment told us that they would like to see technology validated in the same way as drug trials, and they said that some of the companies developing tools had done this, but not all. Despite this demand, the interviewee did recognise that validation processes can be time consuming and expensive which could prevent SMEs (small and medium enterprises) from competing and surviving against larger companies. Instead they suggested there could be a balance:

> *"whereby a tool may get a CE mark or FDA approval, but we need to know what basis it has been approved upon".*

This way those buying the solution know what basis they need to audit outcomes upon and feedback to the supplier.

To what extent tools have been validated, or on which specific data sets, have implications for staff workflow and thus is connected to building the evidence or business case for the procurement of new technologies too:

> "*The convincing thing is – you scientifically validate, and it has a level of accuracy, but that doesn't necessarily translate into less work for your*

staff. For example, we known that certain image classification AI are very sensitive to the input data, so if the algorithm has been trained in the US or India, their images might look very different to ours so it may require continual audit locally to make sure that the performance is consistent. But that continual audit may mean that there's actually greater staff burden in terms of working time, so then what was the point."

Another interviewee told us that when procuring software there are specific validation and test criteria that need to be met, however because there are so many specific applications of AI there aren't concrete standards for acceptance tests. To try and resolve this problem, specifically within clinical imaging and medical physics, they are in the process of setting up an AI Board:

"The AI Board will essentially convene to review or write a specific document to review a specific kind of software or specific kind of AI. For example, if a clinician wants to buy a product to segment chest x-rays, we'll take the generic template for validating AI, then using clinical expertise for that specific AI problem we'll expand the test and make it specific to that solution."

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