Establishing a Health and Care Quantum Innovation Centre

FULL REPORT

A HEALTH INNOVATION NORTH WEST COAST FEASIBILITY STUDY

February 2026

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Glossary

AI	Artificial Intelligence
API	Application Programming Interface
DHSC	Department for Health and Social Care
DSIT	Department for Science Innovation and Technology
EPSRC	Engineering and Physical Sciences Research Council
HINWC	Health Innovation North West Coast
HQCIC	Healthcare Quantum Computing Innovation Centre
HPC	High-performance computing
KPI	Key performance indicator
NHSE	National Health Service England
NIHR	National Institute for Health and Care Research
NQCC	National Quantum Computing Centre
STFC	Science and Technology Facilities Council
UKRI	UK Research and Innovation

Cover photo: *IBM and Cleveland Clinic's "first quantum computer dedicated to healthcare research" located onsite at the Cleveland Clinic in Cleveland, Ohio, USA.*

1.0 Executive Summary

The UK government is backing quantum computing with a £2 Billion investment in the 2025 compute roadmap and identifies quantum as a strategic long-term investment. This document is a feasibility study, commissioned by UK Science and Technology Network and National Health Service England (NHSE) and conducted by Health Innovation North West Coast (HINWC) to explore current understanding of and potential use cases for quantum computing within the UK's health and social care system.

Data collection included 29 interviews with subject matter experts, 3 workshops, a site visit to the Cleveland Centre in the USA and desktop research between April and July 2025 to:

- identify health and care system needs
- establish relevant use cases
- pinpoint areas that could benefit from this emerging technology.

Most interviewees expressed strong support for developing advanced computing capabilities in the UK context including quantum computing. Experts cite its unique advantages in addressing complex health and social care problems that may have only “small” or limited datasets, such as pharmaceutical development, clinical trial optimisation, personalised medicine, system optimisation and rare disease management. Experts also refer to the limited understanding of quantum computing and the need for clearly defined use cases.

The study highlights that quantum computing is still in its early stages, facing challenges in costs, regulations, operations, data management and workforce. Despite these hurdles, the risks of not developing quantum computing capabilities may be high, potentially leaving the UK behind in this field.

This study’s key recommendation is the creation of a Health and Care Quantum Innovation Centre (HCQIC). This centre would be a single access point for advanced computing, integrating quantum computing with high-performance computing (HPC) and artificial intelligence (AI). This could allow health and social care to explore where HPC is accelerated by AI and then where AI can no longer support and where quantum is needed. It would offer open access to resources, foster collaboration, support funding applications, and be built on a foundation of governance, ethics, education and public engagement.

This report suggests different operating and funding models for a HCQIC and identifies potential KPIs for the centre, focusing on health outcomes, research outputs, operational metrics, economic effects and engagement. Several operating and funding models are suggested, including a central hub, hybrid and NHS-centric approaches.

While quantum computing alone is not a sole solution, it is a critical component of the advanced computing ecosystem needed to solve pressing health and social care challenges. Regarding these challenges, it is anticipated that quantum has the potential to support the three core shifts required by the NHS 10-year Plan 2025 - 2035, namely:

- From hospital to community: shifting care to be more accessible at home and in the community.
- From analogue to digital: using new technology to help staff and allow patients to manage their own care online.
- From sickness to prevention: focusing on reaching people earlier and making it easier to make healthy choices

Quantum computing excels at solving specific complex problems that are effectively impossible for even the most powerful classical supercomputers. Potential use cases identified for healthcare have included accelerating drug discovery by simulating molecular interactions, personalising medicine by analysing large genomic datasets, and enhancing diagnostics through quantum-enhanced imaging and AI. Other applications could include optimising radiation therapy plans, improve clinical trial design, and developing new quantum-resistant encryption methods to protect patient data.

Investment will be needed for the UK to develop domestic quantum computing to realise the benefits for the NHS, wider health and care, and the UK's reputation on the global stage in advanced computing. It is hoped that findings from this report will be a valuable asset in this journey.

2.0 Background

STFC Hartree Centre describes quantum computing as following the principles of quantum mechanics (science dealing with the behaviour of matter and light on the atomic and subatomic scale) to process information. Unlike classical computing, which works with bits (0,1), quantum computing uses quantum bits called qubits. These can exist in multiple states simultaneously, which allows quantum computers to perform complex calculations more efficiently than classical computers.

Quantum computing is currently emerging and experimental across all fields, including health and care. In 2025, Innovate UK published the report: 'Quantum for Life: How UK life sciences and healthcare can benefit from quantum technologies' to give those working in health care and life sciences an understanding of what quantum technologies can do now and what it may be capable of in the future. This includes several applications in quantum computing, sensing and imaging.

The Digital and Technologies Sector Plan, part of the UK's Modern Industrial Strategy, published on 23 June 2025, identifies quantum technologies as a "frontier technology" where there is high potential for growth across all sectors - including life sciences, driving productivity, creating new projects, services and business models.

The UK Science and Technology Network, STFC Hartree Centre and NHSE wish to harness the potential of this technology by establishing a Health and Care Quantum Computing Innovation Centre (HCQIC) within the UK's health and social care system. They asked HINWC to support the development of a business case by conducting a feasibility study to ask the following questions:

- Does the health and social care system need quantum computing?
- What use cases could be established from the need?
- What areas of health and social care could benefit from quantum computing?

Benefits could include, but are not limited to, direct cost savings, indirect cost savings (i.e., time released back into care, workforce efficiencies), and improved patient safety and care (including more personalised and preventative care).

3.0 Methodology

This study followed grounded theory (a qualitative method designed to inductively generate theory from data) and included:

- one to one semi-structured anonymised interviews with clinicians, technologists and managers
- three participatory workshops, each with 7-10 mixed participants from health and social care in the UK
- a site visit and in-person interviews (included in the 30) at the Cleveland Clinic (Ohio, USA), which the first quantum computer (IBM System One) dedicated to healthcare research
- desktop research

The engagement plan in Appendix 1 outlines the approach taken. The interviews have been coded without names in agreement with the interviewees. The roles of stakeholders engaged are outlined in Appendix 2.

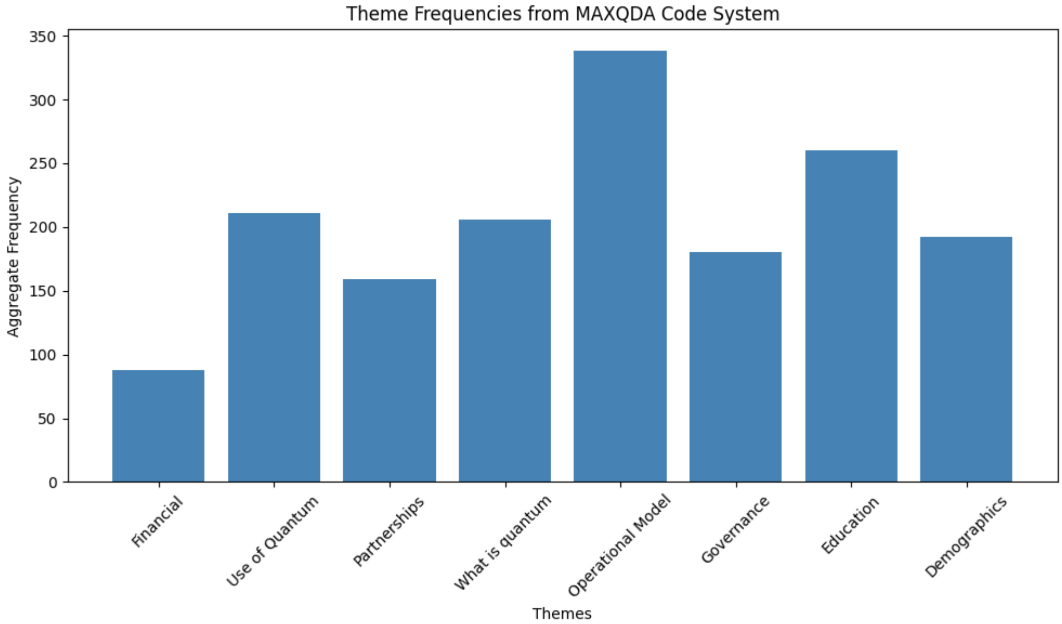
MAXQDA software was used to enable the qualitative data generated by the interviews and workshops to be formatted for analysis. Grounded theory was then used to identify the coding. Co-Pilot's analysis function was used to assist with synthesising the outputs of the data formatted by MAXQDA.

4.0 USA Quantum Computing Team Interviews (Cleveland Clinic)

In April 2025 to support the feasibility study, we were asked to visit Cleveland Clinic (CC) in Ohio who have their own quantum computer on site. Our aim was to understand how they are currently using the quantum computer and their ambitions for quantum computing within health. We also wanted to draw on their experience of using quantum computing in health to understand what a Quantum Computing Centre for Health could offer the UK.

The key themes that emerged from the eight interviews are detailed in Table 1 and explored in section 4.1.

Table 1 – Cleveland Centre Interviews Key Themes



4.1 Operational Model (Staff, Technical, Engagement)

This is the most dominant theme (338 mentions), indicating a strong focus on staff technical requirements and engagement. The operational model outlined by CC is a machine based on site in full view in the staff canteen (which they describe as 'Science on View'). All interviewees mention that they do not just focus on quantum, their operational model is predicated on using all computational power and resources appropriately. The key takeaway is to ensure the use cases are appropriate for the technology and having the right governance wrapped around. *'we're using it for the right use cases… making sure that we have the right job going to the right tool and we're not just using quantum for the sake of using quantum.' (CC01)*

Interviewees were clear that using only quantum was not an option. It is an emerging technology that is only just being understood, so access to different modalities is required in order to best understand where quantum is the right technology to use. *'Think about what should go in the pipeline as your research experience with HPC and AI leads to you "graduating" towards quantum computing, learning and using developing quantum applications.' (CC02)*

Partnership appears to be a key component of the operational model of CC, specifically the partnership with IBM, who helped them acquire the computer they have on site. It also allows them to share expertise through a service agreement, where they provide clinical expertise and IBM provide the technical and analytical support. This allows teams to mentor and learn from each other. It is a 10-year partnership, currently in year 4. CC chose IBM because of the 'shared values' between the two organisations.

Using HPC and AI the partnership is developing hybrid cloud projects. There are approximately 50 ongoing projects utilising a mixture of HPC, AI and Quantum. These projects are being conducted by approximately 100 researchers combined with IBM resource. Projects they invest in are managed via a joint steering committee and a scientific priority list of work they agree to complete.

Development of use cases is a key component of CC's operational model, so they have set up systems to allow them to prioritise these as they are identified, with the support of research through their partnership with IBM. They are clear that any projects undertaken 'mustn't just serve academic interest, it must serve, translational research interest, practical, real-world research. It must bring things forward to improve health and care.'

Curated data will be needed for use cases, and this featured strongly in the operational model discussions. Data cannot be prepared in the same way as it is for AI. Quantum requires more specific preparation. This is where the shared utilisation of skills with the IBM partnership helps. It was stated that Personal Identifiable Data (PID) is not needed within the quantum machine and they don't allow any type of PID to go through, one interviewee stated that: '*You have to convert it to what it needs to be to go on the machine, in doing so, you lose this ability to re identify the patient that it came from'.* This is another area where the partnership with IBM has been invaluable in understanding how the data needs to be converted.

Several key issues around developing the technical elements of the operational model were also identified. The quantum computer has to be kept running so the requirement to have it on a separate power circuit was considered important to mitigate the impact of power outages. Maintenance is generally done out of hours for the least disruption. The physical size of the machine presents challenges in terms of the amount of cooling it requires. Even though the machine is large, it only provides 127 qubits which while large, is not a huge amount of computing power, which in turn limits the size of the problems that can be addressed. CC also drew attention to the problem around noise or error within the hardware. This needs to be understood and addressed as challenges are taken on.

Finance is a major consideration in setting up a UK computer based on the lessons from CC. Whilst CC don't have to pay to use the machine as part of their co-ownership with IBM, they do charge external organisations to use it. The cost is approx. $1.60 per second, so there will need to be consideration as to how the UK would approach charging to create a sustainable model.

From the operational side, a key theme running through all interviews related to the management of stakeholders and communication with patients and public to facilitate the creation of quantum communities. They viewed that engagement as a way of ensuring they were doing 'good': *'I like to think of technology as being, morally agnostic. With any piece of technology, if you can do something good with it, undoubtedly, there's some terrible things you can do with it, and so we do need to think about how we are using this technology to enable a wide range of patients or cohorts or citizens within the world to benefit from the best approaches using the technology.'(CC03).* Their aim is to take the fear and mystery out of quantum computing.

4.2 Education (Clinical, Academic, Technical)

Education was the second most dominant theme. Interviewees spoke of the need for time and resource in education and training to equip both the current and next generation workforce with the skills and confidence needed to realise the potential of quantum. CC has invested a lot of resource in education, which they credit with getting them to 80% utilisation of their quantum computer. They recognise the talent pipeline is a major challenge, and the only way to address this is working with academia to ensure availability of educational pathways and routes to study which promote it as a career. The specific areas identified are data science, statisticians and students who can work with the linear algebra needed for quantum computing. To try and solve this CC have been working with Miami University in Ohio, who will be one of the first domestic colleges to teach the coding needed for quantum. They will also offer a Masters course and PhD routes.

CC interviewees noted the importance of a workforce that is familiar with quantum computing and the self-efficacy needed so they can at least ask questions of the machine*. 'It's hard technology, you have to take the time to build that comfort and confidence in your teams' (CC06).*

One interviewee CC07 summed this up well:

*'What you're trying to do is to provide the infrastructure and the platforms to people who can then be very curious and intense and imagine and dream what that could be and then try to make it happen. So, **you are providing opportunity for a future that could not and would not ever exist if you don't do it**.' (CC07)*

4.3 Governance (Operational, Data)

Under the governance theme, interviewees spoke of the need for strong governance arrangements via structures such as a board of directors, a steering committee, an ethics board, a conflict-of-interest subcommittee and a research & education sub-committee.

There was some level of agreement that quantum governance would be similar to AI, but it was noted that quantum will have some of its own governance issue unique to this modality such as quantum encryption.

The need for good service level agreements with partners was stressed several times, and the need to involve the public from the start. CC have public members on their ethics steering committee and board to ensure transparency of this complex technology. They view this as critical for success.

CC work on a scientific priority list allowing them to select projects aligned to organisational and governmental priorities that will have the biggest impact. This is key to getting buy-in across local, regional and national levels. Everything is reviewed by the ethics board and is run through community members.

Interviewees also spoke of the need for governance around physical and data security, together with regulatory oversight. There is a need to ensure the physical and virtual security of the machine, making certain the right people are using it. Cyber security is a big issue for quantum. Most governments are looking to quantum to maintain and strengthen national security, and there will likely be a 'first past the post' situation which then could affect all other countries. The quantum computer has to be used in the right way so there needs to be good regulation around it. '*'**With any piece of technology, if you can do something good with it, undoubtedly, there's some terrible things you can do with it,** and so we do need to think about how we are using this technology to enable a wide range of patients or cohorts or citizens within the world to benefit from the best approaches using the technology.' (CC03)*

Data issues were also raised in terms of errors in computation, but there was thinking this might be easier to manage than the drift in data caused by AI. They highlighted the limitations of current quantum computing capability such as not being able to reidentify data once it has been transformed for the quantum computer, and that current qubit size means that you might only be able to look at 100 to 200 patients' worth of data before being overcome by error rate.

4.4 Use of Quantum (Health, Other, Opportunities)

The interviewees were very positive about the progress they had made in finding key use cases for quantum computing. One of the main areas interviewees reported opportunities for utilising quantum were drug discovery and clinical trials. This could significantly reduce the time taken to get new drugs to market. *'Quantum's **biggest potential** is actually taking a look at how we can **discover drugs faster** and take aim at that 17 years that we say it takes to get something from bench to bedside.' (CC01)*

Other key areas were validating the confirmation of small molecules, and analysis on the front end of clinical trials to look at '*the **most optimised way of a clinical problem that presents.'** (CC01)* This may help stop clinical trials having to 'poke people' so much.

Optimisation, simulation and agent-based modelling in drug discovery where key area of focus. An interviewee pointed out: '*'I kind of find myself closer to the **optimization routes** because a lot of things that I do **requires inverse modelling optimization**, trying to extract, markers or properties and that fit into **quantum optimization**. (CC02)*

Further opportunities may include protein structure analysis, quantum chemistry, and rare diseases. For instance, an expert suggested: 'if *you wanted to fully analyse or fully enumerate all the components, all of the different potential structures that a protein may have… once you get up to about 100 amino acids or so, in order to fully enumerate that set of 100 amino acids **using classical computing, you're at the exceeding beyond the heat death of the universe in terms of the time it would take**. It's such a hard problem that that, if we had powerful enough computers maybe you could address this, and so **quantum computing** actually is one of these approaches that is likely to **give us an advantage** and so, for example doing optimization or conformational search because of its ability to use superposition and entanglement and so forth in order to analyse these problems.' (CC03)*

The key message that came across in all of the interviews was that quantum alone is not the solution to the problems we want to address in health and social care, there needs to be a mix of computing modalities: HPC, AI and quantum computing. In fact, of the 50 projects ongoing at CC only 25% involve quantum. '***'AI plus Quantum computing**, the way the computing is done, can create different model topologies. Similar to when we were using linear statistics for a while now, we have jumped to neural networks, right? But is what quantum can offer the next jump? Sure, in **quantum, we can actually look at datasets that are actually not as large as what AI needs.** Because if you think about it, if you can suddenly do something like that, it **opens up many more research possibilities** for investigators - can we look **at rare diseases** when there is often quite **limited data**?' (CC02).*

Equity of access came up in that less developed countries may not be able to afford to own or potentially access quantum computing, so this is something which needs to be considered as quantum becomes more available around the globe to those who have invested.

The overall sentiment expressed by interviewees was that quantum is in its early stages and having their own quantum computer on site allows them to test hypotheses for the use of quantum and fail fast: '*Right now, very much experimental technology' (CC01).*

Interviewees were seeing the benefit of being able to work with staff on site test out projects and fail fast developing the best use of the technology as it grows rapidly. *'So, we don't shy away from trying new things. We're not afraid to fail and we feel that even failure we can learn from and puts us further ahead of others.' (CC07)*

5.0 UK Stakeholder Interviews

Over the course of three months, 21 individuals from varying backgrounds were interviewed. Their roles are listed in Appendix 2. Interviewees expressed a **wide spectrum of understanding** of quantum computing, from complete unfamiliarity to deep technical engagement. Quantum is often compared to HPC and AI, with some grasp of its unique capabilities. There's optimism about its potential in health, care and genomics, but also caution about hype, data requirements, and the skills gap. The emerging themes are summarised below.

5.1 Understanding Quantum

Of all the people interviewed, not one person considered themselves to be an expert in quantum. When questioned about their understanding of quantum computing, interviewees' answers ranged from 'no understanding at all', to 'good understanding of what quantum computing is'. These responses included those from people who work in this field. This appears to support how new the technology is, and how much there is to develop, particularly in the health and care field.

'Familiar, but by no means would I say I am an expert' (QC10)
'now quite familiar, because I've been doing some revision on the subject recently' (QC8)
'Not at all familiar' (QC19)

Comparisons with Classical Computing
Quantum was often framed as, *"more powerful supercomputers", "different product with different use cases"* and *"hard to distinguish from HPC or AI"*, with some interviewees noting key differences in problem-solving and architecture.

Conceptual and Scientific Framing
Interviewees made references to **quantum physics** (Planck's equations, quantum optics, many-body physics), **procedural challenges** ("How do we verify quantum results?") and **scalability** ("Future qubit growth will dwarf current numbers").

Applications and Promise
There was strong interest in **healthcare and genomics** (epigenetics, non-coding genome, service-user data), **AI parallels** (large datasets, algorithm design), and the **social determinants of health** (quantum as a tool for complex systems).

Hype vs Reality
Interviewees expressed mixed views on the promise of quantum set against the current reality. They reported they were *"confused by hype vs reality", that "quantum feels shiny but creates unrealistic expectations"*, that it was *"hard to prioritise use cases without advanced teams"* and that *"quantum readiness is a huge barrier".*

5.2 Quantum Computing Use Cases

Interviewees described a variety of current and potential use cases for quantum in healthcare:

Diagnostics & Predictive Analytics
- Early disease detection from complex datasets
- Pattern recognition in imaging and genomics

Drug Discovery & Genomics
- Simulating molecular interactions
- Searching vast chemical spaces for new compounds

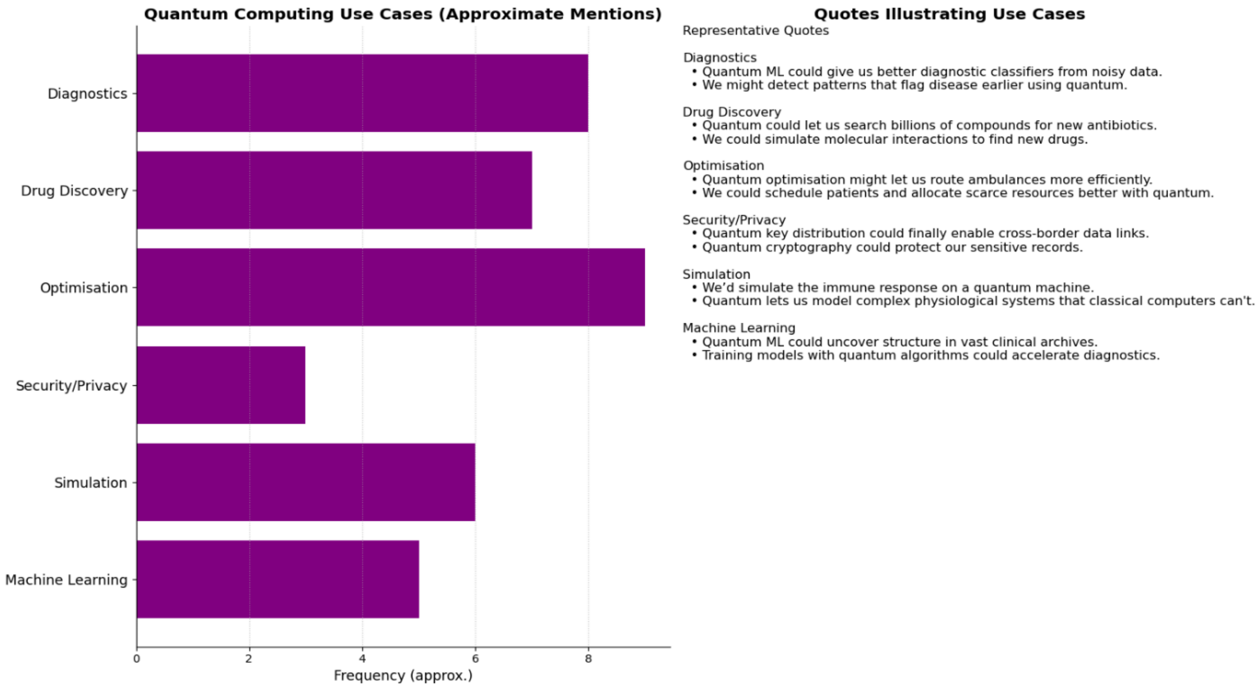
Optimisation
- Scheduling patients and staff
- Routing ambulances and allocating resources efficiently

Security & Privacy
- Quantum cryptography for secure data sharing
- Protecting sensitive health records

Simulation of Complex Systems
- Modelling physiological systems or epidemics
- Forecasting outcomes in healthcare scenarios

Machine Learning Enhancements
- Accelerating model training on large datasets
- Improving diagnostic classifiers with quantum ML

Table 2 – Quantum Use Cases Identified by CC Interviewees



5.3 <u>Operational Considerations</u>

Stakeholder Management

Stakeholder management was considered a high priority area for the emergence of quantum computing. The level of understanding is very low at this point, so any centre would need to work with stakeholders to help them understand the technologies available, together with how and when to use each one, with the aim of building-up an iterative understanding of quantum computing. The emphasis was very much on awareness raising, selling the benefits and building communities. Interviews suggest the building of the conversation with health and social care needs to start early and align with current work around the Secure Data Environments (SDE) being developed across the country.

'The conversations that we're having across the UK in terms of trusted research environments and secure data environments. How do we make sure it's not competing with what's already existing or being built. How do we collaborate rather than compete?' (QC17)

'we're very interested in its potential in terms of impacting patients and also cost effectiveness as well' (QC15)

'we really want to promote is collaboration between institutes because what we don't want is to have all these siloed working' (QC15)

All of the interviewees expressed views on the need for awareness raising & selling the vision. They felt it very important to have clear messaging and early engagement, allowing people to see the potential for quantum in their everyday work.

*"We will never get social care joined up later… **it has to start together**" (QC21)*

There were calls to ensure development of communities of practice, allowing sharing and collaboration over ‘wicked’ problems, learning from each other, cross sector collaboration, and including public and private sector partnerships similar to that which Cleveland Clinic interviewees spoke about.

‘Review of those scientific groups who have said they would take a quantum computing approach to a particular medical problem’ (QC13)

The types of engagement mentioned across the majority of interviews were: annual forums, hackathons, engagement teams, linkage back to national and international programmes of work and close working relationships with incubators/accelerators for spinout companies and investments.

‘Equity - lowering the barriers of smaller companies and smaller research groups that wouldn't otherwise be able to afford powerful facilities’ (QC13)

It appeared universally understood by all interviewees that a project like this will fail without continuous stakeholder commitment and buy-in. Any quantum innovation centre would require its stakeholders to hold it to account, structuring the direction of travel and ensuring behavioural alignment with the growing quantum eco system nationally and internationally. It would also need its identified stakeholders to inform understanding of the size of the market, who may benefit and develop the use cases matched to the ‘wicked’ problems identified in health and social care.

The public were mentioned several times as key stakeholders, particularly the need to ensure they understand what quantum computing can and cannot do to support their wellbeing. It was also felt that wider engagement and understanding could help develop the talent pipeline the UK will need to grow quantum computing capabilities and deliver initiatives.

5.4 Key Insights by Stakeholder Type

Industry

- Seen as key partners for innovation and investment.
- Mentions of IBM, pharma leads, and spinout potential.
- *“**Powerful industry partners** from the biopharmaceutical sector”*

Academia

- Central to research and community building.
- Concerns about engagement and equity.
- *“**Lowering the barriers** for smaller research groups”*

Government

- Includes national and local actors.
- Importance of policy alignment and early engagement.
- *“Tackle the mayor early on… dropped into **Parliament conversations**”*

Clinicians

- Crucial for practical implementation and credibility.
- Need for buy-in and understanding of use cases.
- *“Having clinicians with quantum innovators… **everyone in the room together**”*

NHS

- Viewed as a key system to engage with.
- Challenges in integration and relevance.
- *"They don't engage properly with the NHS system. What are the* ***wicked problems****?"*

Patients

- Focus on outcomes and public interest.
- Seen as ultimate beneficiaries.
- *"****Better patient outcomes****… cost effectiveness"*

Social Care

- Notably **underrepresented.**
- One quote highlights persistent disconnect.
- *"We'll join social care up later… never happens"*

5.5 Patient and Public Involvement

Patient and public involvement (PPIE) was another area where interviewees expressed strong views on ensuring they are a part of the journey towards using quantum, what that means and how it could ultimately benefit them. There was mention of the need to build trust and make quantum computing explainable, allowing people to make informed decisions on the use of their own data.

'There needs to be quite a lot of engagement with the public and involvement in terms of what quantum computing is' (QC 17)

'We want don't want people to be afraid of technology' (QC01)

There was requirement for PPIE to be embedded from the start, ensuring they are represented on boards and community groups. Some proactive engagement was recommended to ensure people do not feel their data is being used for commercial gain, and this should be integral to the operation of any centre.

'I think that's how we'll get progression for quantum computing and health. Having clinicians with quantum innovators, with people who are working on the tech, with patients' (QC15)

'We know from the public in all the existing PPIE that they are highly concerned about their data being used for commercial benefit' (QC17)

'it's that bit about openness and transparency and having public members on your board and groups' (QC16)

The PPIE will also need to have an educational element, where it provides outreach to school, colleges and universities in order to showcase the careers that will be needed for a quantum ready future. Economic growth in the region could showcase the centre as an asset providing jobs and skills development.

5.6 Data

Data was understood to be a critical challenge when talking through how we might use quantum computing. Lessons learned from the Secure Data Environment can be used to understand some of the key problems that are likely to be faced. Most patient level data is demographics, clinical records, care needs and interventions. Approximately 20% of this data is structured, the rest is unstructured data such as imaging, voice and genomics. The handling and transformation of this data will be key to success.

The majority of data comes from GP Practices, hospitals, NHS Trusts, and registries such as maternity, cancer and ambulance. It can also come from pharma and open-source government data sets. Fragmentation of the data is an issue: '*"NHS data… in **multiple formats on different systems**… poorly curated"*

We know from the SDE work that data preparation is in itself a challenge, with cleansing and algorithm development being extremely time consuming. Quantum requires another form of preparation which will add to the complexity. It was thought there will be a need and the skills to provide:

- **Concierge support** (discovery, prep, QA, governance).
- **Federation** across UK and internationally.
- **Formatting** for quantum and AI workflows.

Interviewees placed emphasis on any centre being robust on GDPR compliance, pseudonymisation, and use of linkage keys that would engender public trust.

Barriers & Challenges

- Key issues include:
  - **Compliance**, **fragmentation**, **provenance**, **quality**, **access**, **sovereignty**, **bias**.
  - *"Health data is still immature."*
  - *"We're not just going to ask for a dump of NHS data… that's useless to quantum."*
  - *"If we use poor quality data, we embed existing **health inequalities**."*

Opportunities

- NHS data is a **"goldmine"** if curated and used well with the potential for:
  - **Genomics integration**
  - **Preventative medicine**
  - **International collaboration**

- "The NHS has unrivalled data…a goldmine we sit on"

Key Insights

- **Patient data** is central, but often **unstructured** and **fragmented** across systems.
- **Genomic and imaging data** are emerging areas with potential for **preventative medicine** and **precision health**.
- **NHS data** is rich but with opportunities for better curation, requiring federation and formatting at times.
- **Biobanks and registries** offer high-value datasets for quantum applications.
- **Pharma** is a minor but relevant source, often linked to clinical and GP data.

5.7 Information Governance

Information governance is a key consideration in health and social care innovation implementation, and a centre such this is no exception. There is expectation that adequate security and safeguards will be in place, with those who raised this in interview placing emphasis on encryption, password policies and pseudonymisation. There was also consideration given to the fact that quantum will require different governance to AI and this was mentioned by The Cleveland Clinic, *"Start at the same level as AI… then assess appropriateness."*

Concern was raised around the use of unconsented data, mindful that the NHS has attempted several high-profile programmes around unconsented data which have provoked a strong reaction from the public, and subsequently not been successful. Interviewees wanted any proposed centre to have a strong emphasis on the legal and ethical obligations associated with being entrusted with patient data. There was mention around genomics data *"Genomics data… any genome sequence is identifiable."*

There was a call for proportionality around risk-based governance so as not to stifle innovation in quantum computing, wanting clear guidelines from the start *"All governance needs to be proportionate to the specific risk."* All interviewees mentioned GDPR and emphasised that a centre should be robust in this area from the very start.

Barriers were identified around the chain of custody, data controller sign off and international data sharing agreements, interviewees talked of the legal ramifications of data transfers.

5.8 Key Performance Indicators

Through the course of the interviews, we were able to identify the KPIs the interviewees felt could be the most important to demonstrate the impact of a centre:

Health & Care Outcomes

- Improved well-being and quality of life
- Reduced demand on services
- Prevention of deterioration and early illness detection
- Lower error rates in diagnostics or interventions
- Outcome risk management

Research & Knowledge Outputs

- Number of papers, publications, and citations
- Research grants and PhD completions
- Scientific impact (e.g. Nature papers)
- Evidence base strength
- Peer-reviewed outputs
- Use of quantum algorithms in NHS settings

Operational & Adoption Metrics

- Number of use cases, studies, and problems solved

- User counts, project volume, and engagement events
- Translation into real-time system change
- Deployment milestones and turnaround times
- Capacity utilisation (e.g. 24/7 use of quantum centres)

Economic & Societal Effects

- Jobs created, career pathways, and local employment
- Business growth, inward investment, and spin-outs
- Value for money and NHS savings
- Return on investment (ROI)—though flagged as hard to prove
- International collaborations and visibility

Programme Design & Governance

- Evaluation frameworks and impact routes
- Short-term vs long-term KPIs
- Resilience and future capacity planning
- Transparency and visibility of outcomes
- Mission-oriented goals (e.g. “quantum advantage by 2030”)

Engagement & Training

- Public engagement metrics
- Training programme reach
- Knowledge transfer into organisations

Challenges in Measuring Success

- **ROI is hard to quantify**—especially for long-term or foundational work.
- **Lag between innovation and impact**—benefits may take years to materialise.
- **Evolving goals**—KPIs may need to change as technology and context shift.
- **Distribution of benefit**—not just outputs, but who actually gains.
- **Intangible outcomes**—like trust, visibility, and public understanding.

Suggested Approach to KPI Design

To build a meaningful KPI framework:

- **Start with clear use cases**: Define the problems to be solved.
- **Measure across multiple dimensions**:
  - Clinical impact
  - Research productivity
  - Adoption and usage
  - Economic spill-offs
  - Engagement and trust
- **Include both quantitative and qualitative metrics.**
- **Plan for evolution**: KPIs should adapt as the programme matures.

5.9 Staffing

Staffing was a key consideration for all interviewees. They identified the need for dedicated teams, layered structures and ensuring adequate capacity. Concerns were around the capacity limit and ensuring inclusive participation and regional equity as there is always a concern that technology like this is centred around Oxford, Cambridge and London. Those interviewed wanted to ensure balanced stakeholder access.

Patient and public involvement and engagement was seen by all interviewees as crucial to the success of a quantum computing centre. Public trust is currently low, especially in the secondary use of data, so there were strong calls for early and ongoing engagement, education and addressing of how this will not exacerbate inequalities. There are also concerns over private sector involvement and data transparency which need to be considered when entering into partnerships with the private sector.

The roles needed were identified as concierge support, engagement teams (to start liaising with organisations on the opportunity and start the educational piece), and clear points of contact for business development and collaboration. A centre would need to have adequate resources, funding and skills to allow the development of use cases. There is a need for staff who understand the technology and its application.

Skills Shortages & Retention

Concerns about:

- **Scarcity of quantum talent**: “People who can write algorithms… are pretty rare.”
- **Retention**: “How do you maintain those skills in the UK?”
- **Pay gaps**: “DDAT roles don’t pay well in the NHS.”
- **Capability gaps** in specialised quantum roles.

Inclusive Hiring & Alternative Routes

Recognition that talent may come from:

- **Non-traditional backgrounds**, including neurodiverse individuals.
- **Academic and informal networks**.

Building Capacity in Context

Staffing must align with:

- NHS challenges and quantum research priorities.
- Broader community-building efforts.
- Risk of isolation: “It just ends up being a thing… floating on its own.”

5.10 Education and Skills

Education and skills for quantum computing were highlighted across the board as a potential barrier for the use of quantum computing in the UK&I.

Interviewees felt a centre would need to address this by:

- Raising awareness of quantum technologies.

- Starting education early (e.g., school children visiting centres).
- Creating simple teaching materials and short courses.
- Establishing flagship programmes or centres for public engagement.

There needs to be a skills pipeline developed alongside any centre that can attract and retain talent, this may be especially important if the centre was to be located in the north west of the country, where several regions suffer from ‘brain drain’ compared to London and the South East. There is ambition for the centre to attract talent and be a place that bridges disciplines i.e. physicists, engineers and clinicians.

5.11 Contextual Awareness

Interviewees acknowledged:

- Health and care staff are too busy to engage with long-term tech.
- Even those aware of quantum need convincing.
- Education must align perception with realistic expectations.

Representative Quotes

- *“How do you actually maintain those skills in the UK?”*
- *“This needs to be a symbol for upskilling our population.”*
- *“You need to start doing some of that education piece very, very early on.”*
- *“We need an educational programme that brings in high performance computing, supercomputing, deep learning…”*

5.12 Financial

Quantum computing is expensive to build and operate. This was recognised by those familiar with quantum computing and identified as a potential barrier. It was also recognised that these costs may likely reduce over time. In considering how to manage this challenge, discussions turned to public and private sector partnerships such as IBM and Cleveland Clinic, grant funding, pharma investment, venture capital funding, sovereign wealth fund and UKRI and EPSRC schemes.

Interviewees raised questions about the market size and what the potential ROI and local economic benefits might be.

Challenges & Barriers

- Acknowledgement of financial hurdles:
  - *“We can’t sell anything right now… very cost intensive to develop.”*
  - *“Privatising and using finances around healthcare is problematic.”*

Representative Quotes

- *“Quantum computing is horrendously expensive.”*
- *“One funding initiative… the SPRI grant… builds a path for increased quantum investment.”*
- *“Underwrite it and give people access to it for free… charge pharma.”*
- *“Make sure our services are costed, and cost is recovered fairly.”*
- *“Sustainable funding is key.”*

5.13 Technical

Only a few of those interviewed knew enough to suggest areas for development on the technical side of a Health and Care Quantum Innovation Centre, but the key areas of focus were:

Data Engineering

- Preparing, formatting, and scaling data for quantum workflows.
- *"Chunking up analysis… selecting active spaces and dimensionality."*

Infrastructure

- Debate over building vs. remote access.
- Space, cooling, and reuse of existing facilities.
- *"Instead of building their own quantum computer… remote accessing IBM or NQCC."*

Integration

- Hybrid workflows combining quantum with AI and HPC.
- *"Trying to develop hybrid quantum–classical workflows."*

Algorithms

- Need for quantum-native algorithms tailored to healthcare.
- *"Translating healthcare problems into quantum-native algorithms."*

Hardware

- Early-stage tech, limited fault tolerance, sovereign security concerns.
- *"We don't yet have fully fledged fault-tolerant machines."*

Real-World Testing

- Verification and validation in clinical settings.
- *"You need to test it within an inch of its life before NHS implementation."*

Skills & Capability

- Regional expertise gaps and pipeline challenges.
- *"Hard to prioritise use cases without an advanced quantum team."*

Standards & Interoperability

- Need for protocols to handle messy legacy systems.
- *"Measured interoperability… 400 hospital trust systems won't make sense to quantum."*

Key Technical Themes Explored

a) Infrastructure Strategy

- Strong preference for **remote/cloud access** to quantum resources (e.g. IBM, NQCC, STFC Hartree Centre).
- Avoid premature investment in proprietary hardware.
- Consider **repurposing existing facilities** for quantum infrastructure (e.g. cooling, space).

b) Standards & Interoperability

- Need for **standardised APIs, data formats, and protocols**.

- Emphasis on **data anonymisation**, **interoperability** with ~400 NHS systems, and **legal/ethical data handling**.

c) Testing & Validation

- Demand for **rigorous real-world testing** before deployment.
- Emphasis on **benchmarking algorithms** and ensuring they work across diverse datasets.

d) Governance & Ethics

- Technical deployment must be paired with **governance frameworks**, **public engagement**, and **ethical oversight**.

e) Skills & Talent

- Need to **build a quantum-ready workforce**.
- Importance of **cross-disciplinary collaboration** (clinicians, data scientists, quantum experts).

f) Algorithm Development

- Expectation of **custom quantum-native algorithms**.
- Interest in **hybrid quantum-classical and AI + quantum workflows**.

g) Centralisation & Collaboration

- Calls for a **Centre of Excellence** to coordinate efforts, manage relationships, and host testbeds.

h) Security & Sovereignty

- Some interest in **sovereign quantum systems** for secure computation.

5.14 <u>Governance</u>

We asked interviewees to describe the governance required for CC's utilisation of quantum, and where the UK&I should focus in developing its quantum resource for health and care. They placed emphasis on building a UK&I community dedicated to understanding the roles of HPC, AI and quantum in improving and developing health and social care services. They also emphasised SME engagement and development.

Community Building

- Emphasis on forming and sustaining **communities of practice**.
- Need for **co-production**, **co-design**, and **continuous recruitment**.
- Desire to build **cross-disciplinary networks** (e.g. physicists, engineers, clinicians, data scientists).

Collaboration

- Focus on **cross-institutional and cross-sector cooperation**.
- Examples include:
    - NHS, academia, and industry hubs.
    - Integration with **Trusted Research Environments** and **NIHR**.
    - Shared benchmarking and de-risking across sectors (e.g. energy, healthcare).

Partnerships

- Success depends on **stakeholder commitment** and **engagement**.
- Comments highlight:
  - Risks of failure without buy-in.
  - Importance of **complementary roles** and avoiding duplication.
  - Need for **multi-partner consortia** (e.g. IBM, Quantinuum, STFC Hartree Centre).

Governance Structures

- Governance is about **process**, not just technology:
  - "How do we collaborate rather than compete?"
  - "How do we build a community that lasts?"
  - "How do we connect NIHR and healthcare bodies into a quantum ecosystem?"
- Ethical and legal concerns are present but less frequent:
  - Only one segment explicitly mentions **data protection and ethical use**.

Representative Quotes

a) Overarching – focuses on overarching governance concerns—stakeholder engagement, leadership, and coordination:

- *"If you do not have commitment and the people that will actually use the research or drive the research on board… I've seen an incredible project fail"*
- *"We would be very, very willing to participate in a centre like this. We've done it many, many times"*
- *"Finding the match between algorithms and the appropriate data sets… requires really, really close collaboration"*

b) Community - emphasises building and sustaining communities of practice around quantum and health:

- *"Having that access to a team who could… screen that for you and help you just get started"*
- *"We've got such a rich ecosystem of quantum companies… and healthcare/genomics institutes"*
- *"Quantum AI like NHS Hackathon"*

c) Collaboration - explores how organisations and disciplines work together, and when collaboration is strategic vs. inefficient:

- *"Quantum needs to focus. Massive collaboration at the current time could waste a lot of time and money"*
- *"Plug into the main programme. I think it's the number one thing"*
- *"Inputs from industry… they normally have a very different view than scientists, and that's all valuable"*

d) Partnership - focuses on formal relationships, co-funding, and aligning with national programmes:

- *"Joint funded projects to give us both time to interact"*
- *"A focus team within the NHS… working with the National Quantum Computing Centre, STFC Hartree Centre, IBM"*
- *"Get investment banks and centres to put money into the fund"*

5.15 Barriers, Challenges, Benefits & Opportunities

Table 3 - Barriers, Challenges, Benefits & Opportunities Identified by Interviewees

Barriers / Challenges	Benefits / Opportunities
Regulation	Accelerate drugs to market
Talent Pipeline	Closer working relationships with industry to solve problems.
Cyber security	Optimising clinical trials
Physical security	Job Creation
Expensive (Capital)	Skills development
Expensive (On going costs)	Economic growth
Errors in computational	Quantum advantage for smaller data sets
Data availability	Validating confirmation of small molecules
Physically large	Increase of personalised medicine
Can only tackle small problems at present	Speed of computational power
Noise around machine	Quantum Chemistry
Different encoding to classical computing and AI	Quantum centric supercomputing
Qbit count	Physics based modelling
Privacy concerns (Cryptography)	Quantum optimisation
Communication barriers between science disciplines	Rare diseases
Equity of hardware availability and access	Protein structure prediction
Data management and storage	validating the confirmation of small molecules
Cannot reidentify data	Companion to HPC
Funding (Uk)	Quantum enhanced machine learning
Siloed data (UK)	
Unstructured and messy data (UK)	
Data linage and provenance (UK)	
Difficult to recruit from social care (Uk)	
Workforce challenges likely to get worse (UK)	
Fibre and Copper infrastructure (UK)	
Cross organisational data sharing (UK)	
Understanding what quantum is good at	
Access to quantum technology is limited by geography, infrastructure, and expertise.	

6.0 UK Stakeholder Workshops

Three workshops were held with a variety of stakeholders focusing on:

- Social Care and Social Determinants of Health
- Operational Management
- Governance and Implementation

These three workshops aimed to clarify core functions, identify users / user profiles, outline governance principles and identify potential use cases. They also considered feasibility, strategy, operations, impact, value, evaluation and future thinking. The following sections contain summaries of the key themes and insights from each workshop. Additional outputs were captured on digital whiteboards and are reproduced in Appendix 5 (Figs 1 – 7).

6.1 Workshop One - Social Care and Social Determinants of Health

This workshop focused on social care and the social determinants of health in relation to a potential Healthcare Quantum Computing Innovation Centre (HQCIC). The workshop featured discussions on current challenges and opportunities, and breakout sessions to identify priority needs and potential applications of quantum technology in healthcare. The key themes and insights were:

- **Defining quantum computing**: participants discussed how quantum computers differ from classical computers by leveraging quantum phenomena such as superposition and entanglement, allowing them to process complex problems more efficiently. They are not viewed as replacements for classical computers but serve as computational accelerators for specific problem types.
- **Potential healthcare applications**: participants discussed how quantum computing currently shows promise in chemical simulations (e.g., drug discovery, protein folding), optimization problems (e.g., resource allocation in hospitals), complex machine learning (e.g., genomics, disease classification), cryptography, and quantum sensing for advanced diagnostics.
- **Current limitations and research needs**: participants discussed how quantum technology is still in the research phase with challenges such as encoding problems onto quantum circuits, hardware noise, and error rates. The field will require ongoing development in hardware, algorithms, and problem mapping to realize its full potential.
- **Data challenges in health and social care**: participants considered data quality, availability, and integration across health, social care, and wider social determinants to be significant issues. They acknowledged efforts will be needed to curate and clean data, ensuring it is suitable for advanced computing applications including quantum computing.
- **Importance of cross-sector collaboration**: participants felt that establishing a HQCIC will require broad governance and collaboration involving health, social care, public health, local authorities, academia, and the third sector. They considered this collaboration to be essential for aligning research priorities and ensuring the centre addresses real-world problems effectively.
- **Educational and communication needs**: participants recognized the gap in understanding quantum computing among clinicians and social care professionals. They proposed effective translation and education would be necessary to demonstrate quantum computing's practical benefits and engage end users as champions of the technology.
- **Strategic importance for the UK**: participants highlighted the UK's opportunity to be at the forefront of quantum computing in health and social care, emphasizing the need to prepare for future technology adoption, inward investment, and creation of high-tech jobs in the sector.

- **Workshop outcomes and next steps**: participants identified priority needs such as modelling interventions, optimizing resources, linking diverse data sets, and understanding population health.

Potential use cases & areas of impact

Workshop One featured breakout sessions where participants considered potential use cases where quantum could have impact. These are summarised and grouped by thematic domain in Table 4 below

Table 4 – Potential Use Cases and Areas of Impact Identified in Workshop One

Digital Twin & Simulation	– Creating digital twins of populations to simulate interventions (e.g. balance classes to prevent falls). – Using synthetic populations to model health and care outcomes without compromising privacy.
Genomics and Omics	– Integrating genomic data into patient records for personalised care planning. – Using DNA and omics data to inform risk stratification and early intervention.
Risk Stratification & Prevention	– Predicting frailty, falls, and hospital admissions using health and social data. – Targeting preventive services based on stratified risk profiles
Social Care & Discharge Planning	– Modelling delays in hospital discharge due to fragmented care packages. – Identifying social care drivers of readmissions and system inefficiencies.
Workforce Planning	– Forecasting future workforce needs based on demographic and disease trends. – Modelling training and recruitment strategies over 5–20 year horizons.
Forecasting & Strategic Modelling	– Scenario modelling for public health interventions and service redesign. – Simulating long-term impacts of policy changes and environmental shifts.
Personalised Care	– Tailoring care pathways using patient history, lifestyle, and genomic data. – Supporting clinicians with decision tools that synthesise complex data.
Wearables & Sensors	– Using data from smartwatches and home sensors for early detection and triage. – Integrating passive monitoring into predictive models.
Data Integration & Interoperability	– Linking health, social care, and environmental data for holistic analysis. – Overcoming fragmentation to enable real-time, cross-sector insights.
Legal, Ethical & Governance Challenges	– Navigating consent, GDPR, and secondary data use restrictions. – Exploring regional consent models and ethical frameworks for data use.
Synthetic Data & Privacy-Preserving Analytics	– Generating synthetic datasets for testing quantum and AI models. – Creating digital environments for safe experimentation.
AI, Machine Learning & Quantum Synergy	– Enhancing AI models with quantum computing for faster, deeper insights. – Benchmarking quantum against classical methods for specific tasks.
Safeguarding & Abuse Detection	– Linking police, education, and health data to identify at-risk individuals. – Using predictive models to flag safeguarding concerns early.
Use Case Evaluation & Translation	– Developing triage systems to assess which problems are quantum-suitable. – Creating translational roles to bridge technical and clinical domains.

6.2 Workshop Two - Operational Management

This workshop focused on operational management considerations of a potential HQCIC. Participants explored such a centre's core roles, user engagement, technology infrastructure, funding models, and operational challenges in the context of emerging quantum computing technology for health and care. The key themes and insights were:

- **Core functions focus on innovation and collaboration**: participants felt a HQCIC should aim to provide innovators with access to quantum computing technology, enable healthcare professionals to influence quantum technology development, and serve as a multidisciplinary test bed for research and innovation. It should also function as a convening space for stakeholders to build relationships and collaborate effectively.
- **Phased maturity and strategic roadmap**: participants emphasised a phased approach to development, recognising different stages of quantum technology maturity and healthcare system readiness over 3 to 10 years. Participants felt early phases should focus on small, agile projects and clinical engagement, while later stages would be associated with broader adoption across healthcare settings.
- **User engagement and co-production**: participants felt a HQCIC should adopt a broad and inclusive user base, involving academia, industry, health and care delivery systems, and patient/public engagement. It was felt that co-production would be crucial to ensuring technology development aligned with clinical needs and to avoid technology being imposed without user input.
- **Operational challenges and resource allocation**: participants identified a key challenge would be providing time and resources for busy clinicians and researchers to engage with quantum projects. Funding dedicated roles to bridge technical and clinical expertise were seen as essential to enable meaningful collaboration and progress.
- **Technology infrastructure and data governance**: participants felt a HQCIC must address the technical realities of quantum computing, including remote access to quantum machines, data privacy, and information governance. Hosting sensitive healthcare data within national borders will be critical, and a centre would need to integrate with existing infrastructures like Secure Data Environments (SDEs) and the National Quantum Computing Centre (NQCC).
- **Funding and sustainability models**: multi-year funding independent of typical NHS yearly cycles was advocated to allow for maturation of technology and impact. Mixed funding streams, including public-private partnerships, were considered beneficial, with the need to balance diverse funders' expectations and manage funds transparently.
- **Project triage and referral pathways**: participants felt a HQCIC should implement a triage function to assess whether projects are suitable for quantum computing or better served by other technologies. Effective referral pathways to

appropriate research or commercial entities are important to maintain credibility and efficient use of resources.

- **Integration with national and regional initiatives**: a HQCIC is envisioned to complement, not duplicate, existing national programs such as the NQCC and Health Data Research Service (HDRS). Its location in the North West leverages existing infrastructure and economic development opportunities, but collaboration across regions and sectors is essential.

6.3 Workshop Three - Governance and Implementation

This workshop focused on governance and implementation considerations of a potential Quantum Health and Care Innovation Centre. Discussions covered the current state and future trajectory of quantum computing technology, data infrastructure, governance, and the integration of healthcare needs with emerging quantum capabilities. The key themes and insights were:

- **Quantum technology landscape**: participants discussed the current landscape and noted the UK currently lacks a quantum computer of sufficient size for practical health and care applications, with useful-scale quantum systems expected within 3-4 years. It was felt quantum computers will act as accelerators integrated with other technologies like AI and high-performance computing, handling specific accuracy-limited problems. Participants acknowledged quantum computing is not a disruptive step-change but will evolve incrementally over time.

- **Data considerations for quantum computing**: participants considered how due to current hardware and algorithmic limitations, quantum computing works best with smaller structured datasets. They acknowledged hardware is rapidly advancing, but algorithmic development lags behind. They felt preparing health and care data for quantum use will involve ensuring data quality, cleanliness, and appropriate structuring, and will need to address challenges with unstructured data which comprise about 80% of patient records.

- **Information governance and data sovereignty**: participants considered health and care data governance to be critical, with requirements often mandating that data remain within the UK. It was felt that quantum computing may not require transferring entire datasets but rather sending specific instructions or parameters, mitigating some governance concerns. Participants acknowledged the evolving data infrastructure will consolidate secure data environments regionally, aiming for fewer access points while maintaining local engagement and governance.

- **Integration with existing quantum infrastructure**: participants felt the proposed HQCIC would complement existing UK quantum infrastructure such as the National Quantum Computing Centre (NQCC), focusing on enterprise-ready machines and clinician-led use cases. A HQCIC should collaborate across the quantum ecosystem to ensure the right combination of technologies addresses healthcare challenges, with a pipeline from fundamental research to applied solutions.

- **Governance, sustainability, and IP management**: participants felt that establishing clear governance structures will be essential, including openness, transparency, and protecting intellectual property. They acknowledged the NHS currently faces challenges with IP commercialization, and future frameworks would be expected to standardize data access and IP management nationally, balancing public benefit with commercial partnerships.
- **Workforce and cultural readiness**: participants identified a gap between rapid hardware advancements and the development of skilled personnel capable of developing quantum software and integrating it into health and care workflows. They felt preparing the workforce to gain the most from quantum will involve upskilling and engaging health and care professionals to ensure technology adoption aligns with needs and practices. They also acknowledged that culture change and storytelling will be necessary to foster acceptance and understanding.
- **Data ecosystem challenges**: participants discussed how health and care data is fragmented across multiple legacy systems with varying levels of maturity, complicating data integration and research. They recognised that efforts are underway to rationalise infrastructure and data holdings to create efficient, federated environments that maintain agility and local responsiveness. They also acknowledged funding models and incentives are evolving to support data quality improvement and accessibility.
- **Practical applications and innovation strategy**: participants felt near-term quantum applications may focus on optimization problems like staff rostering and transport scheduling, which use less sensitive data and provide cross-sector benefits. They felt small-scale test cases and living labs could be valuable for experiential learning, partnership building, and demonstrating value. They proposed a HQCIC should aim to lead a health ecosystem-driven approach to quantum computing, avoiding technology-driven pitfalls seen in AI adoption.

7.0 Key Findings

7.1 Overall findings from across all our data sources used in this study suggest quantum computing in health and care is currently nascent and experimental. Interviewees consistently described it as “early-stage” and “not yet ready for full deployment.” The study identified several critical themes:

Access: Connectivity (on-site vs cloud), equitable usage, and data governance are central concerns.

Financial: High costs necessitate hybrid funding models involving public, private, and philanthropic sources.

Intellectual Property: Risks around IP concentration and competitive exposure in multi-partner environments.

Technical: Challenges include data preparation, integration with legacy NHS systems, algorithm development, and testing.

Governance & Community: Success depends on cross-sector collaboration, ethical oversight, and sustained stakeholder commitment.

Operational: Emphasis on scalability, system-wide rollout, and integration with broader NHS digital transformation efforts.

Throughout the interviews with both Cleveland and UK we identified barrier and challenges that interviewees thought we would face in create a centre for quantum computing. These are listed below on table 3.

7.2 From the findings, a vision for a Health and Care Quantum Innovation Centre (HCQIC) emerged. The proposed HCQIC would operate as a Quantum Technical Operations Hub, comprising:

- A centralised/federated hub for coordination, supplier management, and infrastructure planning.
- Standards & APIs to ensure interoperability with NHS systems.
- A federated data platform with built-in privacy and compliance.
- An R&D Algorithm Factory to translate clinical problems into quantum solutions.
- Skills & Community Building initiatives including training, public engagement, and diversity programmes.
- Governance & Programme Management structures to ensure ethical and strategic oversight.
- An evolutionary roadmap from cloud access to owned hardware.
- Two complementary funding models:
- A Hybrid Operational Model blending public and private investment.
- An NHS/Care-Centric Model focused on health outcomes and equity.
- A Quantum Skills & Education Hub to build literacy and workforce capacity.

7.3 Quantum – Current State

The interviews and workshops identified that quantum is not fully understood. This means both those who are unfamiliar with quantum, and even those who are familiar struggle to identify new uses cases beyond the currently understood areas of development. Table 3 in section 5.18 outlines the barriers and challenges identified across all interviews and workshops and the potential benefits and opportunities identified.

The interviews and workshops also identified current understanding around where quantum excels and where it has its limitations. This is outlined in Table 5 below

Table 5 – Current Understanding of Quantum Advantages and Limitations

What is Quantum good at	What is quantum not good at
Small data sets	Identifiable data
Where a limit is reached with large classical computing.	Quantum computing struggles with scalability, data ingestion, and solving large real-world problems.
Using superposition and entanglement to analyse complex problems i.e. Protein structures	Quantum computing is currently expensive to access, operate, and scale.
Examining more states at one time, so not more data but more things at once at a slower speed	Quantum solutions often don't translate well to messy, large-scale, real-world problems.
Quantum enables faster processing and decision-making.	
Quantum excels at solving problems with many interdependent variables	

The interviews enabled the current UK and international eco system within which quantum will exist to be mapped as follows:

Data Centres

- Over 490 active data centres across 79 UK markets, with major hubs in:
  - London (182 centres)
  - Manchester (30)
  - Slough (19)
  - Liverpool, Cardiff, Edinburgh, Birmingham, Cambridge and others. *(Appendix 4, 1)*
- The UK government has designated data centres as critical national infrastructure, streamlining planning laws to support expansion.
- Power capacity is forecasted to exceed 4GW by 2030, driven by AI, cloud computing, and digital transformation. *(Appendix 4, 2)*

High-Performance Computing (HPC)

- The UK hosts several Tier-2 National HPC Centres, including:
  - NI-HPC (Northern Ireland)
  - Daresbury Laboratory (Liverpool City Region) – £30M supercomputing centre for business and academia. *(Appendix 4, 3)*
- Facilities include HPE Cray EX systems with hundreds of thousands of cores and petaflop-scale performance. (Appendix 4, 4)

Quantum Computing Infrastructure

- The National Quantum Computing Centre (NQCC) at Harwell Campus is a flagship facility for quantum R&D and deployment. *(Appendix 4, 5)*
- The UK has launched five quantum hubs to support applications in healthcare, security, and infrastructure. *(Appendix 4, 6)*
- A London Quantum Technology Cluster brings together UCL, Imperial, and King's College with industry and government. *(Appendix 4, 7)*

Strategic Investment & Roadmap

- The UK Compute Roadmap (2025) outlines a £2 billion plan to build a national compute ecosystem:
  - Integrates AI, traditional HPC, and quantum systems.
  - Establishes AI Growth Zones and regional supercomputing centres.
  - Aims to position the UK as a global leader in compute infrastructure. *(Appendix 4, 8)*

Named Facilities and Organisations

- National Quantum Computing Centre (NQCC) at Harwell
- Five Quantum Hubs under the UK National Quantum Technologies Programme (e.g. QCA-3, QBioMed)
- Digital Catapult, National Physical Laboratory, STFC Hartree Centre (Daresbury)
- University-linked centres: Oxford, Cambridge, UCL, Imperial, King's, Lancaster, Nottingham, Glasgow, Edinburgh, Strathclyde, Heriot-Watt
- Companies: IBM, Honeywell, Cambridge Quantum/NQIT, Continuum

Geographic Distribution

- Strong activity in Oxford–Cambridge–London triangle
- Active regions: Bristol, Glasgow, Edinburgh, Strathclyde
- Less activity noted in: Manchester, Liverpool, Lancaster
- Desire for a Northwest-based facility

8.0 Insight & Analysis

8.1 Potential benefits of quantum computing in health and social care

Ninety per cent of interviewees were supportive of the development of quantum computing and the opportunities it would afford for health and care.

Interviewees identified a number of instances where quantum could provide a unique advantage in addressing health and social care problems.

The 10 per cent of interviewees who were unsupportive referenced more hype than reality currently and the fact that we have not yet fully exploited high-performance computing (HPC) and artificial intelligence (AI) (see section below: *Establishing a Health and Care Quantum Innovation Centre*).

Quantum computing and machine learning may be better suited to tasks involving small data sets due to the possibility of generalising better than classical machine learning. It may better solve problems with many interdependent variables, due to greater “expressibility” of variables, their overlap and connections.

This information could be provided almost instantaneously, accelerating our ability to make decisions and enabling significant savings in time and cost. For health and social care this means it has the potential to:

- open up a world of personalised medicine by simulating protein-chemical interactions.
- aid drug development by showing how proteins interact with drugs and other proteins.
- aid in illnesses diagnosis, especially in rare conditions and diseases where less data is available, leading to faster and more efficient treatment.
- expand academic and clinical research data sets to make faster progress and discoveries in research areas with limited evidence bases (e.g., microbiomes, women's health, paediatric health)
- solve challenging combinatorial optimisation problems (e.g., care pathways, population health management).

8.2 Potential use cases

Therefore, use cases that have currently been identified for health and social care include:

- Development of personalised medicine
- Drug discovery and accelerating drugs to market
- Clinical trial optimisation (i.e., in silico arms of clinical trials)

- Expansion of clinical research
- Targeted medicine
- Improved management of rare diseases and conditions
- Protecting sensitive data by providing secure lines and encryption (quantum cryptography)

However, throughout interviews and workshops, it appears that quantum is not fully understood yet. Even those familiar with quantum can struggle to identify new use cases beyond these current areas of development.

The need to clearly define use cases was a common theme from interviewees at the Cleveland Clinic. This would also ensure that the right technologies were being used in these use cases (e.g., HPC, AI or quantum).

8.3 Current limitations and challenges in quantum computing

The following were recurring challenges mentioned throughout the interviews. They are grouped into six categories in Table 6:

Table 6 – Challenges Identified by CC Interviewees

Operational	Workforce	Data
• Embedding a sustainable operational model: success depends on cross-sector collaboration and sustained stakeholder commitment • Ability to achieve health and care system-wide scalability/roll-outs, and integration with broader NHS digital transformation efforts • Understanding of quantum (e.g., what it is, how it is used), leading to challenges of public trust and engagement • Physical access to quantum technology is limited by geography, infrastructure and expertise, leading to issues of connectivity and equitable usage	• Skills shortage and small talent pipeline for quantum computing and advanced computing generally – which is likely to get worse in the short to medium term without interventions in the education system	• Governance: management and storage; cross-organisational data sharing; transferring data outside of the UK • Data availability • Siloed data/ interoperability issues • Unstructured and "messy" data • Data linage and provenance

Regulation	Financial	Functional
• Other governance, beyond data, ethics • Evolving regulation (around quantum specifically or broader) • Cyber security • Privacy concerns (i.e., cryptography) • Other governance, beyond data	• High costs (capital and ongoing) • Funding challenges • Demonstrating value/ROI • Risks around intellectual property concentration and competitive exposure in multi-partner environments	• Physical size of machine • Physical and virtual security (e.g, making sure the right people are using the machine) • Noise generated by the machine • Equity of hardware availability and access • Fibre and copper infrastructure • Communication barriers between science disciplines

Interviewees who are thought leaders in this field, consistently described quantum as “early-stage” and “not yet ready for full deployment.”

Quantum computing is currently expensive to access, operate and scale. It struggles with large datasets and therefore solving large-scale real-world problems.

An interviewee at the Cleveland Clinic raised an issue of re-identification of data. When working with genetic data using AI, they feed the algorithm actual genetic data and therefore, they can re identify the anonymised data. With quantum you enter your transformed (i.e. simulated data) which then cannot be reidentified. This issue had not been raised anywhere else but should be a consideration as use cases develop.

8.4 Risks of not developing quantum computing

The UK does not currently have an error-corrected quantum computer. Having access to quantum computing is essential to explore any of the identified use cases and to continue to develop the technology. The Cleveland Clinic has the ability to decide to develop areas where they feel quantum would be most effective. They can drive innovation with their clinical and operational staff and acquire new skills.

All interviews, workshops and visits conveyed a strong desire for the UK to “catch up” with global trends, and the opportunities quantum computing can afford to health and social care.

Interviewees would like to see a “meaningful-sized” quantum computer to support this ambition be created. The location for this could be flexible, however the North West is recognised as an opportune place with the presence of STFC Hartree Centre, with its capacity in HPC and developments in cryogenics, the establishment of the future headquarters of the National Cyber Force in Samlesbury, Lancashire, the development of a Northern Technology Corridor, and regional infrastructure.

9.0 Recommendations

9.1 Creation of a Health and Care Quantum Innovation Centre

From our research it appears that a general understanding of the best use of quantum computing and its potential impact is still developing. Currently, we are not using HPC and AI to full capacity. Until that happens, we will not be able to understand where quantum can support, enhance and progress health and social care.

All interviewees stated a centre solely devoted to health and social care quantum computing would not work. However, there was overwhelming support to develop a centre that could explore all aspects of computing power. A centre to understand where HPC and AI get us to, then exploring how quantum can take us that step further. The Cleveland Clinic uses quantum computing alongside HPC and AI capability with success. This mixed-method approach to computing as meant that their current computers are at 80% utilisation.

Regardless of the technologies covered by the centre, it was still recognised that we need to “get ahead” of quantum to understand where it offers most value and to start building the skills needed to ensure we get the most out of it. Health and Social care also need to start engaging with patients and public to educate them about these technologies, understand how they feel about them and where issues may arise.

9.2 Elements of a Health and Care Quantum Innovation Centre

Based on all the information collected, a Health and Care Quantum Innovation Centre (HCQIC) the centre should:

- offer users a single front door for health and care sector to access advanced computing
- be open access, not linked to a particular academic or industry institution
- a central location for any enquiries relating to the use of advanced computational techniques with health and care data
- provide a collaborative community for progressing quantum computing, research and innovation related to health and care, including patient and public involvement and engagement.
- support users to apply for funding opportunities
- advocate for cross sectorial collaboration
- encourage health and social care communities to provide improved pathways of care using advanced computing technologies
- allow funded time for users to explore “wicked problems” and co-design outputs using varying advanced computing modalities.

The centre should be built on a foundation of:

- governance, ethics and equity
- education and outreach to children and young people to develop the future workforce
- public and patient involvement and engagement, as their data is ultimately the greatest asset
- maximising the use of data being collected across health and social care and wider.

Aspects of the centre should include:

- quantum, along with HPC and AI, avoiding siloed approaches.
- a centralised/federated hub for coordination, supplier management and infrastructure planning.
- a marketplace for a variety of services related to health and care data use and computing.
- standards and application programming interfaces (APIs) to ensure interoperability with NHS and care systems.
- alignment with the NHS Secure Data Environment (SDE), other data infrastructure such as Health Data Research UK (HDRUK), as well as social care and the digital transformation agenda.
- a hub for education training and coaching related to data and advanced computing application in health and care.

9.3 Demonstrating the value of a Health & Care Quantum Innovation Centre

Through our research, possible KPIs for the centre were identified that could represent potential impacts of a HCQIC:

a) Health and care outcomes

- Improved well-being and quality of life
- Reduced demand on services
- Prevention of deterioration and early illness detection
- Lower error rates in diagnostics or interventions

b) Research and knowledge outputs

- Number of papers, publications and citations
- Research grants and PhD completions
- Evidence base strength
- Peer-reviewed outputs
- Use of quantum algorithms in NHS and care settings

c) Operational and adoption metrics

- Number of use cases, studies and problems solved
- User counts, project volume and engagement events
- Translation into real-time system change
- Capacity use (e.g., 24/7 use of quantum centres)

d) Economic and societal effects

- Jobs created, skills developed career pathways and local employment
- Business growth, inward investment and university spinouts
- Value for money and NHS and care savings
- Return on investment (flagged as hard to prove)
- International collaborations and visibility

a) Engagement and training

- Public engagement metrics
- Training programme reach
- Knowledge transfer into organisations

9.4 Operating and funding models for a Health and Care Quantum Innovation Centre

A full-value and sustainable financial model is key to moving forward with the centre, as is governance and programme management structures to ensure ethical and strategic oversight. Interviews with the Cleveland Centre mentioned the following key elements:

- Board of directors
- Ethics board
- Community members
- Finance subcommittee
- Conflict of interest committee

- Research and education committee
- Intellectual property expertise
- Legal, commercial agreement and contracting expertise
- Links to grant funding opportunities

From the learnings, there are a number of options for how the HCQIC could operate, sustain itself and engage with stakeholders. These are detailed in Section 11 and can help develop further business cases.

10.0 Options for a Health and Care Quantum Innovation Centre

10.1 Central Hub Model

a) Centralised or federated hub that coordinates quantum access, infrastructure, and partnerships. It would have a technical operating phase (1-4 years) with an evolutionary roadmap (5-10 years). Each component is interdependent in delivering a robust, scalable and ethical quantum technical capability.

- A centre to:
  - Initially provide remote/cloud-based access to quantum resources
  - Manage supplier relationships (IBM, NQCC, STFC Hartree Centre)
  - Host test beds and pilot projects, that healthcare has demand signalled
  - Assess outsourcing versus sovereignty over time, and plan for physical infrastructure (including HPC and cryogenics)
  - Quantum business support programme
  - Guide phased implementation and scaling of quantum capabilities

b) Standards and APIs

- Define and enforce:
  - Interoperability, data formats and integration protocols
  - Middleware to integrate quantum with NHS, NIHR and UKRI legacy systems

c) Secure data environment

- Build-in:
  - Anonymisation, consent management, audit trails
  - Synthetic data tools for safe prototyping
  - Alignment to SDE timescales where appropriate
  - Legal/ethical compliance mechanisms

d) Research and development, and algorithm factory

- Translate health and care problems into quantum-native algorithms
- Manages testing/validation with benchmarking
- Develop hybrid pipelines (quantum + classical + AI)
- Maintain a catalogue of validated use cases

e) Skills and community building

- Co-ordinate:
  - Creation of a talent pipeline

  - Training, hackathons, secondments
  - Credentialing (granting a designation, such as a certificate or license, by assessing an individual's knowledge, skill or performance level) and open-source toolkits
  - Public engagement and trust-building
  - Leverage and build on existing training mechanisms (e.g., STFC Hartree Centre, National Centre for Digital Innovation and Quantum Supercharger Library)
  - The creation of quantum-relevant higher and further education courses, degrees and PhDs

f) Governance and programme management

- Embed:
  - Ethical review, regulatory advice, risk management
  - Deployment checklists and incident escalation
  - Programme office for tracking and coordination

10.2 Hybrid Model

a) Mixed public–private sector funding streams

- Public:
  - Core infrastructure funded via UK Research and Innovation (UKRI), Engineering and Physical Sciences Research Council (EPSRC), or Department for Science, Innovation and Technology (DSIT) Quantum Mission
  - Access subsidies for academic, NHS and social care users
- Private:
  - Commercial partners (e.g., pharmaceuticals, biotech, tech firms) pay for compute time, data access and tailored services
  - Venture capital and philanthropic funds support innovation and spinouts potentially coming from partnering universities

b) Tiered access model

- **Tier 1**: Free or subsidised access for academic, NHS and social care research aligned with public health and care goals
- **Tier 2**: Discounted access for early-stage startups and small to medium enterprises (SMEs)
- **Tier 3**: Full cost recovery for corporate research and development, and commercial use

c) Cost recovery and sustainability

- Transparent pricing for:
  - Compute time
  - Data storage and processing
  - Technical support and training

- Reinvestment of surplus into:
  - Talent development
  - Infrastructure upgrades
  - Community engagement

d) Strategic partnerships

- Long-term agreements with:
  - NHS Trusts
  - Local authorities
  - Social care providers
  - Universities
  - International partnerships i.e. Singapore, Japan and USA
  - Industry consortia
  - Public Sector Bodies (DHSC, DSIT)
  - Member Organisations (e.g., Tech UK, TSA Voice)
  - Health Care Innovation Hubs (e.g., Alder Hey Innovation)
- Shared investment in:
  - Facilities
  - Talent pipelines
  - Joint research programmes
  - Joint staff

e) Innovation incentives

- Incubator/accelerator attached to the centre:
  - Supports spinouts
  - Attracts investment
  - Drives regional growth
- IP-sharing frameworks to balance public benefit and commercialisation

10.3 NHS-centric Model

a) Core public investment

- Infrastructure and staffing funded via:
  - UKRI/EPSRC grants aligned with NHS priorities
  - DSIT's Quantum Mission and NQCC partnerships
  - DHSC health and social care innovation budgets
- Focus on clinical relevance, health and care equity, and data access and security

b) Tiered access for NHS Trusts and social care

- **Tier 1**: Free access for NHS and social care-led research aligned with national health and care priorities (e.g., genomics, diagnostics, waiting list reduction)

- **Tier 2**: Subsidised access for regional NHS organisations, arm's length bodies and integrated care boards (ICBs)
- **Tier 3**: Cost-recovery access for NHS, social care/industry joint ventures

c) Strategic co-funding

- NHS and social care collaborate with:
  - Pharma and MedTech firms for translational research
  - Charities (e.g., Wellcome, British Heart Foundation) for population health studies
  - Academic partners for workforce development and training
  - Big Tech (e.g., IBM, Quantinuum, Alice & Bob, PsiQuantum)
- Shared investment in:
  - Quantum-ready data environments
  - Secure compute infrastructure
  - Clinical trials and algorithm development

d) Value-based investment logic

- Funding tied to:
  - Improved patient outcomes
  - Operational efficiency (e.g., diagnostics, triage, resource allocation)
  - Cost-effectiveness (e.g., personalised medicine, drug discovery)
- ROI measured in health and care impact, not just financial return

e) Governance and equity

- Transparent governance via DHSC and IG frameworks
- Ensure regional equity and inclusive access across NHS and social care geographies
- Embed public trust and ethical oversight in all funding decisions

10.4 Quantum skills and education hub

A regional centre of excellence designed to build human capacity in quantum technologies and related fields (e.g. high-performance computing, AI, cybersecurity) through education, training, and public engagement to help tackle the skills shortage in these fields. This hub will:

- build early awareness and realistic understanding.
- create a centralised, scalable model for training and engagement
- support regional innovation and economic development.

Core components:

a) Education programme
  - School outreach: workshops, visits and curriculum-aligned materials
  - Public awareness: exhibitions, explainer sessions and interactive demos
  - Online learning: short courses, webinars and certification pathways

- Higher and further education: Engagement to support creation of quantum-relevant courses, degrees and PhDs

b) Skills Pipeline Development
   - Upskilling for clinicians, analysts and tech professionals
   - Partnerships with universities (e.g., Lancaster, Liverpool, Nottingham).
   - Internships and apprenticeships in quantum and data science

c) Cross-disciplinary collaboration
   - Bring together physicists, engineers, clinicians and policymakers.
   - Host hackathons, research sprints and innovation labs.

d) Workforce integration
   - Align with regional workforce development plans.
   - Support digital, data and technology (DDAT) roles and NHS, social care digital transformation goals.
   - Address diversity and retention challenges (e.g. brain drain).

11.0 Limitations

a) It is unclear where the funding of an enterprise sovereign computer will come from

b) NHSE is being subsumed into DHSC. Therefore, interviews were conducted against a backdrop of uncertainty.

c) Despite four interviewees being from social care backgrounds and a workshop focused on the social determinants of health and social care, the voice of care sector has been less represented and fewer use cases identified.

d) There are few people with deep expertise in both quantum computing and healthcare, meaning the report may have missed crucial interdisciplinary insights.

e) Information has been gathered from a cohort in health and care with a low understanding of quantum computing.

f) Quantum computing is still largely in development, making it challenging to predict when, or if, certain quantum capabilities will become practical. This makes it hard to recommend use cases.

g) Both quantum computing technology is moving quickly. Hardware approaches, algorithms, and regulatory frameworks are all in flux, and any specific technical recommendations could be outdated within months.

12.0 Conclusion

From the research undertaken, it appears a centre that brings together, HPC, AI and quantum computing is needed to harness the value of advanced computing. Although the costs to develop this technology are high, the potential risks of being left behind are higher.

The questions this feasibility study was asked to address were:

- Does the health and social care system need quantum computing?
- What use cases could be established from the need?
- What areas of health and social care could benefit from quantum computing?

The answer to the first is absolutely, not only for the NHS, health and social care, and economic growth, but for the UK's wider reputation as a global thought leader. However, quantum is not the silver bullet. Quantum computing is one of a number of vital tools in the toolbelt of advanced computing. All types of computing must be considered when deciding the best approach to finding solutions to our biggest health and care challenges.

The second and third questions are inter-related. Early use cases and areas of health and care that could benefit from quantum technology have already been identified, but many have not been properly explored. This is because having access to quantum computing is essential to explore any of the identified use cases and to continue to develop the technology.

The UK will need to build a domestic "meaningfully-sized" quantum computer in order to drive innovation and develop vital workforce expertise in the technology.

Building and using a quantum computer will have a long list of challenges, some of the biggest being access to HPC and cryogenics, governance, data integration, access, costs and skills shortages. But, nothing ventured, is nothing gained. This is why the most valuable insight from this study is a vision for a centre that brings together, HPC, AI and quantum computing to harness the value of advanced computing.

Interviewees had extensive amounts of insight into various operational and funding models that this centre could adopt. A centre like this could not just serve health and social care but allow for the domestic development of quantum computing altogether. These models need further investigation.

Appendix 1 – Engagement Plan

Stakeholder Communication	Activity	Milestone + Target Date
1. Objectives		
Invite stakeholders to participate	Personal outreach, with request and options for level of engagement, reply directed to Engagement Lead	20-30 confirmed participants 7-10 per specialty area 6 June 2025
Inform stakeholders about progress.	Bi-monthly status/engagement email, offers for 30-minute chats if desired.	Ongoing June-July 2025
Engage stakeholders in feedback capture processes.	Survey availability and schedule workshop, interviews, and rapid insights sessions. Offer survey to all participants in the first instance.	Commence 19 May 2025 Ongoing June-July 2025
Gather feedback to improve project outcomes.	Capture participant data and feedback from survey, workshop, interviews, and rapid insights sessions. Handover to Evaluation Lead for analysis.	Data handover June-July 2025 Workshop data package 4 August 2025
2. Stakeholder Identification and Analysis		
Stakeholder identification	Stakeholder list review and development with steering/advisory group, to include role, position, and "perspective grouping"	Populated outreach list complete 14 May 2025
Stakeholder analysis	Stakeholder outreach to assess influence, interest, and communication needs	Mixed methods/sources 30 May 2025
3. Key Messages		
Create invitational messaging for key groups	Draft 1-2 paragraph invitational messages to include project overview and personalised "ask" aligned to "perspective grouping"	Draft approved 2 May 2025
Develop messaging for varying engagement levels and stages	Draft standard reminder and update communications for tailoring according to project stage	Template complete 3 June 2025
4. Communication Methods and Channels		
Email: regular updates to all stakeholders.	GDPR request and communication calendar	GDPR via initial comms 30 May 2025
Meetings: Planned meetings with key stakeholders.	Weekly steering group calls Monthly highlight reports	Ongoing through end of project
5. Engagement Activities		
Survey	Distribute survey to all stakeholders and track responses	50% response data per group 5 June 2025
Workshops (mixed participant groups)	Schedule, design, and deliver two "focus group" workshops for priority topical and organisational themes	7-10 participants per group Delivery complete 27 June 2025
Rapid Insights Sessions (survey for those unavailable)	Schedule and hold two (identical) rapid insights sessions to confirm/inform draft findings	Delivery complete 11 August 2025
6. Roles and Responsibilities		
Project Manager	Manage engagement scheduling and information capture/storage	N/A
Engagement Coach	Draft communications and activity content for advisory review, deliver workshops and rapid insight sessions	N/A
7. Monitoring and Evaluation		
KPIs: Stakeholder engagement, number of feedback responses.	Metrics to be defined May 2025	Workshop analysis complete 4 August 2025
Reports: Regular communication activity reports.	Feedback mechanisms and structure to be confirmed	Ongoing through end of project

Appendix 2 – Stakeholder Roles

Role	Area of Quantum
Programme Administrator (CC01)	day-to-day administration of keeping the computer optimised, keeping access Federated from various partners, internal and external, as well as leveraging the quantum computer to build an ecosystem of additional users.
Chief Scientist for the Discovery Accelerator.	Bring investigators on the Cleveland Clinic side, both biomedical researchers, clinical researchers of direct coordination with IBM staff to share their expertise in quantum computing, but also in any other areas of technology
Cleveland Clinic lead for quantum computing, Discovery Accelerator	Protein structure prediction Biomarker discovery applying quantum computing, for example to rare diseases Clinical trial optimization Drug discovery
Managing Director for Experimental Therapy, The Drug Discovery Centre	Looking to put Drug Discovery Centre with AI machine learning and quantum for an end-to-end AI and Quantum based platform for drug discovery, and antibody discovery. Our goal is quantum computation to apply global Centre for Pathology research in human health and personalised medicine.
Staff Scientist	Computer aided drug design. Quantum machine learning with just classical machine learning
Cleveland Clinic's Chief Research Information Officer	To bring technology to research across the health system locations. Three categories of biomedical research: • Quantum chemistry (problems related to simulations, different types of simulations of structures or chemical interactions or biophysics driven interactions). • Quantum machine learning, (problems where we've taken machine learning as far as it can go) • Quantum optimization of complex processes
Chief Research and Academic Officer	Accelerating clinical trial enrolment Drug discovery
Physician Scientist	Diseases in the gut. Researching how host cells respond to microbes in the gut and our response to inflammation
NHSE Senior digital and data Leadership	Two roles from this area, no direct link to quantum yet
Social determinants of health, social care senior advisory leadership	No direct link to quantum
Social care and regulated care digital leadership	Three roles from this area no direct link to quantum yet
Roles in private sector quantum leadership	Interviewed 10 roles from organisations that are actively pursuing quantum computing and also supporting national centres.
Roles from academic institutions	Both roles understand quantum and are thinking of it's applications.
Secure data environment	Two roles from secure data environment work, no direct link to quantum yet.

Appendix 3 – Question Sets

Healthcare Quantum Computer Centre of Excellence, feasibility Study Interview crib sheet (Cleveland Clinic)

Thank you for agreeing to be interviewed, and contributing your expertise to the development and understanding of how the proposed Healthcare Quantum Computer Centre of Excellence (HQCCE) would be utilised by Health and Social Care in UK&I. This interview should last no more than 1 hour.

Consent

We will use this interview and your views in the write up of the feasibility study. To facilitate this we will be recording this session and transcribing the conversation to be included in our evidence. This interview is not conducted under an NDA please use your discretion in what you feel is appropriate to disclose in this interview. (e.g. anything relating to IP. not appropriate)

I consent to the contents of this interview and my views to be used in the feasibility study being developed by Health Innovation North West Coast.

Name:
Signature:
Date:

Background

STFC Hartree Centre and NHS England wish to establish a Healthcare Quantum Computing Centre of Excellence (HQCCE), they have asked Health Innovation North West Coast (HINWC) to support the development of the final business case by conducting a feasibility Study to understand the following:

1) Need from healthcare for Quantum Computing
2) What use cases could be established from the need
3) Areas of most importance in healthcare for quantum

This work also must align to the National Quantum Strategy Missions, in particular Misson 1

'By 2035, there will be accessible, UK-based quantum computers capable of running 1 trillion operations and supporting applications that provide benefits well in excess of classical supercomputers across key sectors of the economy.'

And also, Mission 3

'By 2030, every NHS Trust will benefit from quantum sensing-enabled solutions, helping those with chronic illness live healthier, longer lives through early diagnosis and treatment.'

The hypothesis from STFC Hartree Centre is 'Health and Social care doesn't understand quantum computing or how it can be applied to support the system and its challenges' This feasibility work will aim to understand if this is true or to what extent it is true or false.

General Questions

- Could you tell me about yourself and your expertise and role here at Cleveland Clinic and also sign the agreement for consent to record and use this interview?
- Could you explain your role as it links to quantum computing?
- What is your definition of quantum computing?
- How do you currently or plan to use quantum in healthcare?
- Why do you think quantum is needed in healthcare?
- Where do you see the biggest potential for quantum computing in healthcare?
- What do you see as the benefits of quantum computing to healthcare?
- What do you see as the main challenges to adopting quantum computing within healthcare?

Technical

- How does the data need to be presented?
- Does quantum require the same governance structure as AI or is it different i.e. will it requires ongoing management to look for drift or bias etc?
- What challenges have you encountered around data and how have you overcome them?
- What are the technical challenges to instillation of quantum computing?

Finance

- Have you done any cost benefits analysis on quantum computing in healthcare or any thinking around economic value?
- How is quantum funded for your organisation, initially and ongoing, is it a self-sustainable model.

Operational

- Do you have any details of your operating model or suggestions around potential operating models.
- What's your staffing model
- How do you bring in the patient voice?
- Thinking about public and patient engagement how do you ensure user centred design and co-creation of quantum?
- What have been the main challenges of standing up a facility of this nature?
- How do you bring in the understanding of healthcare needs and challenges to ask the right research questions of the data?

Commercial

- Do you have commercial model for income generation opportunities?
- How do your mange the commercialisation of the quantum for healthcare?

Closing questions

- Anything else in general you think we should know?
- Is there anything else you think we should know around quantum computing in healthcare that will support our developing business case?
- Is there anyone else you think we should speak to, could you provide contact details?

PDF

Quantum Interviews
- Main Question Set.p

Appendix 4 – Quotes

Reference	Quote	Interview code
Operational Model	*'We aspire to have our investigators run, as we say,* ***the right job, at the right time, on the right hardware.*** *So, we're sending the right jobs to quantum that are appropriate. But we're also not selling short what problems could be answered using other modalities.'*	CC01
Operational Model	*'it's most important to consider quantum computing as like a coprocessor in that it's not going to replace all computing. So classical computing, which is bits instead of qubits is very good at a lot of tasks, it scales pretty well'*	CC03
Operational Model	*'At Cleveland Clinic, we are an organisation that has* ***research embedded in our mission.*** *We know that without taking calculated risks, we will not be first at anything, so we have to explore. We have to study. And so that's why for us* ***it made sense, to invest in quantum.'***	CC06
Operational Model	*'So I'm not just using the quantum computer, and what we've worked out here is the workflow required to* ***use quantum, HPC and AI together****.'*	CC07

Appendix 5 – Workshop Outputs

Figure 1 – Value Proposition

<table>
<tr><th colspan="2">Value Map</th><th colspan="2">Customer Profile</th></tr>
<tr>
<td rowspan="2">Products and Services
What products and services will you offer your customer so they can get the job done?
– Funded time with data and computing experts to work on and solve ‘wicked’ problems
– A marketplace for a variety of services related to health and social care data use and computing
– Collaborative community for progressing quantum technology and computing research and innovation related to health and care (PPIE)
– Education, training and coaching related to data and advances computing applications in health and care (PPIE)</td>
<td>Gain Creators
What will you offer the customer to help them achieve their goals?
– Single front door for all health and care advanced computing queries
– Funded time for innovation, research and real-world evaluation (fellows, workforce schemes etc.)
– The space and support to co-design quantum technology development</td>
<td>Gains
What would make the customer happy, or what would make the job easier?
– A place to go for complex computational needs and data access
– A central location for queries related to advanced computing
– Learning more about what computing functions can do in which situations, and when / is computing solutions can be combined</td>
<td rowspan="2">Customer Jobs
What jobs does the customer or user need to get done
– Innovators want access to the computing technology for use cases
– HCPs influencing development of quantum to serve health & care system need
– Multidisciplinary teams want test bed space to research and innovate
– Stakeholder communities need a convening function to bring work together
– Research needs
– Enterprise needs</td>
</tr>
<tr>
<td>Pain Relievers
How can you relieve customer pains? What problems can you eradicate?
– Shared benefit from HCQIC activity to influence / sustain health and care communities through quantum and advanced computing innovation
– Collaborative network to influence and support development of quantum technology
– Grants / funded schemes for cross-sector collaboration and for health & care innovators to study & test “near enterprise ready” innovations</td>
<td>Pains
What is troubling to the customer, or preventing them from getting the job done?
– Cultural divide in health & care collaboration
– Disjoined data management & BI communication
– Single year funding
– Limited knowledge of quantum & advanced computing potential
– Data access and availability</td>
</tr>
</table>

Figure 2 – Roadmap Considerations / Future Thinking

Incremental Change

	Year 1	Years 2 - 3	Year 5	Year 10
Centre Governance & Operations	– Business model framework co-designed and implemented – Establish partnership working framework			
Tech Landscape	– "No quantum computer in the UK that is big enough to do anything useful" – We have experimental but not commercially ready QC (NQCC testbeds for proof-of-concept use)	– Quantum as part of a toolkit including adjacent technologies – Safeguarding concerns – Accuracy gains... – UK Sovereign national compute capabilities – Useful functionality available?	– Large-scale, privately-owned quantum computer in UK. Shared / part government funded	– Scale-up: quantum data centres across the UK
Data Landscape	– Identifying the data needs for quantum? Sending instructions for QC to build a circuit... – Health Data Research Service development – Still in research phase of determining structure and management of data – Regional data access committee with governance to include diverse stakeholders (ICB level too)	– Common commercial frameworks for patient data – getting closer on access and availability but still not clear re: IP standardisation – Recognising intersection between local need driven by HCPs and providers etc. and QC application – Pan North / Northern Powerhouse alignment – Data persistence and archiving needs?		– Maturity of system, leaner, high quality systems for data control
External Dependencies	– DSIT Quantum Strategy – NHS restructure fallout – Health Innovation Network investment and reach			

KEY
Milestone or event
Significant dependency
Feature or enabler

Figure 3 – Core Functions

- NQCC intersection
- Ensuring that the work of the Centre creates tangible change
- Centre "creates time" for professionals via funded posts & other funded schemes
- Evaluation that leads to meaningful and tangible transformation
- Testbed/Living Lab co-location to develop incubation potential (NW initially?)
- The Centre must complement other functions SDE, HRD, NQCC
- Clinical Engagement and readying the sector for this work
- Active participant shaping development in Quantum as it relates to health
- Co -designed projects with multi-purpose and multi-sector teams
- "a multi-way" dialogue
- Training and Learning
- Pipeline and adoption plans

Figure 4 - Strategy

- Stages of Maturity/Phasing
- Co-Production accessibility
- Accessibility to technology
- Clarify focus... identify key functions, remain within scope by signposting
- Opportunity scanning "when the data is there"
- Starting with the innovators in research spaces
- Pipeline and adoption strategy
- Focus on near-enterprise ready tech (with an eye to what tech needs exist)
- Parity between pilots and "other" projects
- Stakeholder engagement strategy/plan
- Seek 3 year funding to stand up the centre and begin evaluations
- What other funding models are possible? Can multiple funding sources be combined?

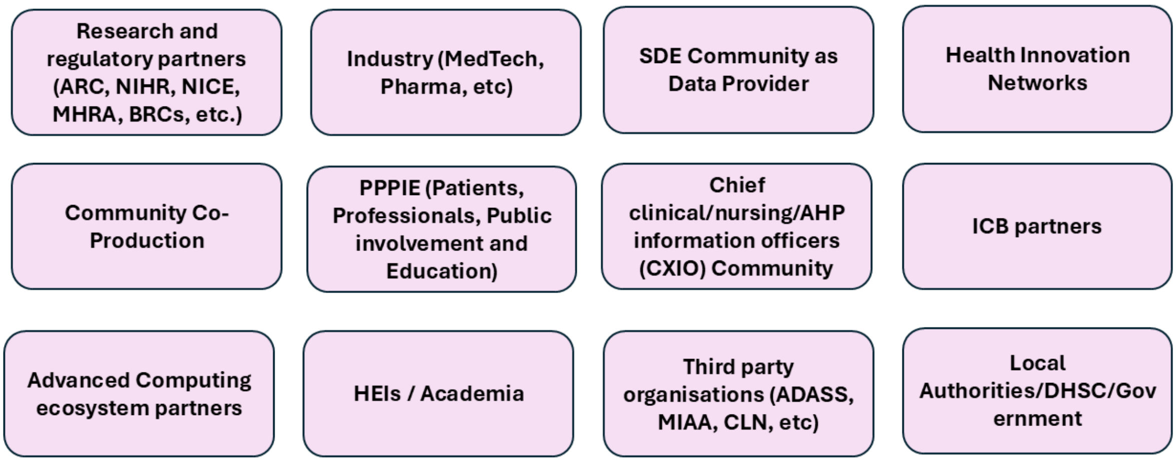
Figure 5 – Governance & Evaluation

- Inclusive
- Information Governance policy
- Clinical / Care Safety policy
- Leadership and advisory architecture
- Idenifying year 1, 2, and 3 metrics for evaulation (2, 3, 5, 10?)
- Clarity of NHS role as data guardian
- Can we explore BRC model? other models?

Figure 6 - Operations

- Clinical Safety/ Care Safety review
- Information Governance review
- Project/Programme methodology and resourcing
- Matrix model of workstreams with common management framework?
- Where / with whom does triage sit? What does redirection / signposting look like?
- Access to Subject Matter Experts
- Information management systems articulated
- Communication and feedback mechanisms

Figure 7 – Stakeholders, Users & Contributors



Appendix 6 – Further Information

1) UK Industrial Strategy – Published June 2025
2) UK Digital and Technologies Sector Plan – Published June 2025
3) UKRI Innovate UK: Quantum for Life: How UK life sciences and healthcare can benefit from quantum technologies
4) DSIT Press Release: Government support to get quantum to work faster, boosting UK's health, defence, energy and more – published November 2025
5) DSIT National Quantum Strategy Missions – updated December 2023
6) STFC Hartree Centre: Quantum Computing
7) Quantum Software Lab, University of Edinburgh
8) National Quantum Computing Centre
9) UK's £2 Billion Compute Roadmap Signals Country's Ambition For Quantum Leadership – UKQuantum

Quantum Innovators

IBM

PsiQuantum

Quantinuum

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Appendix 7 - Acknowledgements

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