

Fellowship in Clinical AI: Cohort 1 Evaluation

November 2023

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1. Acknowledgements

This evaluation was conducted by the Health Innovation Network (the Academic Health Science Network for south London) on behalf of Health Education England (HEE) Digital AI and Robotics Technology Education (DART-ED) and Faculty of the Fellowship in Clinical AI (formerly part of the London Medical Imaging & AI Centre for Value Based Healthcare - 'the faculty', hereafter). It would not have been possible without the scale of input from the faculty of the fellowship and HEE staff, as well as fellowship supervisors, fellows and stakeholders who agreed to take part in interviews and focus groups.

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2. Executive Summary

2.1. Fellowship context

Health Education England (HEE) Digital AI and Robotics Technology Education (DART-ED) and Faculty of the Fellowship in Clinical AI have developed a Fellowship in Clinical Artificial Intelligence to allow specialty trainee clinicians (participating in specialty trainee year three or above, or general practitioner vocational trainee scheme year two or above) to gain expertise in clinical AI in an integrated pathway alongside their specialty training and implement ground-breaking work using state-of-the-art AI software in live hospital environments.

2.2. Background on fellowship Cohort 1

The first fellowship cohort consisted of eleven fellows and took place between June 2022 and June 2023. Fellows were attached to an NHS trust for 12 months whereby they worked with a dedicated project team to develop, deploy, maintain, and evaluate clinical AI software in live hospital environments.

During their post fellows also enrolled in the Clinical Artificial Intelligence Curriculum developed by the faculty, gaining skills and knowledge through a combination of bespoke small-group masterclass workshops, self-paced remote learning in programming via 'Datacamp', and a modular series of pre-recorded lectures (King's College London's Innovations Scholars Programme: Artificial Intelligence pillar). Fellows committed two days per week to the fellowship. Of six participating NHS Trusts, five were based in London, with East Kent Hospitals University NHS Foundation Trust the exception.

2.3. Evaluation approach and methods

DART-ED commissioned the Health Innovation Network (HIN) - the Academic Health Science Network for south London - to undertake an evaluation to provide insight into:

- Fellows' experiences of the fellowship, and the extent the fellowship aligned with fellows' clinical training and competencies.
- Fellows' learning and career outcomes resulting from fellowship participation.
- The impacts of hosting a fellow on NHS host Trusts.
- How the programme can be improved for future cohorts, including how longer-term sustainability might be secured.

The evaluation adopted a mixed-method approach, including in-depth interviews and focus groups, an online stakeholder feedback form and project documentation and output review. A substantial qualitative longitudinal component was applied due to the small number of participants and to explore in-depth key stakeholders' journey through the programme.

To provide a holistic and representative view of the fellowship, a variety of stakeholders were included in the evaluation, including fellows, project supervisors (i.e., clinical AI leads in host NHS trusts), project-placement staff, The faculty and senior staff from Health Education England.

2.4. Key findings

2.4.1. Fellows' experiences of the fellowship programme

- Overall, the fellowship offered a valuable, unique, and worthwhile learning experience for fellows. With hindsight, all noted they would participate in the fellowship again, and all would recommend it to colleagues.

Project Placements

- Project placements were central to fellows' programme experience and learning outcomes. Fellows described a variety of experiences across the cohort, with some projects focusing on technical AI development, and others on deployment and evaluation of AI software into within clinical settings. Gaining at least a basic understanding of technical AI components was considered valuable by fellows.
- Most fellows were satisfied with their projects, however some felt their experience would have benefited from being part of multi-disciplinary teams located in a physical space, from better integration with project teams, and from greater alignment with their clinical expertise.
- Most fellows felt the balance of working two days per week on the fellowship alongside clinical duties was feasible and appropriate given the circumstances, however, it did present challenges and tensions at times. Supervisors were generally of the view this was the minimum time commitment required to gain value from the experience.
- Fellow and supervisor views corroborated certain project characteristics underpinned successful project experiences and beneficial learning outcomes, including: flexibility within project placements to align with fellows' skillsets, interests, and learning objectives; exposure to multi-disciplinary teams to clinical AI experts and practitioners; effective fellow integration with project teams; appropriately resourced project placements; exposure to multiple projects at different stages of the AI lifecycle, and; having a physical project space where fellows could interact with their project team.
- These factors were expressed to varying degrees within each project context, contributing to each fellow having a unique learning environment and experience. Project experience was also influenced by fellows' skillsets, areas of interest and approach to learning.
- Two broad categories of views emerged regarding alignment between fellows' clinical competencies and their project's clinical area. One group felt alignment wasn't essential nor necessarily desirable for a successful project experience, as the fellowship develops core skills and knowledge transferable to any clinical context. The other saw alignment as preferable, as it can facilitate more effective and efficient learning, increase the value of fellow contributions to project outcomes, and improve fellows' career development outcomes.
- Some projects experienced notable challenges and delays. Despite this, all fellows were able to adapt to their project environments and identify learning opportunities and experiences that drove forward their clinical AI knowledge, skills, and confidence, and supported future career objectives.

Datacamp and Masterclass Workshop Sessions

- Fellows presented mixed views on the accessibility and utility of Datacamp and engagement with Datacamp varied notably across the cohort. Some found it useful as a basic introduction to certain technical aspects central to clinical AI, however, use beyond that was limited. Others found it provided an indispensable reference tool that guided their learning and development. Others still felt it had little utility for them personally.
- There was consensus amongst fellows that Masterclass Workshop Sessions were a highly valuable aspect of the fellowship, notably due to them providing exposure to experts in their respective fields, and the platform sessions provided for open discussion and networking. Sessions presenting foundational content would have benefited fellows more had they been scheduled for earlier stages of the programme. This is a change The faculty have put in place for Cohort 2 of the fellowship, which is currently underway.

2.4.2. Fellowship outputs, outcomes, and impact.

Fellows' learning outcomes

- Fellows described achieving valuable 'soft skills' outcomes alongside more tangible, technically based learning outcomes and outputs. Most felt that the project placement component provided unparalleled experiential learning transferable to other clinical contexts.
- Some fellows felt a shift in mindset was required to accommodate for 'softer' learning outcomes being a core fellowship objective. Whilst others appreciated this perspective, they also had focus on delivering more tangible outputs - such as academic papers and conference presentations.
- 'Soft skills' outcomes identified by fellows themselves included: increased confidence to operate within the clinical AI 'space'; confidence and tools to expand clinical AI networks; increased confidence and ability to integrate and work with technical AI teams; increased confidence and ability to advocate for clinical AI solutions; nuanced and grounded understanding of their role within appropriate and effective propagation of AI solutions across the health system.
- The composition of individual fellows' technical AI learning outcomes was dependent on the nature of their project. As a group, fellows highlighted a variety of technical learning outcomes, including increased understanding of technical domains underpinning product and software development; proficiency in coding and software development; awareness and knowledge of Clinical AI deployment processes and requirements; expertise in evaluating AI technologies, including how to conduct a clinical AI trial, and; increased understanding and confidence in identifying appropriate use cases for clinical AI.
- Individuals from all participant groups emphasised the importance of the programme focusing on developing clinician skills as catalysts for the spread and adoption of clinical AI across the health system, rather than as AI technicians.

Career development outcomes

- Fellows agreed that participation in the fellowship has fostered a diversity and depth of experience and learning that has significantly improved career development prospects. Some fellows noted more immediate outcomes because of the fellowship, such as acceptance onto related fellowships or academic programmes.
- Fellows agreed that being a Clinical AI Fellow was an attractive and valuable addition to their CV that would stand out to potential employers. The experiential project component of the fellowship in particular will enable fellows to emphasise experiences and skills that very few peers outside the cohort will have.
- Some fellows noted that the fellowship had indirectly led to activity and outputs that would bolster their employability (e.g., delivering presentations at conferences and panel events, and authoring academic papers).

Impact on NHS host organisations

- Supervisors and project team staff expressed mixed views on the extent to which fellows impacted their projects, and input and resource required to host a fellow.
- Some felt fellows themselves were the primary, or sole, beneficiary of the programme, whereas others felt impacts and benefits of the fellowship were mutual, with fellows in some cases adding significant value to their project.
- Expectation management presented a challenge in some contexts, with project team members expecting fellows to bring established clinical AI expertise, and fellows expecting to be fully

immersed and supported through all aspects of the AI lifecycle. The faculty have sought to address this in part by integrating a pre-placement 'Supervisor Briefing' for subsequent cohorts. This was successfully delivered for Cohort 2, which is ongoing at the time of writing.

- In terms of value added by fellows, stakeholders noted fellows can: provide a fresh clinical perspective to projects, helping overcome challenges, bring new ideas and validate AI software outputs; provide important additional resource to drive forward project implementation where projects had focus on deployment and evaluation; directly support high quality project output that will have significant local and wider impacts resulting from their practical application, and; confer their own learning, skills and knowledge to services across the trust and broader health system.
- Across the supervisor group there were different levels of comfort in identifying appropriate project placements aligned to the fellowship's objectives. Some understood the more dynamic, unstructured nature of the learning experience being provided. Others however found this challenging and had trouble identifying an appropriate project for their fellow. In response to this challenge, the faculty have refined existing project quality assurance processes, providing greater clarity on expected project characteristics, and expectations on fellows' involvement within it. These developments were put in place for Cohort 2 project establishment phase.

2.4.3. Fellowship future directions

- Aspects identified to help expand and improve future delivery of the programme included: increased internal operational resource; introduction of an external advisory function; external curriculum development support; improved communications and marketing capacity and approach, and improved communication and cooperation with NHS partners. The faculty plan to recruit a programme support officer in 2024 to provide additional operational and programme management capacity.
- 'Outward facing' areas of future strategic development for the programme included: increasing focus on spread and adoption of digital and AI technology; attracting and recruiting fellows committed to pursuing practical application of clinical AI and digital health; emphasising the role of clinical AI fellows as catalysts for change across the system; expanding the fellowship offer to include additional clinical professions across health and social care, and: considering benefits and risks of central vs regional funding and administrative models. The faculty have made concerted effort to expand the application pool to other clinical professions for subsequent cohorts, evidenced by a broadening professional eligibility in Cohort 3 to include workforce groups including Nursing and Midwifery, Allied Health Professionals, and Pharmacy Professionals.
- In terms of fellowship accreditation, three potential approaches were discussed: project/fellow-level accreditation, faculty level accreditation, and 'micro-accreditation' (i.e., that would involve bodies such as the Faculty of Clinical Informatics, General Medical Council or Nursing and Midwifery Council providing accreditation for relevant components of the fellowship based on pre-existing curricula). Faculty level accreditation may provide a useful compromise between external validation, and the programme retaining autonomy over its design and implementation.

2.5. Key Recommendations

The evaluation makes the following recommendations based on the detailed findings presented throughout the report.

2.5.1. Project placements experiences

1. **Prioritise multi-project placements** to expose fellows to multiple stages of the AI lifecycle, and

mitigate risks associated with single-project placements. In light of this recommendation, the faculty have refined existing project quality assurance processes for subsequent cohorts, providing greater clarity on expected project characteristics, and expectations on fellows' involvement within it.

2. **Prioritise projects with multi-disciplinary teams** to provide fellows a dynamic, multi-faceted learning experience. Teams with a physical location of work can provide additional benefit to facilitate integration and learning. Quality assurance developments have been put in place for subsequent cohorts to address this recommendation - see detail above.
3. **Ensure project teams are aware of, and equipped to support, fellowship objectives.** This might involve clarifying the fellowship's broader aims, objectives, and approach, as well as the need for adaptability to support individual fellows with their unique skills-set and interests. Leveraging project supervisors as gatekeepers might provide an effective approach to achieve this goal. A supervisor briefing session has been introduced for subsequent cohorts to mitigate against this challenge.
4. **Explore opportunities for projects that occupy higher institutional levels**, such as at Trust or Integrated Care System level, to expand the pool of suitable clinical AI projects for fellows. This is a longer-term recommendation that aligns with expanded clinical AI capacity and increased fellowship profile and awareness.
5. **Consider increasing emphasis on clinical alignment between projects and fellows' clinical competencies** where possible and desired by fellows. This might improve project-level outcomes for both the fellow and their placement project, as well as enhance career development outcomes. The faculty have responded to this through enacting project-based matching for fellows in recruitment of subsequent cohorts following the pilot, giving applicants more information and autonomy to align to their own clinical interests.
6. **Consider facilitating active mentorship between Cohort 1 alumni and Cohort 2 fellows** to provide mentorship and support, given their wealth of relevant experience, skills, and knowledge. Alumni invitations to fellow Show & Tell presentations and graduation in Cohort 2 were instituted to encourage such interactions.

2.5.2. Datacamp and Masterclass Workshop Sessions

1. **Consider additional technical training opportunities** alongside Datacamp, such as a face-to-face "boot-camp" at the beginning of the fellowship, combining lectures and coding sessions. Collaborative 'Hackathon' workshops might facilitate team-based learning and interaction, particularly for fellows working on isolated or small-team projects. In response to this the faculty have established a boot-camp at the beginning of the fellowship for subsequent cohorts. This will front-load foundational content critical to optimising fellows' experience and learning throughout the fellowship.
2. **Strategically schedule Masterclass Workshop Sessions content**, prioritising foundational topics earlier in the program to enable practical application of learning throughout the fellowship. This change has been successfully implemented by the faculty for ongoing Cohort 2 and is planned for all future cohorts.

2.5.3. Supporting fellows learning outcomes

1. **Emphasise the value of soft skills alongside technical learning outcomes** from the project outset to help allay fellows' concerns regarding non-technical focus. Consider supporting fellows to identify and foster opportunities for soft skills growth, e.g., improving presentation skills,

expanding relevant networks, and building confidence in advocating for clinical AI solutions.

2. **Provide additional guidance and resource to equip and encourage project teams to support fellows' learning** in an integrated way and across the breadth and depth of real-world clinical AI. Consider effective gatekeepers to instil this culture of learning.
3. **Encourage project leads to proactively mitigate risks** by implementing Quality Assurance criteria for projects to identify and address potential risks more effectively. Quality assurance developments have been put in place for subsequent cohorts to address this recommendation - see detail above.
4. **Improve fellows' learning potential by a) identifying and prioritising multi-project, multi-disciplinary sites for project placements, b) emphasising the role of project teams in supervising and supporting fellows' learning** as discussed 2.5.1 above. Quality assurance developments have been put in place as outlined in 2.5.1 above.
5. **Provide fellows greater opportunity for collaborative working and peer support.** This might be particularly beneficial for fellows working within small and/or remote project teams. This has been encouraged in subsequent cohorts through scheduling longer face-to-face contact (full days, increased from half days) on workshop days.
6. **Ensure fellows have access to academic journals and other publications.** Fellows without academic affiliations were not able to access academic outputs pertinent to clinical AI, which presented a barrier to learning. In subsequent cohorts, supervisors were briefed more directly on the specific academic resources expected for their fellows.

2.5.4. Supporting host organisations

1. **Develop a function to provide additional guidance and support to supervisors** who struggle to structure fellows' project learning experiences within existing projects. This might take the form of guidance resources, examples of successful projects, planned regular supervisor touchpoints, and a supervisor network.
2. **Shift emphasis to project team-based fellow support and supervision** to share the burden of learning and support on supervisors. This might also improve integration and learning outcomes. Based on this recommendation, The faculty have developed quality assurance processes to ensure future project placement teams have required capacity to support fellows with a broad learning experience.
3. **Improve expectation management** to increase likelihood of positive and productive fellow and project team interactions. Increase project team understanding of the fellowship and its aims and objectives, and what skills, background and interests fellows are likely to bring to placements. A supervisor briefing session has been introduced for subsequent cohorts to mitigate against this challenge.
4. **Consider providing additional resource** alongside fellows, such as laptops, license agreements, and budget to support their work effectively and reduce burden on host teams.
5. **Provide additional HR support** to streamline the process of receiving honorary contracts, ensure smooth and timely fellow engagement in projects, and to avoid burden being placed on host organisation staff. To address this recommendation, the faculty plan to recruit a programme support officer in 2024 to provide additional operational and programme management capacity.

2.5.5. Fellowship future directions

1. **Consider the benefits, risks, and implications of different approaches to accreditation.** Whilst formal accreditation fully backed by an external provider may not be suitable nor desirable for the programme, alternative more dynamic approaches to accreditation – such as faculty level or micro-accreditation – may help deliver meaningful outcomes for fellows whilst enabling the faculty to maintain autonomy over programme structure and curricula. The pilot cohort was provided fellow-level accreditation with a certificate of completion of the programme.
2. **Action operational developments identified by the faculty.** Evaluation findings support the appropriateness of suggested developments, which are likely to become increasingly pertinent vis a vis intended thematic and geographic programme expansion, and to ensure programme sustainability.
3. **Consider strategic programme developments carefully.** For example, expansion to other clinical professions will require new programme structures and approaches. This will most likely be successful with a co-production approach with relevant clinical bodies, such as the Nursing and Midwifery Council, to ensure appropriate recruitment, learning and skills development that serve the intended clinical area. The faculty have made concerted effort to expand the application pool to other clinical professions for subsequent cohorts, with consensus criteria for eligibility developed with NHS England's Chief Nursing Information Officer, Chief Pharmacy Information Officer, and Office of the Chief AHP for Cohort 3.

3. Project Background

3.1. Project Context

Artificial Intelligence (AI) expertise in clinicians is fundamental to its safe and effective use in healthcare. Up to now clinicians have accessed AI-related training via formal academic routes, which is costly, time consuming, and interrupts or supplants clinical training. Furthermore, most routes lack curricula relevant to clinical AI and the application of AI software in live hospital environments. [The Topol Review](#) highlights an unfulfilled need for a route to clinical AI expertise integrated within existing clinical training.

Health Education England (HEE, hereafter) Digital AI and Robotics Technology Education (DART-ED) and The London Medical Imaging & AI Centre for Value Based Healthcare (AI Centre, hereafter) have developed a Fellowship in Clinical Artificial Intelligence to allow specialty trainee clinicians (participating in specialty trainee year three or above, or general practitioner vocational trainee scheme year two or above) to gain expertise in clinical AI in an integrated pathway alongside their specialty training and implement ground-breaking work using state-of-the-art AI software in live hospital environments.

“The NHS should create or increase the numbers of clinician, scientist, technologist and knowledge specialist posts with dedicated, accredited time, with the opportunity of working in partnership with academia and/or the health tech industry to design, implement and use digital, Artificial Intelligence and robotics technologies.”

Recommendation DM4/AIR5 from the Digital Medicine and AI & Robotics Panels, The Topol Review

3.2. Background Information on Cohort 1

The first fellowship cohort took place between May 2022 and June 2023. Fellows were attached to an NHS trust for 12 months whereby they worked with local and regional organisations to develop, deploy, maintain, and evaluate clinical AI software in live hospital environments.

During their post fellows also enrolled in the Clinical Artificial Intelligence Curriculum from the AI Centre, gaining skills and knowledge through a combination of bespoke small-group masterclass workshops, self-paced remote learning in programming via 'Datacamp', and a modular series of pre-recorded lectures (King's College London's Innovations Scholars Programme: Artificial Intelligence pillar). Figure 1 Clinical AI Curriculum mapped onto the AI Lifecycle.

Fellows received supervision in their post from their host trust lead in clinical AI. The programme was open to specialty trainee clinicians with a training number in training regions London or Kent, Surrey, and Sussex (KSS). The fellowship occupied two days per week and was completed alongside clinical training.

A total of 11 fellows took part in Cohort 1. Ten fellows were based in London - three posted within Guy's and St. Thomas's Trust (GSTT), two within King's College Hospital NHS Foundation Trust (KCL), two within Imperial College Healthcare NHS Trust (ICH), two within South London and Maudsley NHS Foundation Trust (SLAM), and one within University College London Hospital NHS Trust (UCL). One fellow was posted within East Kent Hospitals University NHS Foundation Trust (EKHU).

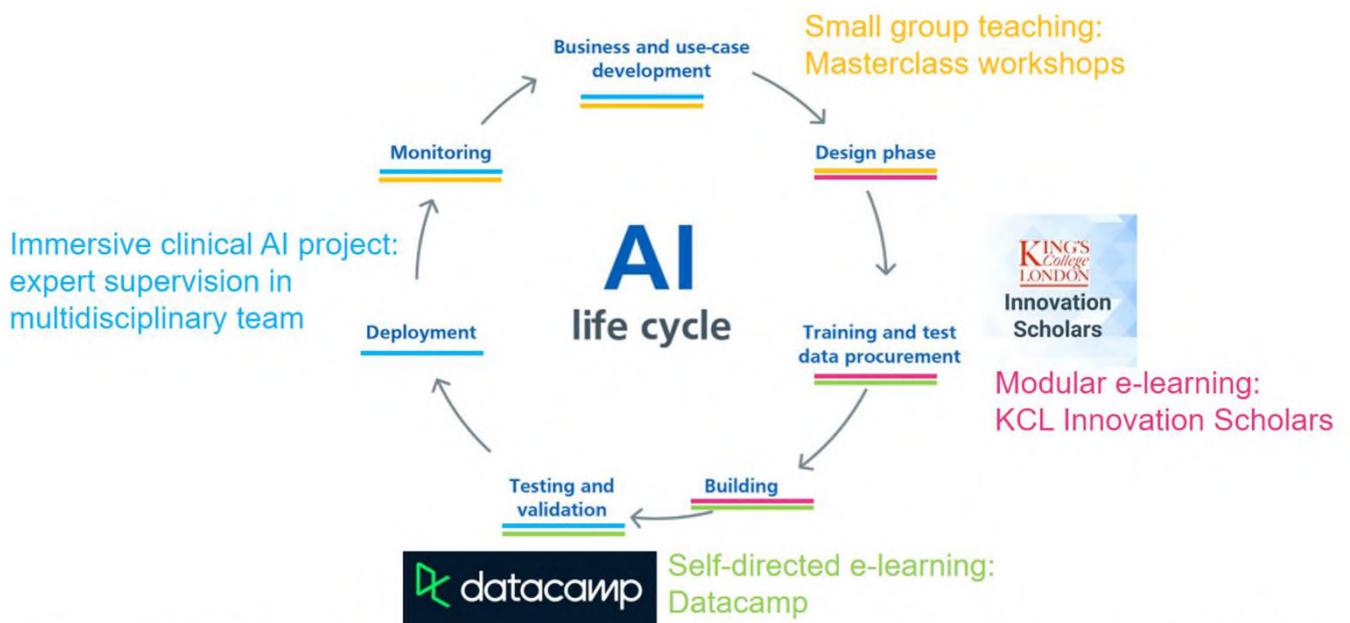


Figure 1. Learning content of the Clinical AI Curriculum as mapped onto the life cycle of AI (adapted from NHSX). The full scope of the life cycle is encompassed by the 4 delivery methods of immersive clinical project work, small group teaching, large group teaching, and self-directed learning.

Figure 1 Clinical AI Curriculum mapped onto the AI Lifecycle

4. Evaluation design

4.1. Evaluation aims and key questions

Evaluation aims and questions were developed and refined by the HIN in collaboration with HEE and the AI Centre. The **evaluation's overarching aims** were to:

1. Gain ongoing insight and feedback to support improvements to the fellowship programme during Cohort 1 (May 2022-June 2023).
2. Determine the impact of the fellowship programme for fellows and NHS organisations to justify funding beyond Cohort 2 (which will take place between July 2023-July 2024).

More specifically, the evaluation has sought to address the following **key questions**:

1. What are fellows' experiences of the fellowship programme?
2. How does the fellowship align with fellows' clinical training and competencies?
3. What have fellows learned through participating in the programme?
4. What outcomes does the fellowship have on fellows' career development?
5. What impacts do fellows' projects have on NHS host organisations?
6. How can the programme be improved for future cohorts?
7. What would accreditation for the fellowship programme look like?

4.2. Evaluation Approach

The evaluation adopted a mixed-method approach, leveraging a range of methods including in-depth interviews and focus groups, a stakeholder feedback form and project documentation and output review. A substantial qualitative longitudinal component was applied due to the small number of participants and to explore in-depth key stakeholders' journey through the programme.

To provide a holistic and representative view of the fellowship, a variety of stakeholders were included in the evaluation, including fellows, project supervisors (i.e., clinical AI leads in host NHS trusts), project-placement staff, The faculty and senior staff from Health Education England (HEE).

To strengthen the quality of the evaluation and maximise the value of the findings, evaluation design and analysis has been informed by an established evaluation framework for training interventions. The Evaluation Practice Toolkit¹ was developed by King's College London and Health Education England to determine the effectiveness and impact of training and development initiatives. Specifically, the evaluation leveraged insights from the Kirkpatrick model², which focuses on four levels of outcome:

1. **Reactions:** How do people engage with the fellowship? How relevant do they think it is? How satisfied are they with it?
2. **Learning:** What knowledge or skills have they learned from the fellowship (i.e., against the learning objectives of the programme and more widely)?
3. **Behaviour:** What changes in behaviour have occurred due to the fellowship?
4. **Results:** What impacts does the fellowship have on the wider world? What are the personal impacts for fellows' career development and opportunities? What are the impacts for healthcare and NHS organisations stemming from fellows' projects?

¹ <https://kclpure.kcl.ac.uk/portal/en/publications/evaluation-practice-toolkit>

² DL Kirkpatrick. *Evaluating training programs: The four levels*. 1994

4.3. Methods and data sampling

The following data-collection methods, sample-sizes and audiences were deployed as part of the evaluation:

- **Fellow focus groups:** fellows participated in focus groups at three time points across the fellowship (0/5/12 months) to map their journey through the programme from start to completion. The purpose of the focus groups was to support reflexivity amongst the fellows about their experiences and learning. Five focus groups were conducted in total, involving all 11 fellows.
- **Interviews with clinical AI project supervisors:** supervisors were invited to short 30 minute one to one online interviews at two time points (five and 12 months) during the fellowship programme. Interviews aimed to understand their perspective on fellows' project engagement, experience and outcomes and delivery of the programme overall. A total of eight interviews involving seven of nine Cohort 1 supervisors were conducted:
 - Five supervisors were interviewed in the first stage to understand initial perspectives on the fellowship and fellow progress.
 - Three supervisors were interviewed in the second stage at the end of the fellowship, providing insights that fed directly into three in-depth project case studies, as well as providing end-line insight for the broader evaluation.
- **Fellow interviews:** to supplement fellow focus group insights and provide data for in-depth project case studies, three fellows participated in short (30-minute) online 1-1 interviews within the latter stages of the fellowship.
- **Faculty focus groups:** the purpose of the faculty focus groups was to collectively explore the programme both looking back on how the programme performed (strengths and weaknesses) and forward to consider improvements. A total of two focus groups involving four faculty members were conducted at the mid- and end-line of Cohort 1.
- **Health Education England (HEE) focus group:** four senior staff within HEE took part in a 45-minute online focus group to discuss perceived need for the fellowship programme, avenues for development, and how the programme might be sustained in future.
- **Online stakeholder feedback form:** an online feedback form was sent to all known project placement team staff (including clinical, technical, administrative, and managerial roles), and was open for completion between months eight and nine of Cohort 1. The form explored perceptions on the fellowship's benefits, challenges, and areas for improvement. The feedback form included both quantitative and qualitative (i.e., free text) questions with a view to capture a richer understanding of project team perceptions.

Table 1 provides an overview of audiences and data collection methods for each key evaluation question.

Table 1: Matrix showing key evaluation questions, audiences & methods.

Evaluation question	Audience & Methods					
	Fellow Focus Groups	Supervisor interviews	Fellow interviews	HEE Focus Group	Stakeholder feedback form	Project doc. review
1. What are fellows' experiences of the fellowship programme?	✓	✓	✓	✗	✗	✓
2. How does the fellowship align with clinical training and competencies?	✓	✓	✓	✓	✗	✗
3. What are fellows' learning outcomes through participating in the programme?	✓	✓	✓	✗	✗	✓
4. What are the outcomes on fellows' behaviour and career development?	✓	✓	✓	✗	✗	✓
5. What would accreditation for the fellowship programme look like?	✓	✓	✗	✓	✗	✗
6. What impacts do fellows' projects have on NHS host organisations?	✗	✓	✗	✗	✓	✗
7. How can the programme be improved for future cohorts?	✓	✓	✓	✗	✓	✗

5. Findings

Evaluation findings are structured into three main sections. Firstly, **section 5.1 unpacks fellows' experiences of the programme, providing insights into their project placements, and perspectives on Datacamp and Masterclass Workshop Sessions.** This section also considers fellowship alignment with their clinical area of expertise, as well as the logistics of participating in the fellowship alongside continued clinical training. Evaluation questions one and two are answered in this section.

Section 5.2 details fellowship outputs, outcomes, and impacts. It describes fellows' learning outputs and outcomes, covering technical skills and knowledge attainment as well as valuable 'soft skills' development. It then moves on to consider the more immediate and longer-term impact of the fellowship on fellows' careers. Lastly, the section provides insight into the impact of the fellowship on host projects. Evaluation questions three to five are answered in this section.

Possible future directions of the fellowship programme are considered in section 5.3. Insights are presented across two broad categories: 'internal' developments to programme structure and operation, and 'outward' facing strategic development opportunities. The section concludes with consideration of what accreditation for the programme might look like, and the risks involved. Evaluation questions six and seven are answered in this section.

5.1. What are fellows' experiences of the fellowship programme?

The following section presents insights into fellows' experiences of the fellowship programme. The section structure mirrors different components of the fellowship, i.e., the experiential project-placement component, self-led learning via 'Datacamp', and monthly 'Masterclass' sessions. It concludes by providing perspectives on fellowship alignment with fellows' clinical training and competencies.

5.1.1. Project placement

This sub-section presents insights into fellows' experiences of their project-placements, integrating supervisor perspectives where relevant. Italicised sub-headings relate to key thematic areas that emerged from focus group and interview discussions with fellows, and therefore represent important areas of experience for fellows.

Working through the full AI lifecycle

At programme outset fellows had expectation that all project placements would involve working through all aspects of the AI lifecycle, from initial product design and development, through validation, deployment, and evaluation. In reality, fellows gained exposure to different aspects of the AI lifecycle through their projects, which was a cause of initial frustration for some. Through project experience, however, fellows understood the challenges and timeframes associated with clinical AI projects, and subsequently managed expectations accordingly.

Fellows and supervisors noted a mitigating feature could be to create project-placement experiences that offer exposure to more than one extant project, enabling fellows to pivot towards different projects at various stages of the AI lifecycle³. Some fellows have extended their project placement to gain exposure to evaluation stages of the lifecycle.

³ Fellowship faculty have developed existing project quality assurance processes, providing greater clarity on expected project characteristics - including, where possible, providing fellows with placements that offer exposure to more than one clinical AI project. These developments were put in place for Cohort 2 project establishment and are planned for use in all future cohorts.

- Several fellows indicated that ideally the fellowship would offer exposure to all stages of the AI lifecycle, which would afford the greatest learning experience and provide a greater sense of satisfaction and value for the time spent on placement. In hindsight, however, fellows also understood the real challenges faced by clinical AI projects, and that being part of a full AI lifecycle within the fellowship timeframe was not feasible in most cases.
- A few supervisors emphasised the fellowship's one-year duration meant being exposed to the full AI cycle would be unlikely for most projects. A few supervisors felt there could have been more pro-active management of fellow expectations in this regard.

"Wrapping something up within 12 months, I think it's the most difficult thing. I think that potentially would be a challenge for future cohorts where we might have to define objectives or outputs really clearly and manage expectations really clearly." Supervisor

- Fellows and supervisors noted a mitigating feature could be to create project-placement experiences that offer exposure to more than one extant project, enabling fellows to pivot towards different projects at various stages of the AI lifecycle⁴.

"The end-to-end lifecycle of these kind of projects is beyond the duration of the fellowship. So, in order to get involved in problem specification, use case development and then post deployment surveillance monitoring, you need multiple projects that to sort of dip into to get that experience." Supervisor

- Larger clinical AI 'labs', or similar settings, with multiple projects and multi-disciplinary teams could make cross-lifecycle exposure a more likely outcome than for those working in smaller teams with little or no project variety. Indeed, this was the experience of some fellows, who noted their project context allowed exposure to various projects at different stages of the AI lifecycle.
- However, at present there are challenges in terms of opportunities within the current clinical AI landscape – large, dynamic and multi-project labs are the exception rather than the rule and tend to be concentrated in and around London.

"The challenge is that there are very few centres that have enough of a locus of activity to give you that offering. You can probably do that at Guy's [and St. Thomas'] and UCLH and then it gets very thin on the ground." Supervisor

- A few fellows explained that seeing a project through to completion not only provides important and transferable experiential learning relating to key aspects of the AI lifecycle but increases the likelihood they can meaningfully contribute to tangible project outputs, such as academic papers.
- A few fellows noted they will have the opportunity to experience the full AI lifecycle by extending their project placement beyond the fellowship timeline. In one instance a fellow has agreed with their supervisor to extend involvement for a full year, which should allow them to move beyond procurement and protocol design to deployment and evaluation. This fellow noted that without the opportunity to extend they would have felt the project-placement experience offered significantly less learning and value to them individually.

"I would have been really disappointed if I had to hand this over to someone else because I have put in so much hard work into getting this off the ground, because I know what a big impact this project's going to make, especially if we are successful in running it and are right on our hypothesis." Fellow

⁴ As highlighted in footnote above, faculty have taken steps to address for subsequent cohorts via improved project quality assurance processes.

- However, being able to extend for such a long period of time is unlikely to be a feasible nor desirable option for all fellows and is largely dependent on the project in question securing funding and other required resources to support extended fellow involvement.
- A possible, more feasible, addition to the programme fellows felt would offer valuable learning is a collaborative hypothetical 'side-project' – either as a large group, or two smaller groups – whereby they could work on a smaller clinical AI project enabling them to experience all stages of the AI lifecycle.

Technical AI skills development

Linked to discussions regarding exposure to the full AI lifecycle, fellows and supervisors discussed the extent to which project placements should equip fellows with technical AI skills, such as algorithm development and machine learning. **Projects across the cohort provided fellows with contrasting experiences relating to technical AI skills, with some projects delivering a significant focus on technical AI development, whilst others provided little or no focus on this aspect.**

A variety of views were presented across both groups on the extent to which technical AI development *should* feature as part of fellow projects. Some fellows and supervisors felt attaining higher levels of technical AI proficiency was a desirable outcome, whilst others felt the greatest value of the fellowship, and to the health system, was not in creating AI technicians but in building capacity of clinicians to be able to identify, validate deploy and evaluate appropriate AI and digital health solutions.

- **Some fellows had expectations and desire they would gain direct experience and proficiency in technical aspects of clinical AI, namely coding and algorithm development. Whilst a few were able to gain a desired level of proficiency through their placements, others did not feel they were given adequate opportunity to learn to the level they desired.**

“There wasn't a lot from the technical aspect, [supervisor] was very much, 'Don't worry about the technical aspect. You won't need to do that, there are other people who will do that.' Part of me was like, 'Well, I would quite like to learn a bit more about it.' I was consistently pushed away from that.” Fellow

- Some fellows agreed that their supervisors had expectations fellows would come with established technical skills, and that a core aspect of the fellowship was technical development. They reflected there appeared to be a notable difference between what supervisors and the faculty expected of them.

“I think my supervisor expected someone who was into NLP, which I am not... and somebody who was proficient at coding”. Fellow

- Reflecting on their fellowship experience after the placement a few fellows concluded that whilst they may have expected to gain more exposure and become more proficient in coding and algorithm development via their projects at the outset, they felt in hindsight this would not have been the most effective and valuable use of their time.

“What we have all realised is that the expectations we would be able to code algorithms... that's not realistic, that's not the point of the fellowship. I think we all came at the beginning “Oh yeah Datacamp, we would all know how to code by the end of it.”. Whereas now, we will understand the general principles and where we fit in is slightly different.” Fellow

- Some fellows emphasised that gaining at least a basic understanding of technical AI components was highly valuable, as it bolstered their ability to understand and identify what makes credible AI solutions, and increased their capacity and confidence to communicate that with others.

"You also understand the value in not doing trying to do everything yourself... that all of these people do it better because they are experts, and you know what you don't know which is equally valuable." Fellow

- Whilst one supervisor emphasised that fellow eligibility and recruitment criteria should require existing data science skills, other supervisors interviewed were clear in their view that the fellowship's objectives were not to develop technical skills per se, but to develop skills of clinicians to facilitate effective and appropriate propagation of AI and digital health across the system. This might include an element of exposure to technical AI development in practice, but it is not strictly necessary and should be dependent on the nature of the project as well as the fellow's skills and interests.

"He's [fellow] interested in, 'If I'm a clinician, how am I going to know this is the AI product for me', rather than the clinician that says, 'I really have this clinical need. I want to develop this tool and I'm gonna do it right from the start. And I'm gonna build a team'. So it's a completely different concept." Supervisor

- One supervisor noted that too high an emphasis on attracting fellows with – or who have desires to attain – higher-level data science skills would risk attracting the wrong type of clinician for what the fellowship aims to achieve.

"If you wanted to make it more didactic, or if you configure the program so you have, I don't know, three months of learning Python before, etc., I think you will end up attracting the wrong candidate." Supervisor

Single vs multi-project placements

Whether a project placement has focus on a single project, or provides exposure to multiple projects, was highlighted by fellows and supervisors as an important project characteristic that can define how fellows learn and their subsequent learning outcomes. Fellows' experiences in this regard varied, with some placements being built around a single project, and others being situated within a more dynamic multi-project context.

Single project placements might provide in-depth learning, however they present significant risks related to project challenges and delays, and risk providing fellows a narrow learning experience. Most fellows and supervisors agreed multi-project placements are preferable, as they enable exposure to a variety of projects and learning experiences, with a subsequent breadth and depth of learning outcomes. They also provide resilience against project delays and challenges.

- Both fellows and supervisors highlighted risks associated with over-reliance on a single project underpinning project placements. Whilst a single project might provide a clear context on which to base in-depth learning, it risks being derailed because of unforeseen project challenges and delays, which was the experience of several fellows.
- Without alternative avenues for substantive project engagement, delays can have significant impact on the breadth and depth of a fellow's learning experience. This concern is particularly pertinent given the fixed timeframe of the fellowship.
- Both the fellow and supervisor on a project that experienced delays at the beginning reflected they could have spent time better to provide additional training and alternative learning experiences for their fellow during those early stages, for example via a 'back-up' project. Having a back-up project – even if not a 'live' and expansive project, but one that could still provide a cohesive and targeted learning experience – was noted by a few fellows and supervisors as a feasible and valuable option for those with less diverse project placement environments.

"Because there were so many delays, I should have had a back-up thing to work on. If I didn't have the extra year going forward [project extension], then I would have nothing to show for it but a whole bunch of documents. I have serious document fatigue now." Fellow

- Another risk behind single-project focus is that it can limit fellows' experience, with the corresponding risk of inhibiting attainment of desired learning outcomes. This may be particularly likely when a supervisor lacks the capacity or inclination to support diverse learning experiences and outcomes beyond what is strictly outlined in the project. This was the experience of one fellow, who ended up proactively seeking additional opportunities outside of the prescribed project placement.

"We were seen as a resource because we were clinically skilled, to improve their algorithm, which already existed, rather than learning how to do the AI or to be involved in that. That was one of the things that frustrated me and why I went from one project to something completely separate because I didn't want to be just sitting there labelling things on a computer, which was not what my time was valuable for, but that's what they saw my value being." Fellow

- Relatedly, some fellows highlighted the importance of projects having in-built flexibility to account for the variety of fellows, each with unique skillsets and individual learning objectives and interests. Adopting a rigid, one-size-fits-all approach carries with it additional risks of supervisors and/or fellows having unsatisfactory fellowship experiences.
- One supervisor emphasised that too heavy a focus on a single project can provide negative incentives in terms of defining and assessing fellows' learning, with a resultant reluctance to open up new areas of learning. However, they also highlighted that a depth of learning is also important, and a surface level engagement with multiple projects would not produce the desired learning objectives either. As such, a balance is needed between mitigation of risks alongside building the most valuable learning experience for fellows.

"The pillar project sometimes feels like an anchor, because if all the monitoring is done based on the progress against this project, then you're incentivising people to keep at it, even at the cost of missing out on other educational opportunities. I think that's potentially detrimental to the fellow. But you don't want their year to be surface level or frivolous. You want them to have deep engagement with at least one or two deliverables, and so it's a balance striking thing." Supervisor

- Most fellows and supervisors agreed an ideal context would be one whereby fellows gained exposure to a variety of projects, supported by a team with broad areas of expertise and a willingness to support fellows' learning. They noted this would likely increase enjoyment whilst on placement, as well as facilitate improved learning.

"For example, [supervisor], in the group they work with, they've got a space, they've got different people with different expertise, and they all come together to work in that area. Which is like, great. You can learn tons, ideas, and actually, they're really nice. They're not like, 'You're an idiot. You don't know that.' Whereas I didn't really have that team thing. It was a bit like hassling people." Fellow

- This might raise a question around what the most effective placement 'level' is for any given context: for some trusts and geographical areas, appropriate clinical AI projects are few and far between. It might therefore be necessary to consider going 'up' a level - for example from a single trust level to an Integrated Care System level - to ensure fellows have opportunity to explore different projects. However, this is likely to be achievable only in the longer-term, as system-wide capacity develops and the number of suitable clinical AI projects increases.

“One dimension that's worth exploring is what the right institutional level of a fellowship host is. Is it person-led lab or is it a department, is it a hospital? Is it an ICS or something else? To address the need for there to be sufficient and diverse activity to provide an enriching experience for the fellow. When you have fellows attached to single people, particularly when they don't have a team, that's a very risky scenario for the fellow.” Supervisor

- The faculty identified that the current health system landscape presents distinct challenges. Technology adoption across the NHS is slow and inconsistent, including clinical AI. As a result, there exists a limited pool of appropriate – or ideal – clinical AI contexts from which to identify supervisors and projects, and within which to place fellows. To a degree, this was understood as an unavoidable challenge at present, due to the nascent stages of the fellowship programme, and the state of play across the NHS.

“It's very hard. And it's definitely not ideal. We've always been in a very awkward space when it comes to technology adoption in the NHS. And the side effect of that is there aren't good consistent learning opportunities. But we need training opportunities otherwise you're in even worse situation where we're continuing to buy these systems and not investing in the people. And so it's been a bit chicken egg. Particularly with the first cohort.” The faculty

- The faculty have acknowledged this and have thus made purposeful efforts to mitigate against challenges and risks associated with single-project placements. They have emphasised to fellows and supervisors that whilst a single project may present the core drive of experience and learning in some cases, fellows should be proactively encouraged to adopt a multi-faceted learning approach by seeking additional and varied practical learning opportunities.

Project team composition and integration

Fellows conveyed that project team composition and levels of integration were important contributing factors of project experience, particularly impacting on what, how and when they learned about clinical AI. Projects across the cohort presented a range of project environments with a notable degree of variance in team composition and levels of fellow integration within them.

The extent of fellow integration seems to be predominantly based on the nature of the project itself. Key factors that can influence whether integration is substantial and effective include:

- whether projects have an **established team working** in a consolidated physical space.
 - presence of an **engaged supervisor** guiding and supporting interaction with the project team.
 - a project team with **adequate capacity** to engage and support a fellow.
 - **logistical alignment** between fellows' clinical schedule and that of the placement project.
 - the placement being **well-resourced**, e.g., in terms of hardware, software licenses etc.
 - **proactive fellows** that take initiative in engaging project teams to support their learning.
- A few fellows explained that due to the nature of their project they predominantly worked in isolation, with very little input from others aside from their project supervisor. Some project placements did not offer environments conducive to project team integration or peer-peer learning. Some had no designated physical space for a team to congregate and collaborate.

“Most of the engineers are all offsite working remotely, our radiologists working remotely on AI Centre platforms in the cloud. And so they are never physically in the same room together. So I think it's very difficult for a clinical fellow to integrate in that way.” Supervisor

- A few fellows emphasised the challenges of working in isolation on their ability to learn effectively.

“I didn't have a team at all, so I was entirely isolated. I desperately missed the interaction. I didn't have

any developers, or AI professor, or anyone like that to talk to. Anyone to bounce ideas off. I just find it really difficult to even work through a problem without verbalising it.” Fellow

- One fellow described working on their own and having to rely on external resources like online forums to solve technical challenges. Towards the end of their project, they received support from a technical AI expert, but felt it would have been more beneficial to have that support from the beginning.

“I was the team. I had to go to people, ask for data...develop my algorithm and script. If I didn't know anything, I'd be back at Google. I had someone that was able to mentor me through [coding], but that was probably the last two or three months. It would have been useful if I had that beginning.” Fellow

- One supervisor described significant challenges linked to their fellow not being from the project's host trust, which had limited the ease and extent of interaction. Given constraints regarding the limited number of appropriate clinical AI projects across the system, this might present a longer-term consideration for the fellowship to assess.

“A challenge for my fellow and for me has been the fact that he's not a [host trust] employee. If he'd been working at [host trust], it might have been a lot easier. And if he'd been working in a department where a project was being undertaken, it would have been a hell of a lot easier.” Supervisor

- A few fellows, despite formally being assigned to a larger project team, noted a lack of support from their wider project teams. These fellows felt that team members were not dedicated to their assigned projects and had their own priorities, resulting in limited collaboration and a missed opportunity for peer-peer learning.

“I don't think my wider project team were dedicated for this project that I was assigned to. Therefore, there was a lot of begging and cajoling them, to try and get involved, so we can share the same vision. They had their own priorities, and that's understandable. So, yes, that was the struggle.” Fellow

- In reflection on their fellowship experience, a few fellows noted potential for Cohort 1 alumni to provide mentorship and support for Cohort 2 fellows, particularly those not integrated within larger project teams.
- More positively, other fellows described being part of diverse learning environments whereby they worked alongside multi-disciplinary teams. Fellows in these circumstances felt by taking an open and proactive approach they were able to integrate and learn a large amount from the project team, which often included specialists in data science, machine learning, coding, and algorithm development.

“That's one thing I really appreciated. I went to a research lab. I saw the same people every time, I developed relationships, we would have lunch together. I could just bother them if I didn't know how to do something. For me one of those valuable things was that unwritten curriculum of the language of AI and things that people who have been doing this for years are talking and thinking about. That for me was very, very valuable. It was really aided by having a physical presence within it.” Fellow

- For another fellow, informal communication with their wider project team via WhatsApp and 'Slack' was a valuable avenue to engage, contribute and learn from their team.
- Supervisors and the faculty agreed there was significant benefit in fellows being embedded within a multidisciplinary team with the capacity and inclination to share their skills, experience, and knowledge in a direct and contextualised manner. This type of interaction was understood to expedite and expand fellows' learning.

"[It's] absolutely essential. I think probably the major learning will be from [fellow] interacting with all these other people who are engaged with AI work. Just seeing what they're doing, understanding their thinking and observing what kind of issues they're dealing with and how they're working." Supervisor

- Alongside more technical learning, being able to leverage existing templates, documents and procedures where appropriate, rather than starting from scratch, increased the value of fellows' time on placement.

"What made [fellow] and their project relatively successful was that there were lots of people involved and they had access to lots of resources. There was a dedicated project manager, input from other collaborators, support from existing project team regarding approvals, documents etc., so they were able to leverage existing examples and knowledge rather than start from scratch, which helped facilitate and expedite learning. Having to do that alone as a fellow is an impossible task because you don't have the time, you don't have the relationships, you're learning too many things already." Supervisor

- Supervisors also noted proactivity and eagerness to learn, alongside responsiveness from project teams, as core characteristics of a successful fellowship experience.

"Our fellow has been able to gain quite a lot from this process simply because he's decided he's going to interact with various team members in very specific ways. Once he's had that list in order to tick off what he wants to achieve. I think you need someone who's proactive, but you also need that list. And you'll also need the engagement from the team members to be able to do that." Supervisor

- Alongside seeing benefit in shared project-specific spaces, some fellows agreed it would be useful to have a shared and dedicated space for fellows themselves to meet, share learning, provide peer support and work together.

5.1.2. Datacamp

Fellows presented mixed views on the accessibility and utility of Datacamp. Some fellows found it useful as a basic introduction to certain technical aspects central to clinical AI. Others found it provided an indispensable reference tool that guided their learning and development. Others still felt it had little utility for them personally, either due to the nature and demands of their projects, their pre-existing skillset, the format of learning it adopted, or as a result of a lack of time to fully engage in its content.

Fellow engagement with Datacamp varied notably across the cohort, with some accessing and completing a small number of courses predominantly within the first few months of the fellowship, some leveraging the resource on an ad hoc basis at different points in the fellowship, while a few others continued use relatively consistently throughout, completing a larger number of courses.

Alongside Datacamp as an ongoing resource throughout the fellowship, fellows discussed the possibility of a 'boot camp' at the beginning of the fellowship to springboard foundational learning⁵. Fellows also agreed a 'hackathon' approach would be highly valuable.

5.1.3. Benefits of Datacamp

Noted benefits of Datacamp included that it provided:

- **Structured, targeted, and relevant learning.** Particularly in early stages of the fellowship where projects weren't fully up and running, Datacamp provided an accessible introduction to core

⁵ In response to this faculty have established a boot-camp for early stages of the fellowship for subsequent cohorts. This will deliver foundational content critical to optimising fellows' experience and learning throughout the fellowship. Bootcamp was implemented for Cohort 2 of the fellowship.

technical aspects of AI. For fellows whose projects were more heavily focused on technical development, Datacamp was an essential learning tool that guided their technical learning.

"I don't think I'd be doing this project if it weren't for Datacamp. I've had to learn Python from scratch, and as a tool for learning coding, it's been extremely good." Fellow

- **A valuable resource for responsive learning.** Datacamp resources could be accessed dependent on the needs and requirements of projects. Fellows agreed being able to 'cherry-pick' relevant content when needed was a particularly useful approach, as it helped contextualise learning within their project placements, and fit alongside their personal learning trajectories.
- **A practical alternative to project-based, face-to-face learning.** For fellows with limited contact time or mentorship within their project placements, Datacamp provided a critical pillar that guided technical learning, delivering important learning outcomes.
- **A useful conduit to broader learning.** In some cases, Datacamp provided a useful introductory platform for learning, which was subsequently supplemented by other, more detailed sources of information and guided learning.

5.1.4. Challenges with Datacamp

Noted challenges of Datacamp was that it provided:

- **Lack of practical application.** Some fellows found the accessibility and utility of Datacamp limited by a lack of practical application – some fellows felt courses were surface-level and non-contextualised, which made learning challenging.

"I did quite a lot of Datacamp at the beginning, but it wasn't practical at all, and so I just felt like I was learning things like you do on Duolingo, you learn a word, but then you never apply it, and then you're just like, okay, how do I put this into a sentence?" Fellow

- **Non-contextualised learning.** Some fellows found being allocated specific Datacamp learning objectives made engagement with the content more challenging and less valuable. Rather, learning in response to specific project needs led to more valuable and efficient learning outcomes⁶.

"In the early stages we were being set specific modules. I didn't find that particularly helpful, because if my Python fundamentals weren't strong enough to do an NLP module, I could still do it, but it would take me a very long time. Whereas if I had just been left alone to just progress far enough down the Python track, I would have encountered that module anyway, then I would have done it much faster and with much less frustration. So it depends a little bit on the goal." Fellow

- **Variable value dependent on pre-existing knowledge.** Fellows with pre-existing proficiency in technical AI noted that whilst they could see the benefit in Datacamp for others with less experience, for them it wasn't a component of the fellowship that provided significant value.
- **Limited engagement due to time constraints.** For some, despite intention and motivation to commit more time to Datacamp, engagement was limited due to time constraints and a focus on project delivery. In some cases, this was compounded by the fact projects did not require technical AI skills.

⁶ Based on this feedback, faculty have adapted their approach to Datacamp learning, allowing non-prescriptive 'free learning' led by fellows' needs and learning trajectory, but still providing guidance and support where needed.

I'm not sure how much I could benefit from it for the project I'm working on because it requires no coding whatsoever, it's all writing protocols, and designing different governance sheets etc. And truthfully, I don't think I'd have the time for it. Fellow

- Alongside Datacamp as an ongoing resource throughout the fellowship, fellows discussed the possibility of a 'boot camp' at the beginning of the fellowship. Some felt that structured and practical face-to-face training in coding and setting up AI-related tools would have been beneficial, especially for those with limited coding experience. This was a point of feedback The faculty had taken on board, with developments planned for Cohort 2.

"A couple of weeks [for a Boot Camp]. The way I learn, I need someone to ask that question if I get stuck. I'd just be really, much, much faster if I did that." Fellow

- Some fellows discussed their experience of a 'Hackathon' whereby a multi-disciplinary group (i.e., AI technicians and clinicians) came together to work collaboratively to solve a specific (hypothetical) AI-related issue. This was found to be a particularly helpful learning format which fellows felt could be integrated into the fellowship, particularly benefiting those working on more isolated, small-team projects.
- One fellow noted that because they were seated next to proficient coders, they learnt more in three days of Hackathon than Datacamp throughout the fellowship. The other participating fellow understood the benefit went both ways, as they felt their clinical skills were helpful to those focused on coding. In particular, the collaborative and face-to-face nature of Hackathon was beneficial to one fellow who struggled to learn without a level of interaction with others.

"That gives you a team for three days, which is lovely. I had that twice for three days I mean, for me, I just loved working with people. I just wanted some interacting. I am really bad at working in isolation. It's just nice to learn anything with a group of motivated, fun people. That's what I want from any job." Fellow.

5.1.5. Masterclass Workshop Sessions

There was consensus amongst fellows that Masterclass Workshop Sessions were an enjoyable, informative, and highly valuable aspect of the fellowship, notably due to them providing exposure to experts in their respective fields that otherwise fellows would not have access to, and the platform sessions provided for open discussion and networking.

- Fellows agreed coming together in person monthly provided an enjoyable and valuable opportunity for peer-peer learning amongst fellows, where they could share experiences, discuss challenges, and learn from different project contexts.

"You get the feeling that clinical AI is something that a lot of people are talking about, but not than many people have much experience in. So to have a group of people, who we can ask questions about how we should be approaching it is really helpful. Because it's a lot of the same questions that a lot of us are facing, it's nice to see that a lot of us have some of the same answers." Fellow

- Fellows saw building a network of clinical AI practitioners as particularly valuable, not only for the duration of the fellowship programme, but in creating an engaged alumnus.

"There aren't that many people in this health AI space, and they all know each other. And we're going to be some of those people going forward. And we already have the network of the AI fellows, and that's quite helpful. It's something that will become very relevant after we graduate this fellowship." Fellow

- Masterclass Workshop Session content was valued by fellows, however some felt sessions could be strategically scheduled so that foundational content is delivered at earlier stages of the programme. This would optimise practical application of new knowledge⁷.

“The one in January is basically going to teach us all the things I have spent the whole time trying to find out and learn, because it is so relevant to how you evaluate an algorithm in the NHS and the guidelines on that. If I had that at the beginning, it would have saved me so much time”. Fellow

- Similarly, some fellows agreed there would be value in frontloading a larger volume of in-person learning days - a form of ‘bootcamp’ - whereby fellows could be ‘brought up to speed’. Some felt this would optimise their ability to engage and learn on placements from the outset. A suggested format for this was a combination of lectures and time for coding each day. See footnote below on actions taken by The faculty for Cohort 2.

“I would be more successful as a fellow if I had a lot of teaching at the beginning”. Fellow

- Several fellows mentioned they’d like sessions to last a full day, to optimise learning and contact time, particularly when needing to take time to travel to London. It should be noted that during Cohort 1 sessions were extended to a full day from initially being afternoon only.
- Some fellows discussed if the fellowship expanded geographically, they would be happy to travel for masterclasses, but there should also be the option to attend remotely.

5.1.6. How does the fellowship align with clinical training and competencies?

Fellows and supervisors presented a variety of views regarding alignment between fellows’ clinical training and competencies and project placements. The following section considers this question in two components: 1) fellow and supervisor views on alignment between fellows’ clinical competencies and project placements, including perspectives on the extent to which alignment is needed, and the implications of non-alignment, and 2) the logistical alignment between fellows’ clinical training whilst participating in the fellowship.

5.1.7. Alignment between fellows’ clinical competencies and project placements

The extent to which the fellowship can and should seek close alignment between fellows’ clinical competencies and the clinical area of their respective placement projects was raised by fellows and supervisors. Two broad categories of views emerged from the data, with no clear majority for either: 1) Alignment is not essential and not necessarily desirable for a successful project experience, and 2) Alignment is preferable and should be achieved wherever possible to ensure the most beneficial project and learning outcomes are achieved. These two viewpoints are discussed in turn below.

1. Alignment is not essential and not necessarily desirable.
 - Some fellows and supervisors felt that close alignment between a fellow’s clinical expertise and their project subject matter was not essential to deliver a successful project experience. These individuals felt the fellowship experience provided valuable transferable skills that fellows could apply to any clinical and hospital context.

“The role that they are playing is more general, so that isn't to say there isn't a role for subject matter

⁷ Based on this feedback, faculty have made corresponding amendments to Cohort 2, including scheduling Masterclass Workshop Sessions to frontload foundational content, and introduction of a ‘Bootcamp’ to expedite fellow learning on clinical AI fundamentals.

experts in any given AI project. An AI fellow or an AI doctor would be slightly higher-level role, which is more focused around the principles and the application of the technology, whilst also having a general clinical underpinning, that's what allows you to and be effective in that role." Supervisor

- One supervisor noted that whilst clinical alignment may not be essential, some form of complementarity should exist between a fellow's skills, knowledge and interest and the nature of the project. For example, this may be related to a specific AI application or approach that is transferable to a fellow's own clinical area.

"Where possible, it might be beneficial to seek clinical alignment between fellows and their project. It is not essential but may optimise the value of the relationship and engagement." Supervisor

- Fellows added that a degree of flexibility is required to ensure that in instances of non-alignment fellows can meaningfully contribute to projects, as well as gain transferable experience and learning outcomes to take forward post-fellowship.

"I think it could be a bit of a problem if your supervisor wasn't flexible about it. Because the radiomics approach I'm using, I'm not going to be able to use in my day job. But a lot of the softer skills in my day job I will. And she's been great at [identifying] lots of side projects as well." Fellow

2. Alignment is preferable and should be achieved wherever possible.

- Some fellows and supervisors felt alignment would bring most benefit to fellows and projects alike, and as such should be prioritised when matching fellows to placements as far as possible. From this perspective, alignment facilitates more effective and efficient learning on placement, as well as increasing the value of fellow contributions to project outcomes⁸.

"Thematic alignment might also be helpful because then you can make sure that the match between the group and the candidate is as best as it best can be so that there's benefit greatest benefit on both sides." Supervisor

- A few fellows highlighted the large amount of time and effort it can take to learn a new clinical area in enough depth to add value to a project. Given the limited fellowship timeframe, alongside pressures of dedicating only two days per week, some fellows felt greater value could be derived from working on a project already within their area of expertise and interest. This was also raised by some supervisors.

"Given that someone is immersed in something that for many of them is unfamiliar, and basically what we're trying to do is get them up to speed in AI, which is not exactly a simple domain, in one year doing it part time, I think it's not ideal." Supervisor

- Additionally, some fellows felt working within their own trust would provide benefit by enabling them to leverage existing relationships and networks and navigate settings they already know well. Establishing new relationships in an unknown clinical area, whilst trying to exert influence and add value, was seen as an avoidable challenge. Again, this point was reiterated by a few supervisors. As noted above, a lack of system capacity and specifically limited clinical AI projects makes this challenging to address in the short-term. Rather, as system capacity is built and the number of appropriate projects increase, these factors can be more substantively taken into consideration in fellowship programme design.

"A challenge for my fellow and for me has been the fact that he's not a [host trust] employee. If he'd been

⁸ Faculty implemented a project-matching process to mitigate against non-complementary pairings and provide transparency with regards to fellow-placement matching.

working at [host trust], it might have been a lot easier. And if he'd been working in a department where a project was being undertaken, it would have been a hell of a lot easier.” Supervisor

- Some fellows described frustration that areas of alignment existed within the fellow cohort, however were not taken advantage of when matching them to projects. They felt this was a missed opportunity.
- In one fellow’s experience, clinical colleagues had expressed concern the fellow had dedicated a large amount of time and energy to an area outside their clinical training. Some colleagues suggested the fellow was not serious enough about working within their clinical area of training. The fellow themselves disregarded these comments, however they were aware of the optics to others.

“I felt like both jobs thought I was just not working enough. Whereas, the reality is, I was working more for both. Because I was at the beginning of my speciality training I was meeting a lot of new consultants who wanted to see how dedicated I was, and the overriding impression I got from them is that they don't think I'm dedicated at all. Not just that, but the fact that I'm doing a project that is nothing to do with [clinical area] has been incredibly detrimental to my reputation as a [specialist].” Fellow

- Another fellow noted that if they had been working on a project within their clinical area, time spent on project placement would have been considered a research endeavour creditable to their clinical training. As it stood, they felt time spent on placement reflected poorly on their Annual Review of Competency Progression (ARCP) appraisal where they scored lower than usual.
- One fellow noted that working on a project aligned with their clinical training area would have provided much clearer and more valuable career development and would have made applying their learning in future more direct and effective.

“My project was nothing to do with my specialty. I've trained for 15 years in this specialty. I've built a huge network of people. I've trained for ages. Why am I now entering a space where I have to start all over again? If my algorithm had simply been on something [clinical area], I could have presented it at the right conference and built my career.” Fellow

- The faculty understood potential benefits in alignment, noting it had been enabled this where possible. However, given that AI project supply does not match fellow demand, it is not possible to match all fellows with their number one choice of project⁹.
- The faculty noted that Cohort 2 has seen increased project numbers, and as such it has been possible to match almost all fellows with either their number one or number two project preferences. Additionally, the faculty aims to improve clarity of messaging for prospective fellows regarding project nature and the likelihood for clinical alignment. From a fellowship perspective, developing fellows’ AI skills takes precedence over ensuring alignment with clinical area alignment.

5.1.8. Logistics of working on a project placement

Both fellows and supervisors discussed challenges associated with participating on the fellowship. Most fellows felt the balance of working two days per week on the fellowship alongside clinical duties was appropriate given the nature of the programme. However, for some it created notable pressures on ongoing clinical training commitments. Supervisors were generally of the view two days per week was the minimum time commitment required to gain value from the experience.

⁹ Within Cohort 1, project-fellow ratio was 1:1, with 80% of projects related to radiology. Therefore, it simply wasn't possible to provide alignment in all cases.

Some supervisors felt, ideally, the fellowship would be full time, however understood challenges in this.

Challenges related to time commitment and work pressures.

- Most fellows felt the balance of working two days per week on the fellowship alongside clinical duties was feasible and appropriate given the circumstances. However, one fellow reflected the sentiment of others by stating '60% clinical being the absolute limit of where I want to be'; beyond this, fellows felt they would not be able to commit as needed to their clinical training.
- One fellow explained they were struggling with 60% clinical time, particularly with rotations, and felt they 'aren't doing a particularly good job at either sometimes'.
- Given the amount of work stemming from their projects, coupled with a desire to make the most out of the fellowship opportunity, several fellows noted they worked significantly beyond two days per week on their project placements. For some, spending extra time on their project was a consistent feature, whereas for others busier times came in peaks and troughs, which felt more manageable.

"If I'd only worked the days that I was absolutely meant to, then I wouldn't have got anything done."
Fellow

- Some fellows described challenges from misaligned scheduling between clinical training and project commitments. For example, regular project team meetings being scheduled for days and times when fellows would be required to undertake shift work.

"You almost have to satisfy both sides, the clinical and the AI expectations, and not annoy people, and not look like you're slacking at one discipline. That I found tough." Fellow

- Given the demanding nature of the fellowship, one fellow noted the importance of the programme having in-built flexibility, particularly in terms of prescribed outputs and outcomes. Stricter curricula with defined outputs would have reduced the feasibility, and increased the pressure, of participating in the programme.

Challenges related to administration.

- Fellows and supervisors identified notable challenges with regards to fellowship administration during initial stages of the programme, most notably around establishing honorary contracts. In a few instances, delays in receiving honorary contracts limited the onset of meaningful project engagement. While most supervisors and fellows noted receiving valuable support from the faculty in overcoming these challenges, a few would have liked more support in addressing initial administrative challenges.
- In some cases, host trusts encountered administrative challenges regarding cross-organisation recharges, resulting in payment delays.
- Fellows noted that the challenge related to honorary contracts would be compounded for those who work on rotation - which in effect would require a repeat of the process and associated challenges several times within one fellowship cycle.

5.2. Fellowship outputs, outcomes, and impact

This section details fellowship outputs, outcomes and impacts for fellows, supervisors, and the broader host project. Firstly, it details fellows' learning outputs and outcomes as a result of participating in the fellowship, covering 'soft skills' as well as technical skills and knowledge attainment. It then moves on to consider the more immediate and longer-term impact of the fellowship on fellows' careers. Lastly, the section provides insight into the impact of the fellowship on host projects.

5.2.1. What are fellows' learning outputs and outcomes through participating in the programme?

Through participation in the programme fellows described achieving valuable 'soft skills' outcomes alongside more tangible, technically based learning outputs. Some fellows adopted the perspective that they themselves were the most significant outputs of the programme, with the project component in particular providing unique and unparalleled experiential learning they could take forward and apply in other contexts. Whilst others appreciated this perspective, they also had focus on delivering more tangible outputs - such as academic papers - that were felt to signal attainment of knowledge, experience, and expertise more directly.

5.2.1.1. 'Soft skills' learning outcomes

Some fellows explained that a shift in mindset was required to accommodate for the fact that a large part of the fellowship, namely the project placement, was geared towards providing 'softer' learning outcomes. This was somewhat counter to their experience as medics to date, which is generally underpinned by highly structured training and associated outcome measures. Whilst this created initial internal tension for some, others embraced the dynamic of experiential learning within clinical AI and the challenges of navigating through it.

"As medics were used to having something... and I think part of this is getting used to not having that and just say "I have experience in this, and I have experience in that" and not having a masters as a result or a publication or whatever...I think the whole point of this fellowship is to be able to have users, super users, collaborators in AI to be able to upscale NHS staff". Fellow

In reflection, all fellows agreed in the unique value of the experiential learning gained. The fellow group identified the following 'soft skills' outcomes.

- **Increased understanding of the broader clinical AI 'space'.** Some fellows described significant increase in their understanding of the clinical AI 'space', and subsequent increase in their ability to operate within it. For example, feeling confident and able to identify and present at relevant conferences.

"It allows you to understand and appreciate the landscape of who's involved, who the big players around AI [are]. We're trained to present clinical work, when you come out of your comfort zone, it's a whole other ballgame. So, it was nice to be able to do that." Fellow

- **Improved presentation skills.** A few fellows highlighted their improved presentation skills and the opportunity to present their work at conferences and panels, which they didn't expect initially.

"I definitely got so much better at presenting. I've presented something every week, for the past eight weeks, because of this fellowship. So, yes, that's been really good." Fellow

- **Expanded clinical AI networks.** Fellows emphasised the importance of fellowship peers in providing a valuable and sustainable source of support, information, and networking for their

future clinical AI endeavours. Fellows also indicated that increased confidence and clinical AI knowledge drove proactivity in seeking out new learning opportunities and networks.

“One of my skills with the fellowship is I gradually became more confident in leveraging my label as an AI fellow. So, I use that platform to amplify myself, to try and get into certain circles.” Fellow

- **Increased confidence and ability to integrate and work with technical AI teams.** Knowing how to interact with various stakeholders within an AI project team was identified as an important learning outcome by several fellows. Depending on a fellows’ particular project experience, this might include working with data scientists, product developers, statisticians, commercial partners and other partners within the NHS. This was facilitated by increased proficiency with technical AI language, processes, structures, and applications, alongside understanding how these technical aspects interface with real world clinical settings.

“It was important to show I’m not above doing any task and to be helpful, to be involved and engaged. And there’s a quid pro quo, because later on you get asked to contribute to more interesting sides of the project. And you can come back around and see what that engineer has done with your labels, your feedback and you see that the algorithm is working better”. Fellow

- **Increased confidence and ability to advocate for clinical AI solutions.** Fellows highlighted they felt more equipped and able to have meaningful and productive conversations with clinicians and other colleagues around the broader benefit of AI, and how specifically it may be applied in a clinical context.

“One thing I’m confident in my ability of this year is working with technical teams and also working with AI sceptical clinicians. I have lots of interactions with clinicians who are very AI sceptical and that ability to take people with you is going to be really valuable.” Fellow

- **Understanding their role within appropriate and effective propagation of AI solutions across the health system.** Some fellows noted the importance in understanding the value of not trying to do everything yourself, rather leveraging the skills and expertise of others to drive forward meaningful developments.

“You also understand the value in not doing trying to do everything yourself. You, you, you understand that all of these people do it better because they are experts and you know what? You don’t know which is equally valuable.” Fellow

- **Fellows learned about the need for flexibility and adaptability in AI projects,** as technologies and approaches evolve.

5.2.1.2. Technical learning outcomes

Fellows identified learning outcomes related to technical AI development, deployment, and evaluation. The composition of individual fellows’ learning was dependent on the nature of their project and the experiences it afforded them. For example, some projects saw fellows focus on deployment and evaluation which delivered unique learning outcomes to fellows embedded in projects focusing on coding, for example.

As a group, fellows highlighted the following technical learning outcomes.

- **Increased understanding of technical domains underpinning product and software development.** Having direct exposure to clinical AI contexts equipped fellows with grounded insight into and knowledge of various technical disciplines that feed into development of clinical

AI tools. For example, mathematicians, computer scientists, data scientists, software engineers, and biomedical engineers.

"Understanding all the things that you have to put in place to do it well, that is a valuable point to be ending on. Doing this with an element of rigour and understanding of the standards that need to go into it, and how difficult it is and all the things that you have to do along the way to not just implement something, but to implement something that has impact is really powerful". Fellow

- **Proficiency in coding and software development.** Some fellows explained their ability to code (via platforms such as 'Python' and 'R') and develop functional software (i.e., Natural Language Processing tools) were developed significantly. Some had substantial prior experience and knowledge in these areas, however felt the fellowship developed this further, whereas others went from little or no knowledge to feeling they attained a high level of proficiency. A combination of Datacamp, self-identified auxiliary technical training (e.g., leveraging online learning tools), and relevant project experience were noted as core mechanisms behind this learning outcome.
- **Awareness and knowledge of Clinical AI deployment processes and requirements.** Fellows whose projects had a substantial procurement and/or deployment component noted they gained significant awareness and expertise of NHS system processes and requirements, which were understood to be integral to appropriate, safe and effective AI integration into the health system. Knowledge in this domain included Information Governance best practice, regulatory bodies and frameworks, NHS system structures and requirements, and research and deployment ethics.
- **Expertise in evaluating AI technologies, including how to conduct a clinical AI trial.** Where projects maintained a focus on deployment and evaluation, fellows gained grounded and detailed understanding of how clinical AI interventions can be appropriately monitored and evaluated. In one case, a fellow was confident in their ability to design and deploy a clinical trial successfully as a result of their fellowship experience.

"The main thing I've learned that I didn't know before was, how to evaluate AI algorithms in a clinical setting. So, that academic clinicians understand why they work, and that they're valuable and believe them. So, I think that it's very useful." Fellow

- **Increased understanding and confidence in identifying appropriate use cases for clinical AI** in real-world settings, and its impact on patient care.

"As medics we are quite insulated and we hang with our own speciality, from our own background. This has broadened my horizons of the applicability of AI outside different fields...and also from a career perspective it has opened loads of doors... it is nice to know you can build collaboration and with that get more funding." Fellow

- **Contribution to academic outputs.** Some fellows have authored academic papers based on their fellowship experiences and learning. A list of papers produced to date can be found within the appendix.

Processes of acquiring technical knowledge

Fellows commented on the process of acquiring technical learning, which varied dependent on the nature of the project, project team composition and the fellow's approach to learning.

"Everyone is learning and utilising the resources given to us in different ways...everyone is splitting their time differently and I can't compare myself to any of the others, we are not learning the same materials... it is really weird because you as a medic are really used to compare yourself to another person...this is a very adult learning environment, which is quite refreshing actually." Fellow

- Despite variation in project experiences, fellows have been afforded 'protected time' to gain a level of expertise in a new area of interest - something that is otherwise difficult to manage alongside clinical training.

"If you are 100% clinical, to learn to a new skillset, even if you are interested in it, is really difficult... so suddenly to have two days a week, and one of those days you might just spend reading is really valuable. In terms of the aim of the AI centre to upskill a cohort of clinicians, it definitely facilitates this because my understanding of AI and healthcare tech is 3000% higher than it was 6 months ago." Fellow

- For some, Datacamp provided a complementary platform to their project placement, whereby practical guidance and learning was synergistic to project placement requirements. The combination of technical guidance and real-world application helped contextualise learning and understand current and future application.
- For some, performing repetitive tasks as part of AI tool development provided valuable insight into the mechanics of how things work, and opened up more interesting tasks in the future. For example, a few fellows noted their experience auditing and labelling hundreds of clinical images to feed into algorithm development. While this might have been seen as an ineffective use of time, they understood it to add good value to project, as well as providing them important insight into how AI tools are built and how they work.

"It taught me a lot about how you inferred explainability [which] is one of the really critical concepts of machine learning." Fellow

- The faculty reflected on the extent to which fellows achieved learning outcomes as desired, emphasising that whilst the self-led and didactic components of the fellowship generally delivered learning experiences and outcomes as expected, the complex and uncontrolled nature of project placements meant learning experiences and subsequent outcomes were less consistent across the cohort.
- In particular, some fellows did not gain exposure to real world AI deployment and monitoring, which was understood to be an ambitious aim but nonetheless one desired for all fellows. It was felt this was due to the nature of projects and unforeseen externalities, as well as a lack of appreciation for the tight fellowship timeframe on behalf of the supervisors.
- The faculty felt this would naturally improve in Cohort 2 and beyond as faculty and supervisors apply learning from Cohort 1 experiences to project planning, alongside more formal mitigating measures developed by the faculty such as Quality Assurance criteria for projects at the application stage that require more thorough risk identification and associated mitigating measures, as well as; inclusion of more multi-project sites that have greater built-in resilience against risks.

5.2.2. What are the outcomes of the fellowship on fellows' career development?

5.2.2.1. Fellows' perspectives on career development outcomes

Fellows agreed that participation in the fellowship has fostered a diversity and depth of experience and learning that has improved career development prospects. Some fellows noted more immediate outcomes as a result of the fellowship, such as acceptance onto a related fellowship.

- Fellows agreed that being a Clinical AI Fellow was an attractive and valuable addition to their CV that would stand out to potential employers. It was felt the experiential project component of the fellowship in particular would enable fellows to talk about experiences and skills that very few peers outside the cohort would have.

"It's that line on the CV, your signature, saying that you're an AI fellow, it starts conversations, opens doors. I think also, what helps is the fact that it was supported and endorsed by NHS England." Fellow

- Some fellows noted that the fellowship had indirectly led to activity and outputs that would bolster their employability. For example, delivering presentations at conferences and panel events, and authoring academic papers, are experiences and outputs that contribute to fellows' overall professional experience and value, signalling a commitment and proficiency that will be attractive to potential employers.
- A few fellows shared that while the fellowship did not fully match their expectations in some areas relating to specific AI knowledge, skills, and support, it did match their expectations in terms of providing overall benefit to their career development.

"It met my fellowship expectations because it gave me a platform for my next career move. So, I was able to use this as a way to say that I have some experience around AI health informatics. My career goals, it fit with what I wanted to do. How it didn't meet my expectations, was I don't think I got enough support from the wider team. That resulted in a lot of time being spent not very constructively." Fellow

- One fellow likened the fellowship to a unique 'job experience' rather than a course where you receive a qualification/certification at the end, which sets the fellowship apart from other programmes which are generally more theoretical or technical.

"We've also accrued lots of skills, but the thing that matters is that we've actually now been called AI Fellows in a competitive application. That's the bit that goes on our CVs, and that's the unique selling point. Then everything else was a bonus, and that's how I approached it." Fellow

- Some fellows noted their ambition to move towards a consultant position and felt the fellowship would give them an 'edge' over others applying for the same position.

"I was very aware that it was a unique selling point for me, as going into consultant applications - every [medical discipline] registrar has a PhD, and has done research, and how good your research is, and blah, blah, blah. People can debate, but you need something else to stand out. So, yes, that could be a number of things, but actually, AI is one that I think not many people would have and would stand out."
Fellow

- A few fellows noted that participation in the fellowship has already led to other related opportunities. Two fellows successfully applied to The Topol Fellowship¹⁰, and another now sits on

¹⁰ The Topol Fellowship is a Health Education England (HEE) programme that aims to support healthcare professionals, including doctors, nurses, and other allied health professionals, to become champions and innovators in the use of digital technologies and AI in their respective fields.

a Royal College of Medicine best practice subcommittee panel. One fellow explained the fellowship enabled them time, space, and experience to think strategically about what their next career steps could look like.

"I managed to use the fellowship as a source of, 'I'm an expert', to get onto one of the Royal College of Medicine best practice subcommittee panels. Then I leverage myself to get onto a PhD training programme. I think it would have been difficult for me to try and get to those two positions without the AI fellow post. I think the AI fellowship itself gave me brain space, and thinking space, time out of clinical medicine, to actually work on those aspects." Fellow

- A few fellows noted they wanted to pursue a more diverse career where a purely clinical role could be complemented by a different but related area of focus. The fellowship has provided a platform to enable this type of career going forward.

"It's a way of adding value to a hospital or healthcare setting that's not necessarily entirely patient-based. In terms of having a sustainable career I think it's important to have something that's not necessarily clinical facing, and a bit more interesting than doing governance." Fellow

- A few fellows noted the fellowship has expanded opportunities and employability to different sectors, such as in academia and industry as well as clinical career paths. Whilst no fellow actively noted they would pursue careers in an alternate sector, it was noted as a potential outcome.

5.2.2.2. Fellows' career next steps

Fellows identified the following career next steps, indicating a clear commitment across Cohort 1 to pursue clinical AI related avenues, whether in academia, other AI-related fellowships, or involvement in live clinical AI projects. See Figure 2 Fellows' post-fellowship .Figure 2 Fellows' post-fellowship

1. Enrolment in other AI or digital fellowships (four fellows)
2. Enrolment or continuation in Clinical AI PhD (three fellows)
3. Participation in a clinical AI/digital project, including extensions of current fellowship projects (ten fellows)
4. Full time clinical practice (one fellow)

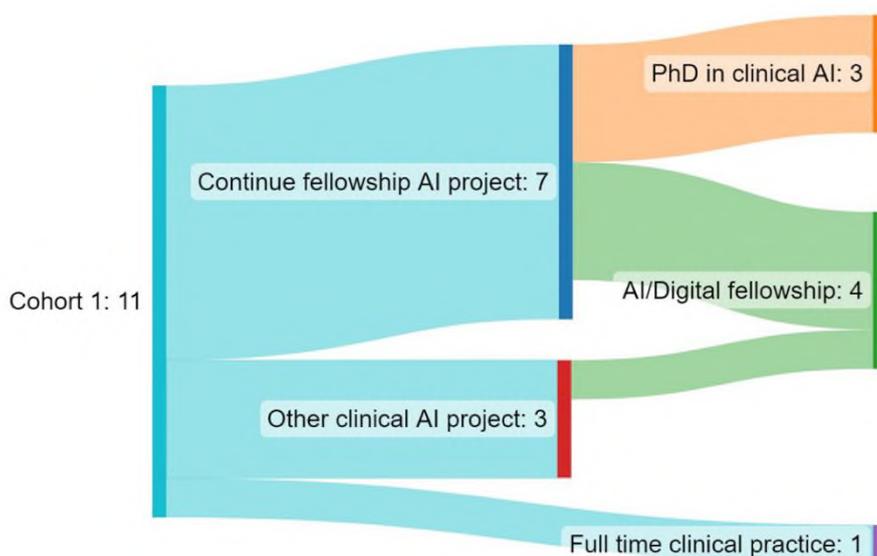


Figure 2 Fellows' post-fellowship career next steps

5.2.3. What impact does the fellowship have on NHS host organisations?

This section includes insights gained from supervisor interviews conducted at programme mid- and end-line and an online stakeholder feedback form administered in the latter months of the fellowship. The term 'NHS host organisation' in this instance represents a large heterogeneity of fellowship projects contexts, rather than entire NHS host organisations per se.

Assessing project impact in terms of medium- or longer-term outcomes on the health system is beyond the remit of this evaluation and would not be possible given project timeframes. Rather, this evaluation provides insight into more immediate implications and outcomes of hosting a fellow.

5.2.3.1. Contribution to project outcomes

Supervisors and project team staff expressed mixed views on the extent to which fellows impacted their projects. Some felt fellows themselves were the primarily, or sole, beneficiary of the programme, whereas others felt impacts and benefits of the fellowship were mutual, with fellows in some cases adding significant value to their project.

In terms of the project placement positively contributing to fellows' learning experiences, stakeholders highlighted that:

- Project placements offered an opportunity not only to develop technical AI skills, but also to understand clinical AI in practice (as discussed in sections 5.1 and 5.2).
- Fellows were enabled to engage with different individuals and teams to expand learning as well as their networks (as discussed in sections 5.1 and 5.2).
- Fellows could join existing projects with established infrastructure and expertise to facilitate and expedite learning.

With regards to fellows providing valuable contributions to projects, the following points were raised.

- **Fellows were able to provide a fresh clinical perspective to the project.** One supervisor emphasised the fellow-project interaction was of mutual benefit. They noted the fellow was proactive and talented, and was able to provide particularly valuable clinical input into the project. The supervisor explained that the likelihood of mutual benefit was to a large degree dependent on specific fellow-project dynamics – for example, if the project team and supervisor are primarily AI technicians, then a clinical fellow may offer significant value, over and above a clinical consultant.

"It depends on the individual and we happen to have an incredibly talented person [who is] great to have around and [has] provided all sorts of useful insights, [they've] been incredibly helpful. I think it will depend on the person. The primary value will be for those groups that are led by people who do not have a clinical background because you know, I imagine some of the groups will be predominantly run by engineers, them having someone who can give a clinical perspective." Supervisor

- **Fellows provided important additional resource to drive forward project implementation** where projects had focus on deployment and evaluation. Some supervisors expressed their satisfaction in the level of professionalism, proactivity, and aptitude fellows displayed whilst working on their projects. Fellows played core roles in project and client management, protocol design, intervention deployment and establishing monitoring and evaluation frameworks.
- **Fellows produced high quality projects** that will have significant local and wider impacts resulting from their practical applicability.

"Both fellows have produced high quality projects that should have significant local and wider impact as healthcare data science initiatives with strong clinical applicability." Supervisor

- One supervisor noted that with the fellows' own learning, **additional value and benefit would be conferred to services across the trust.**

"I'm pleased with both projects being carried out - they should both confer important new knowledge and resources for clinical informatics services in our Trust. Both Fellows have worked hard and have been a pleasure to supervise." Supervisor

5.2.3.2. Implications of hosting a fellow

Supervisors and project team staff presented mixed views regarding implications of hosting a fellow. Some felt at times the experience was challenging, requiring substantial input and resource beyond what was expected. Others felt the input required to support fellows was minimal, particularly given the benefit gained. The following section presents feedback provided by stakeholders.

Fellow supervision and support

- Supervisors presented a variety of experiences and perspectives relating to the volume and frequency of contact with fellows. For most, an hour each week was not feasible, with busy schedules and often multiple other fellows, post-docs, or PhD students within their remit. Compared to others in comparable positions, one hour/week is more support than, say, post-docs would receive.
- As a result, not all supervisors dedicated this amount of time to supervisions, taking a more ad-hoc or 'as-needed' approach. Some allowed their wider project teams to take a more proactive approach in overseeing and guiding fellows, which they felt not only was a more feasible approach, but also a more desirable one to facilitate fellows' learning.

"I'm always saying actually, 'can you go and see so and so'. So you know, there's quite a lot of delegation going on here. So there's no real risk for me. But as I keep harping back to you know, having that multidisciplinary team is so important." Supervisor

- One supervisor highlighted the support their fellow received as being the source of questioning by others within their team, insofar as it was seen to resemble a lack of parity. Another noted the level of support required as being *'burdensome for me and my team'*, as the fellow required a lot of 'handholding'.

"It's quite burdensome for my team, because they need a lot of handholding. I think that aspect just perhaps needed to be fleshed out a little bit more so that her there could be a little bit more independence." Supervisor

- Some supervisors suggested potential benefit in an emphasis of learning and support being provided by the broader project team, rather than an emphasis being on supervisors themselves. This would not only share the burden of learning and support, but also provide broader exposure to aspects of clinical AI. A few supervisors noted they already take this approach.
- In contrast, one supervisor noted that the training and upskilling required by the fellow was minimal, and the contribution they made to the project was significant.

"The contribution they've made to the project has been significant. The requirements on me to train and upskill them has been minimal which has meant that I've received a lot of help in turn from the fellow." Supervisor

Identifying appropriate project placements and learning objectives

- Across the supervisor group there were different levels of comfort in identifying and delivering an appropriate project placement aligned to the fellowship's structure and learning objectives. For some, hosting a fellow was natural, and they understood the more dynamic, unstructured nature of the learning experience being provided.

"The way that the whole program is set up seems right, it has the kind of flexibility that's needed in these things because we can't easily parachute someone into a program and have too structured a form of interaction. There has to be some fluidity there, and also a degree of give when it comes to what exactly they do and how flexibly they can move from one project - sub-project - to another." Supervisor

- Others however found the necessity for a more pragmatic and unstructured approach more challenging, and had trouble identifying an appropriate project – and roles and responsibilities within it – that would satisfy the learning objectives of the fellowship. These supervisors would have liked to receive greater clarity and support from the faculty in terms of how to approach supporting their fellow – for example, with management resources and guidelines on what specifically is expected of supervisors, and greater clarity in terms of desired learning outcomes¹¹.

"There isn't so much clarity about whether it's learning high level skills or whether it's coding for instance. So, are we training clinicians here to learn about how to conduct good research and learn how to make contacts with industry and be sort of more leaders of work? Or are we training people up to actually do coding themselves and develop algorithms and apps kind of more independently? The two things can overlap a bit, but they're quite different in how you might support a fellow to do those things." Supervisor

Areas of improvement

- A few stakeholders noted that **more explicit expectation management** could help shape a more positive fellow and project team experience. This included expectations on availability of project teams to support fellow learning, expectations of fellows their project would be aligned with their own area of clinical expertise, and expectations on the readiness of deployed technologies.

"Fellows had expectations on what projects they would be working on which did not reflect reality on the ground (readiness of deployed technologies, availability of technical teams to pivot to fit one part-time fellow) and their own technical skill. They seemed to have an expectation that they would be able to be matched to their specialty, which was no realistic especially in specialties without any mature technologies or working projects." Supervisor

- It was noted this might also support **more effective team integration**, including project team being aware of, and more equipped to support, fellows' specific learning objectives.
- Some supervisors noted significant HR challenges surrounding fellows' involvement. Delays in receiving honorary contracts limited the onset of meaningful fellow engagement in their respective projects. Some supervisors expressed they would have appreciated **additional administrative support** in this regard.

"I had to do all the chasing myself for the ordinary contracts which, to be frank, I wouldn't enrol with the programme if I needed to do that again." Supervisor

- Some supervisors noted that consideration should be given to **providing additional resource alongside fellows** (e.g. laptops, license agreements etc.). One raised this more hypothetically, as

¹¹ In response to this feedback, faculty have introduced a pre-fellowship supervisor and induction pack, as well as more detailed quality assurance processes built into project selection.

access to resources and equipment wasn't an immediate problem for them at that time, but could see this as a challenge in future and for others. However, another raised that there had been concern within their project team about the resource allocated to a fellow who wasn't a core member. This supervisor felt additional budget alongside fellows could be considered to help mitigate against this challenge.

- For those working within a specific clinical area **greater communication with and support from the faculty** was desired. As it was, fellow projects were developed in what felt like isolation. Indeed, some supervisors interviewed as part of the evaluation corroborate this viewpoint - they felt more support from the faculty on what a fellow's learning experience should target would be helpful guidance.

"[Named clinical discipline] is still a little stuck out on a limb, in the sense that there don't seem to be any other partner sites involved, so we have had to design projects according to our own needs and resources with not much input from the core AI training environment (or at least not as much as would be the case if we were in [another] healthcare specialty, I feel)." Supervisor

5.3. Future directions for the fellowship

This section leverages the faculty and Health Education England (HEE) perspectives on possible future directions of the fellowship programme. Insights are presented across two broad categories: 'internal' developments to programme structure and operation, and 'outward' facing strategic development opportunities. The section concludes with consideration of what accreditation for the programme might look like, and the risks involved.

5.3.1. What changes could be made to the way the programme operates?

The faculty identified the following aspects that could be developed to help expand and improve the future delivery of the programme:

- **Increased internal operational resource.** The faculty noted the introduction of a dedicated programme manager provided significant improvement to administrative components of the fellowship. However, as the programme expands, additional support is likely to be required.
- **Introduction of an external advisory function.** The faculty noted they were in the process of establishing an external advisory board to provide strategic input to the programme's current and future delivery and direction.
- **Curriculum development support.** The faculty identified the need for additional support in developing the programme's curriculum to ensure learning objectives remain relevant and applicable to current and future directions of clinical AI. An expert panel could provide 'peer review and external validation'.
- **Improved communications and marketing offer.** The programme currently leverages faculty resource to create the fellowships communications and marketing offer. While The faculty see this as being of significant help, they also identified risks regarding the sustainability of this approach, particularly given ambitions to scale the fellowship geographically and across other clinical domains. Increased communications and marketing capacity was seen as important for improving fellows' experience, but also in building a clear and appealing marketable identify for donors.

"You know you have companies doing similar things and are not going to do a good job, but they just have better comms and marketing... that's a huge part of it. And having the time to pitch, go to people and show off what we're doing is something I think we're going to need to get resources for. We currently only gain resources to cover ourselves." The faculty

- **Improved communication and cooperation with NHS partners.** The faculty noted that greater support and responsiveness from partner trusts for administrative and operational aspects would help make organisation and delivery of the fellowship more efficient and effective (e.g., organising fellows' contracts). This aim could be supported by increasing awareness of the fellowship within partner trusts, as well as greater communications from HEE highlighting the importance and their backing of the fellowship.

"If it was more known about in the areas where these fellows are going, or from a higher point they said, 'These fellowships are really important for us and we want them to run well and our operational staff should support them', we would spend so much less time on quite simple things really, and we could focus our time on making the experience of the fellow better and outcomes richer." The faculty

5.3.2. What shape could the fellowship take in future?

The faculty and HEE representatives identified the following areas of future development for the programme. At the time of writing, activity in some areas was already underway.

- **Place significant focus on spread and adoption.** One HEE representative noted that a key focus of the fellowship should be on facilitating the spread and adoption of clinical AI solutions. Whilst this is already a core objective, a focus on this aspect should be emphasised and sustained to ensure the programme delivers the appropriate learning experience for fellows, and tackles system needs most directly.
- **Ensure recruitment attracts fellows committed to pursuing practical application of clinical AI and digital health.** Related to the above point, representatives from HEE emphasised the importance of recruiting fellows committed to the spread and adoption of applied clinical AI and digital health in the long term, and in ways that lead to positive outcomes across the health system. An associated programme risk is equipping clinicians with skills and knowledge that do not filter through to practical application and clinical outcomes.

“We don’t want an isolated specialism, [but one] that is a translatable utility for the health service, from care of pregnant women and foetuses, through to neonatal perinatal right way through the lifespan, including how the interplay of long-term conditions in the elderly works at a genetic level.” HEE

- **Emphasise the role of Clinical AI fellows as catalysts for system change rather than technical AI specialists.** Linked to the above point, HEE representatives and the faculty alike are clear the role of the fellowship is to build competency of clinicians to leverage AI tools and navigate health systems appropriately and impactfully to improve efficacy, efficiency, and experience of services. Developing technical AI skills is not the primary objective of the fellowship, and over-emphasis on this aspect presents a risk to the programme.

“One of my worries is that we spend half a million pounds training a doctor and then turn them into a software developer that we didn't need to spend the money developing. So there's a risk associated with the wrong digital data and technology skills on the clinical audience for me. We need to be careful about what outcome we are aiming for, in whom, and the quantity that we're aiming for as well.” HEE

- **Expand fellowship to a range of clinical professions across health and social care,** such as midwifery, nursing, and physiotherapy. The faculty and HEE highlighted that all clinical areas have strong potential to benefit from AI solutions. The faculty is not restricted to certain clinical themes or contexts, but rather requires a broader system level approach whereby both developers and users of technology acquire relevant skills and knowledge. Cohort 2 has already seen the pool of professionals expand to include dentists alongside clinical doctors, and in cohort 3 the eligibility criteria are being further expanded to cover Nursing and Midwifery, Allied Health Professionals, and Pharmacy Professionals. A core part of this process is ensuring the fellowship reflects and aligns with training and career pathways of these professions, and has the appropriate assessment criteria in place to attract and support the right candidates. One challenge is the availability of projects in these specific domains, however a mitigating measure is that the fellowship does not require direct alignment between fellows’ clinical expertise and projects’ clinical focus.
- **Central vs regional fellowship model.** An HEE representative suggested considering the benefits of a centralised approach to project administration and funding (similar to The Topol Fellowship), rather than a regional approach that requires individual deaneries approving, granting access to and funding the fellowship. Centralisation might offer a more effective and efficient route to nationwide adoption and help overcome contracting and funding challenges experienced in Cohort 1. Whilst The faculty noted benefits in this approach, they also identified

challenges - spread and adoption from a central position can be less dynamic and slower to implement, and central funding can be notoriously short-term due to changing national priorities. These factors would present a significant risk to the programme's sustainability. A more feasible, less risky approach could be programme funding at the Integrated Care Service (ICS) level.

5.3.3. What could accreditation for the fellowship programme look like?

Accreditation was discussed across fellow, the faculty and Health Education England (HEE) senior staff.

Fellows presented mixed perspectives on the desirability of accreditation, with some seeing it as unnecessary, others seeing it as a nice to have but not essential, and others still feeling it would be an important addition to the fellowship offer.

The faculty and HEE understood potential value in accreditation, however the faculty are aware of associated challenges and risks with different approaches. The faculty also emphasised that similar fellowships do not offer formal accreditation, with their value understood to reside in experiential aspects.

While fellows' perspectives might be considered when establishing an approach to accreditation, the following section focuses on what accreditation might look like, and the subsequent benefits and risks of different approaches. Therefore, the following has been informed by the perspectives of the faculty and HEE senior staff.

- The faculty have considered different approaches to accreditation, including *who* would be appropriate to provide formal accreditation that would align with the fellowship's aims and objectives.
- Both the faculty and HEE representatives noted the [Faculty of Clinical Informatics](#)¹² (FCI) as a potential body to provide accreditation. A university, such as King's College London, with existing clinical AI and digital health curricula may also provide a suitable partner. In any case, alignment between the accrediting body and the fellowship programme's aims and objectives would need to be sought.
- Another important factor considered is *how* an external partner may provide accreditation. The faculty noted two different approaches in this regard, one whereby accreditation exists at a project/fellow-level, and another whereby the faculty itself accredits the fellowship. 'Micro-accreditation' was another potential approach described by an HEE representative.
 - **Fellow-level accreditation.** Whilst accreditation at the fellow level might satisfy those seeking more formal, tangible fellowship outcomes, it would likely require a high degree of structure and consistent assessment across fellows. Given the large variety of fellowship experiences and learning outcomes across any given cohort - particularly relating to project placements - accreditation at the fellow level had the challenge of assuring uniformity of outcomes for recipients of the accreditation.
 - **Faculty/fellowship-level accreditation.** Accreditation from the faculty as a body delivering an educational fellowship may provide a compromise between no formal accreditation offer, and the option of fellow-level accreditation. Organisational-level accreditation accounts for variability in fellow experience and learning outcomes.

¹² The Faculty of Clinical Informatics (FCI) was established as the multi-disciplinary professional body for all health and social care qualified individuals working as informaticians across the UK. It has developed a [Core Competency Framework \(CCF\)](#) that details the core knowledge and skills-based competencies for Clinical Informaticians.

Certificates issued for fellows of cohort 1 were co-badged with Health Education England, NHS Digital Academy, and the AI Centre for Value Based Healthcare (the faculty's affiliation), reflecting the institutional makeup of the faculty and educational stakeholders.

- **Micro-accreditation.** Another possible approach offered by an HEE representative was 'micro-accreditation', whereby bodies such as the Faculty of Clinical Informatics, General Medical Council or Nursing and Midwifery Council provide accreditation for relevant components of the fellowship. This may also provide a compromise that allows the faculty to retain oversight of the fellowship's structure and core curriculum, whilst also building in formal accreditation valuable to fellows and potential employers.
- Another consideration is over curriculum design and implementation. An external body providing formal fellow-level accreditation might expect greater control and influence over the content and structure of curricula, which might impede faculty autonomy, and increase layers of bureaucracy that might stifle innovation. An organisational-level approach may provide a suitable balance, wherein the faculty retains oversight of curriculum design and the project offer.

"Fellows could work towards a professional accreditation or micro-accreditation via bodies such as the GMC or NMC to build the blocks needed to become that person in that role in the future." The faculty

- It is worth bearing in mind that in terms of an accreditation offer, the Clinical AI fellowship adopts a comparable approach to other fellowships working in a similar space, such as the Topol Fellowship. The faculty noted that it is generally accepted that value from fellowships is derived from their experiential offer, setting them apart from other purely curricula-based training programmes that offer standardised certification.
- Additionally, the faculty noted the fact the fellowship responds directly to [the Topol Review](#) - a formally recognised national healthcare review - as well as being explicitly mentioned in the recent [NHS Long-Term Workforce Plan](#), adding external legitimacy to the aims and objectives of the fellowship.

6. Recommendations

The evaluation makes the following recommendations based on the detailed findings presented throughout the report. *Some recommendations have already been implemented by the faculty - either in part or in full - for Cohort 2 (which is ongoing at the time of writing), and for Cohort 3 (which is scheduled to commence in 2024). Where this is the case, relevant details have been provided alongside the corresponding recommendation, identified by a blue font.*

6.1.1. Project placements experiences

Recommendations below are framed as relating to project placement experiences, however some also directly relate to fellow learning outcomes and host organisation impacts.

- 1. Prioritise multi-project placements.** As far as possible given project availability challenges, consider prioritising project-placements that have in-built capacity to expose fellows to multiple projects at different stages of the AI lifecycle. This might enhance fellows' learning experiences, as well as help mitigate the risks associated with delays and challenges in single-project placements.
 - *In light of this recommendation, The faculty have developed existing project quality assurance processes for subsequent cohorts, providing greater clarity to potential project teams on expected project characteristics, including requirement for multi-project exposure on fellows' placements.*
- 2. Prioritise projects with multi-disciplinary teams.** As far as possible given project availability challenges, aim to identify and select projects that have multi-disciplinary teams with adequate capacity to integrate fellows and proactively support their learning. Teams with a physical location of work can provide additional benefit to facilitate integration and learning.
 - *In light of this recommendation, fellowship faculty have developed existing project quality assurance processes for subsequent cohorts, providing greater clarity to potential project teams on expected project characteristics, including requirement for multi-disciplinary teams with the capacity to share responsibility for fellows' learning and development.*
- 3. Ensure project teams are aware of, and equipped to support, fellowship objectives.** This might involve clarifying the fellowship's broader aims, objectives and approach, as well as the need for adaptability to support individual fellows with their unique skills-set and interests. Leveraging project supervisors as gatekeepers might provide an effective approach to achieve this goal.
 - *In light of this recommendation, a supervisor briefing session has been introduced for subsequent cohorts to mitigate against this challenge by providing greater detail on fellowship approach, objectives and expectations.*
- 4. Assess feasibility for alternative placement sites.** Over the long-term, explore opportunities for project placements that occupy higher institutional levels, such as at Trust or Integrated Care System level, to expand the pool of suitable clinical AI projects for fellows. This might help mitigate scarcity of multi-project sites, and mitigate risks associated with single-project placements.
- 5. Consider increasing emphasis on clinical alignment between projects and fellows' clinical competencies.** Where possible and desired by fellows, consider enabling alignment between project placements and fellows' clinical competencies. This might improve project-level outcomes for both the fellow and their placement project, as well as enhance career development outcomes.
- 6. Post-fellowship extension function.** Consider feasibility of a 'post-fellowship' function that supports fellows to extend their project placements, when feasible and appropriate, to enable

them to experience the full AI lifecycle, and/or see their project through to completion in situations where unforeseen project disruption limits fellow exposure to the AI lifecycle.

7. **Cohort 1 alumni mentorship.** Given their wealth and recency of relevant experience, skills, and knowledge, consider facilitating connections between Cohort 1 alumni and Cohort 2 fellows to provide mentorship and support.

6.1.2. **Datacamp and Masterclass Workshop Sessions**

3. **Offer additional technical training opportunities.** Alongside Datacamp, consider alternative learning formats, such as a face-to-face "boot camp" format at the beginning of the fellowship, combining lectures and coding time to provide intensive and focused learning. Also consider integration of collaborative events like 'Hackathons' into the fellowship program to facilitate team-based learning and interaction, particularly for fellows working on isolated or small-team projects.
 - In response to this, the faculty have established a boot-camp for early stages of the fellowship for subsequent cohorts. This will deliver foundational content critical to optimising fellows' experience and learning throughout the fellowship.
4. **Masterclass Workshop Sessions scheduling.** Strategically schedule Masterclass Workshop Sessions to deliver foundational topics earlier in the program to enable practical application of learning throughout the fellowship.
 - This change has been successfully implemented for ongoing Cohort 2 and is planned for all future cohorts.

6.1.3. **Supporting fellows learning outcomes**

7. **Emphasise the value of soft skills alongside technical learning outcomes.** Given the importance fellows placed on soft skills outcomes, consider emphasising these benefits at the project outset. This might help abate fellows' fears of any non-technical focus, as well as help them identify and foster appropriate opportunities for soft skills growth.
8. **Formalise and facilitate soft-skills development.** Provide ongoing support and resources for fellows to enhance soft skills outcomes, such as improving their presentation skills, expanding their networks, and building confidence in advocating for AI solutions within clinical settings.
9. **Support project teams to facilitate fellows' learning.** Consider providing additional guidance and resource to equip and encourage project teams to support fellows gain a breadth and depth of exposure to real-world clinical AI across its lifecycle. Consider who the most effective gatekeeper might be to instil this culture of learning.
10. **Encourage project leads to effectively mitigate risks.** Implement Quality Assurance criteria for projects to identify and address potential risks more effectively. Include multi-project sites that offer greater resilience against risks.
 - The faculty have developed Quality Assurance criteria for Cohort 2, including emphasis on proposed project placements identifying and mitigating against risks to project delivery.
11. **Identify and prioritise multi-project, multi-disciplinary sites for project placements.** As discussed, exposure to multiple projects and being based within a multidisciplinary team can facilitate a greater breadth of learning, as well as mitigate against inherent risks of single project placements.
 - As detailed above, The faculty have taken active steps to address this recommendation through development of pre-placement Quality Assurance processes, as well as introduction of a pre-placement supervisor briefing.

12. **Shift fellow support and supervision approach to allow for broader project team involvement.** Consider alternative approaches to supervising fellows, such as involving the broader project team in providing learning support and supervision, to share the burden and encourage more diverse exposure to clinical AI aspects.
 - Quality Assurance processes and a supervisor briefing are now in place to incorporate a broader, team-based learning environment for fellows. This was implemented in Cohort 2.
13. **Emphasise the unique value fellows can bring to projects.** Promote the benefits that fellows bring to the projects they are involved in, especially in providing a fresh clinical perspective to contributing significantly to project outcomes. This might improve fellow integration and broader stakeholder buy-in to fellowship aims and objectives.
14. **Provide fellows greater opportunity for collaborative working and peer support.** Given the importance fellows placed on shared physical spaces and collaboration in supporting their learning, consider identifying opportunities for fellow engagement, whether in-person or remote. This might be particularly beneficial for fellows working within small and/or remote project teams.
15. **Ensure fellows have access to academic journals and other publications.** Fellows without academic affiliations were not able to access academic outputs pertinent to clinical AI, which presented a barrier to learning. A fellowship login that provides access to academic information sources could support fellows' skills and knowledge.

6.1.4. Supporting host organisations

6. **Optional support for supervisors.** Develop a function to provide additional guidance and support to supervisors who struggle to identify a project(s) and structure a fellow's learning. This might take the form of guidance resources, examples of previous successful projects, planned regular supervisor touchpoints, and creating a supervisor network.
7. **Adapt approaches to fellow support and supervision.** To share the burden of learning and support and provide fellows with a more diverse exposure to aspects of clinical AI, emphasise learning and support provided by the broader project team, not just supervisors.
 - As noted above, Quality Assurance processes and a supervisor briefing were put in place for Cohort 2, to incorporate a broader, team-based learning environment for fellows.
8. **Improve expectation management.** Improved expectation management might increase likelihood of positive and productive fellow and project team interactions. Consider ways to increase project stakeholder understanding of the fellowship and its aims and objectives, and what skills and background fellows are likely to bring to placements. For example, this could take the form of general information on the fellowship, as well as specific briefing information on the fellow, including their skills, knowledge, and interests.
9. **Consider appropriate additional resource allocation.** Consider providing additional resources alongside fellows, such as laptops and license agreements, to support their work effectively.
10. **Provide additional HR support.** Consider ways to streamline the process of receiving honorary contracts to ensure smooth and timely fellow engagement in projects, and to avoid burden being placed on host organisation staff.

6.1.5. Fellowship future directions

4. **Accreditation.** It is worth considering the benefits, risks and implications of different approaches to accreditation. Whilst formal accreditation fully backed by an external provider may not be suitable nor desirable for the programme, alternative more dynamic approaches to accreditation

- such as faculty level or micro-accreditation - may help deliver meaningful outcomes for fellows whilst enabling the faculty to maintain autonomy over programme structure and curricula.

5. **Operational programme developments. The faculty** identified specific internal developments to support programme efficiency, efficacy, and productivity, such as increased programme management resource, increased communications capacity and development of a communications plan, and increased supervisor support and expectation management. Evaluation findings support the appropriateness of these suggested developments, which are likely to become increasingly pertinent vis a vis intended thematic and geographic programme expansion, and to ensure programme sustainability.

6. **Strategic programme developments.** Stakeholder perspectives validated the fellowship programme as an important initiative targeting a real need across the health system. To keep pace with an evolving clinical AI landscape, alongside ensuring the benefit of clinical AI across the system, the programme should consider strategic developments carefully. For example, expansion to other clinical professions will require new ways of approaching and structuring the programme - this will most likely be successful with a co-production approach with relevant clinical bodies, such as the Nursing and Midwifery Council, to ensure the right people are attracted to the programme, and that the fellowship provides appropriate learning and skills development to serve that clinical area. Work in this regard is already underway, driven by the faculty.

7. Project Case Studies

7.1. Natural Language Processing and image classification models in high dimensional neurology

Project background

This project focused on development of a neuro Natural Language Processing (NLP) model to structure data from a large volume of medical reports, integrating it with an image classification model creating computerised brain imagery. The project assessed the validity of the two models, with the aim of improving the efficiency and efficacy of clinical triage to improve patient outcomes. The project was based at KCL-Wellcome High Dimensional Neurology Lab.

Fellow's involvement

The fellow joined the project during the design phase as the only clinician in an otherwise multidisciplinary team of AI technicians. Initially, their key responsibility was to validate and shape machine learning outputs using their clinical expertise. This contribution was valuable to progress the accuracy of the models and allowed the fellow to build relationships and gain a deeper understanding of the project's technical aspects. During this phase, the fellow also had the opportunity to develop coding and machine learning principles through Datacamp, striking a productive balance between clinical and technical skills.

"What I could do in the initial phase was just be a doctor because there are better people in this lab at doing Python and machine learning and those kinds of technical things, but they needed people to have a look at some of the outputs of the models and work out if it was making sense. So that was where I could add value and credibility." Fellow

Project Successes

The supervisor recognised the fellow's interest and aptitude in digital technology and machine learning, coupled with their flexibility and willingness to learn, was crucial in navigating the multidisciplinary nature of the project. The collaborative approach within the project team, facilitated by the fellow's interpersonal skills, also contributed to the project's success.

"Science is a collaborative process and it involves many people with overlapping tasks. The success depends not just on what they're doing individually, but how they do things collectively. And our fellow is unusually skilled in operating well with others within collaborative groups." Supervisor

Similarly, the fellow felt the project supervisor was skilful in understanding his own confidence and skill levels, moulding the project experience around those, and facilitating increased involvement in more technical aspects of the projects as his skills and confidence increased. The fellow emphasised that working within a dynamic, multi-disciplinary lab exposed him to experts in different domains and a variety of clinical AI projects at different stages of the AI lifecycle, significantly facilitated his learning and enjoyment. Weekly project meetings provided insight to understand others' work, progress made, challenges faced, and solutions.

More broadly, the fellow indicated the fellowship provided valuable 'synergy' between its components, namely Datacamp, Masterclass Workshop Sessions and the project placement. These complementary components led to a holistic, self-reinforcing learning experience.

Project Challenges

Both the fellow and supervisor noted the part-time nature of the fellowship limited either party gaining optimal value from the project format, with the project often demanding more from the fellow than time

would allow. From the fellow's perspective, balancing the demands of the fellowship with clinical responsibilities was challenging, and at times was felt to negatively impact their clinical performance.

While alignment between the fellow's clinical training and project subject matter wasn't seen as essential, the supervisor noted alignment could increase value of the fellowship for both parties. Despite misalignment in this case, the supervisor was very satisfied with the fellow's contributions to the project, and both fellow and supervisor found the fellowship to be a rewarding experience.

Project outcomes

From the supervisor's perspective, the primary outcomes related to the fellow's skill and knowledge development. In addition, the fellow made significant contributions to the project, particularly in driving the development and validation of models for eventual deployment in clinical settings. The fellow explained they learned a great deal from their experience, gaining valuable insight into technical aspects of clinical AI, but more importantly understanding the broader clinical AI context and how to operate effectively within it. This equipped them with unique transferable skills that will benefit future career prospects.

The fellow has intention to apply their newfound knowledge and skills to develop data-driven and machine learning-based solutions to clinical and operational problems. Their next step is a one-year research fellowship in liver transplant anaesthesia, where they will utilise machine learning techniques to enhance safety and efficiency through innovative operative assessment approaches.

7.2. Deploying Chest X-Ray Imaging Models in a hospital Emergency Department

Project background

This project was based at East Kent Hospital University Trust and focused on deploying a proprietary software called qXR, designed to analyse and classify chest X-rays as normal or abnormal. The primary aim of the project was to implement the qXR algorithm in the Emergency Department (ED) and evaluate its impact on reporting accuracy, turn-around time, and, ultimately, patient outcomes.

Fellow's involvement

The fellow's project involvement spanned several stages of the AI lifecycle, including software procurement, validation, and deployment. During the validation stage, the fellow conducted an audit of 50 X-rays, and leveraged Natural Language Processing (NLP) software to analyse a large volume of radiologist reports. This analysis revealed clinical need for the software due to the identification of missed abnormalities and delays in diagnoses.

To enhance engagement and understanding among clinical staff, the fellow designed and administered a comprehensive survey to assess perceptions of qXR. Subsequently, they conducted multiple training sessions for both the ED and radiology departments, ensuring that healthcare professionals were proficient in utilising the software effectively.

The deployment of qXR into a live setting was a critical milestone achieved in the latter stages of the fellowship. This process necessitated close collaboration with procurement, legal, IT, and clinical safety teams at the Trust, as well as ongoing communication with the software provider. Moreover, the fellow was instrumental in creating essential technical protocols, including Data Protection Impact Assessment (DPIA) and Standard Operating Procedures (SOPs), to ensure adherence to data protection and regulatory requirements.

Project Successes

From the supervisor's perspective, the fellow's professional approach and ability to build effective relationships were highlighted as significant successes. Their fresh perspective and ideas invigorated the project, particularly in addressing long-term challenges. The fellow was able to bring broader learning from the fellowship - e.g., insight into AI regulatory frameworks and guidelines that the supervisor didn't feel 'up-to-speed on' - which added notable value to the project and contributed to the supervisor's own learning.

The fellow gained exposure they felt would benefit their career going forward, including in-depth knowledge and experience of NHS operating environments, structures and processes underpinning AI validation and deployment, and managing complex digital health projects. The fellow noted that engagement in panels and conferences stemming from their project experience contributed significantly to their professional development and future career prospects.

Project Challenges

Despite the project's successes, several challenges were faced. Large-scale deployment and integration of the software into existing NHS IT systems proved bureaucratic and time-consuming. Engaging with the Emergency Department and radiology department posed challenges due to a lack of pre-established relationships, prompting the fellow to consider the benefits of working alongside a focal person embedded in the trust to expedite relationship-building and access. Limited responsiveness of the software provider, and the fellow's restricted time allocation for the project were additional obstacles to building project momentum and hitting planned milestones.

The fellow expressed a sense of disappointment concerning the lack of thematic alignment between their clinical area of expertise and the project's focus. They felt a project more closely related to their clinical

specialty would likely have led to greater outcomes and impact for both the project and their own future application of acquired skills and knowledge.

Project outcomes

The project successfully navigated challenging system structures and processes to achieve its aims of deploying the qXR software within the Trust. The fellow was successful in driving forward in-depth stakeholder engagement, overcoming challenges linked to a lack of responsiveness and in preparing the operating context for effective software integration.

Project delays pushed the software evaluation phase outside the fellowship timeframe. However, the project team secured funding for a six-month extension to enable the fellow to continue their involvement. Their role during this phase will involve qualitative and quantitative data collection, aiming to understand clinicians' experiences using the software, as well as analysing clinical outcome data to determine clinical and economic justifications for permanent roll-out. This extension will benefit the project and its outcomes, as well as provide valuable learning for the fellow themselves.

The fellow acknowledged that while they initially desired experience in coding, they ultimately recognised a more valuable role as a bridge between producers of AI solutions and the NHS system.

"It's satisfying that I've been key in this project, and I feel very good about that. I can talk about AI, but I think my skills now are more in digital health. I can see myself going into a consultant position and being someone who improves the software as a whole, not particularly to do AI." Fellow

7.3. Using AI models for Head CT scans in Emergency Departments

Project background

This project involved implementing and evaluating a head CT scan algorithm in Emergency Departments in five NHS sites across England and Scotland. The software, called qER, identifies critical abnormalities on head CT scans such as bleeds, strokes and fractures. Its purpose is to improve turnaround time between when a scan happens and when it's reviewed, helping to triage emergency cases and improve patient health outcomes. Project aims were to deploy the software successfully across the four sites and evaluate its impacts on clinical review turnaround time, and patient journey and health outcomes.

Fellow's involvement

The fellow played an important role in several aspects of project delivery, from protocol design through to deployment. They interacted closely with the technical supplier, including their business component (regarding contractual documentation for each site), their research team (inputting into the design of the protocol and evaluation), and their engineers (relating to deploying and integrating the algorithm).

Additional support included developing pathway flow diagrams for trial sites, and in curating a 'data dictionary' which mapped data points both the supplier and practitioners would collect to inform the evaluation. The fellow worked closely within trust teams across each site, including Emergency Departments and radiology, to ensure successful software integration. Another core component of their involvement included Information Governance and ethical compliance.

Project Successes

The fellow proactively and meaningfully leveraged pre-existing resources and support – such as existing tools, documents and frameworks – to expedite project progression through bureaucratic requirements and hurdles. They played an important role working alongside the technological supplier to coordinate context-specific protocol design. Successful deployment of a new software into complex and unique clinical contexts was also a key project success.

Project Challenges

Working outside their clinical area and engaging with experts in different fields presented a steep learning curve for the fellow. Contracting delays with the technology supplier caused project setbacks, particularly at the beginning of the placement, which impacted on the fellow's learning. The supervisor noted in hindsight they would have organised additional learning opportunities outside the core project to enable more consistent clinical AI exposure and learning throughout the fellowship.

As a result of delays, the fellowship timeframe ended at the point of deployment, omitting the fellow exposure to the project's evaluation phase. Fortunately, the fellow has been able to extend their project involvement for a twelve-month period to support real-world evaluation – without this the fellow felt significant value of the fellowship would have been lost.

Project outcomes

A core project output is the prospective trial protocol, which will be published for others to use as a practical resource for future clinical AI trials. The fellow gained invaluable experience in clinical research and digital health implementation, understanding resource requirements, feasibility, budgeting, and IT deployment in AI projects.

The fellow felt they learned a significant amount by getting involved in the practicalities of a clinical AI trial. Compared to a clinical AI PhD, the exposure was intensive, and the learning curve was steep, however the experience was unique and ultimately provided a valuable learning experience.

“There's huge value in terms of taking those experiences to other clinical AI related clinical trials, knowing exactly what needs to be done, because I was learning at the same time as doing. I have so much insight

now in terms of how to negotiate things. You know how to present things to people in information governments or R&D in terms of the kinds of phrases you need to use to get people on board. You know, those are all unique things. I feel that you can only get it if you've been in those situations.” Fellow

The fellow now feels confident in their ability to design and conduct a clinical trial. As there is scant evidence on clinical AI trials in the literature, the fellow believes the final trial output has potential to be a ‘game changer’. Not only that, but they feel the project itself has potential to lead to real-world benefits at scale.

8. Appendices

8.1. Online feedback form: detailed findings

8.1.1.1. Respondent overview

Of 36 project team members who were sent the feedback form, a total of 11 responses were received. Four of the six NHS host organisations participating in Cohort 1 delivered responses, with East Kent Hospital University Trust and University College Hospital the two host organisations returning no responses (representing two of the eleven participating fellows).

Project supervisors represented over half of respondents (n=six). Other respondents included data and computer science technicians working alongside fellows (including a 'senior developer', a 'senior research statistician' and a clinical scientist'), a representative of a fellowship funding body, and a finance business partner involved in overseeing project expenditure.

8.1.1.2. Respondent's experience of hosting a fellow

Respondents were asked to rate their overall experience of hosting a clinical AI fellow using a five-point positivity scale¹³. Ten respondents answered definitively, with a further one respondent noting they couldn't make an assessment due to their lack of proximity to the fellow themselves. Eight respondents indicated a positive experience of hosting a fellow, with the remaining two providing a neutral response of 'Neither positive nor negative'. Figure 3 provides a breakdown of responses by NHS trust.

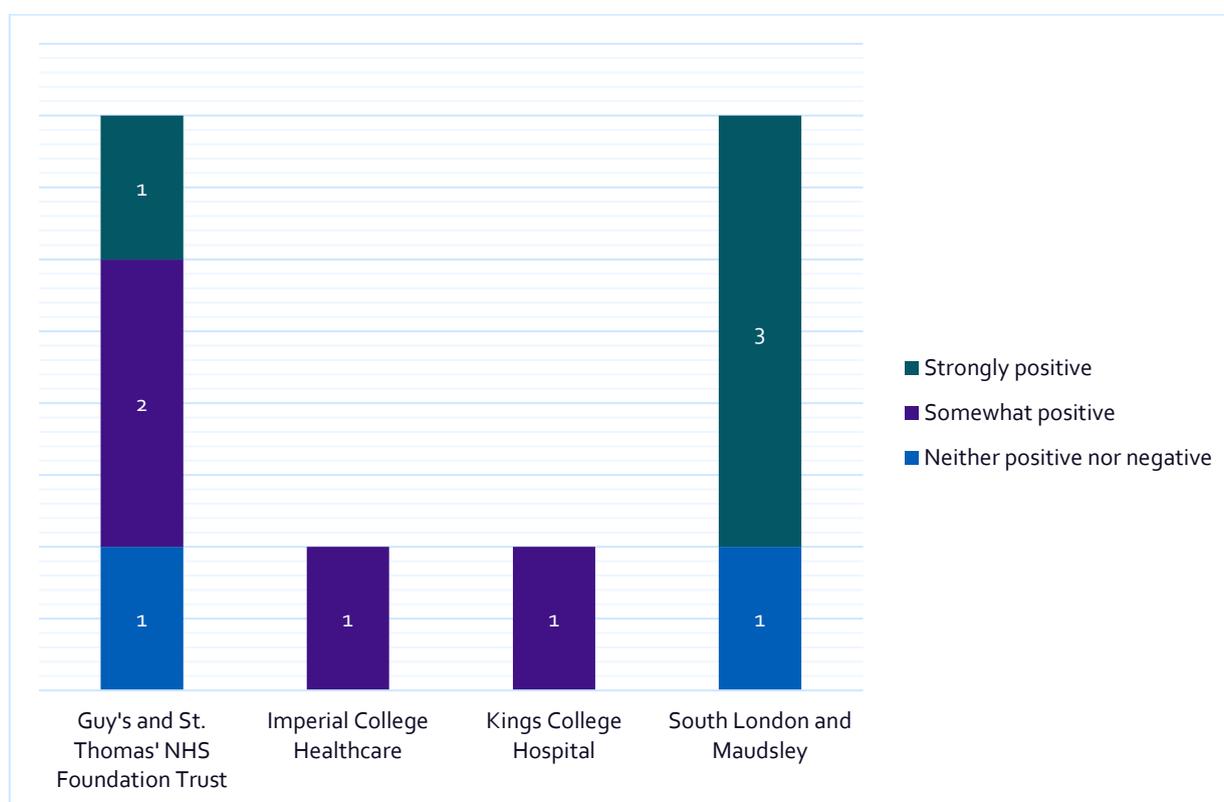


Figure 3 Host trust experiences of hosting a fellow

¹³ The scale was as follows: 'Strongly positive', 'Somewhat positive', 'Neither positive nor negative', 'Somewhat negative', 'Strongly Negative', with a final option of 'I am unsure' for those unable to make a determination.

8.1.1.3. Stakeholder perceptions of what worked well within fellows' project placements

Respondent feedback on what worked well related to two broad categories, 1) areas where project placements have positively contributed to fellows' learning and development, and 2) areas where fellows have offered valuable contributions to projects and their outputs.

In terms of positively contributing to fellows' learning experiences, respondents highlighted that:

- Project placements offered an opportunity not only to develop technical AI skills, but also to understand clinical AI in practice.
- Fellows were enabled to engage with different individuals and teams to expand learning as well as well as their networks.
- Fellows could join existing projects with established infrastructure and expertise to facilitate and expedite learning.

Respondents highlighted the following with regards to fellows providing valuable contributions to projects:

- Fellow was able to provide a fresh clinical perspective to the project.
- Training and upskilling required was minimal, and as a result the fellow provided 'significant contribution'

"The contribution they've made to the project has been significant. The requirements on me to train and upskill them has been minimal which has meant that I've received a lot of help in turn from the fellow."
Supervisor

- Fellows produced high quality projects that will have significant local and wider impacts resulting from their practical applicability.

"Both Fellows have produced high quality projects that should have significant local and wider impact as healthcare data science initiatives with strong clinical applicability." Supervisor

- One supervisor highlighted that with the fellows' own learning, additional value and benefit would be conferred to services across the trust.

"I'm pleased with both projects being carried out - they should both confer important new knowledge and resources for clinical informatics services in our Trust. Both Fellows have worked hard and have been a pleasure to supervise." Supervisor

8.1.1.4. Stakeholder perceptions of what could be improved within fellows' project placements

- A few respondents noted that greater expectation management could help shape a more positive fellow and project team experience. This included: expectations on availability of project teams to support fellow learning; expectations of fellows their project would be aligned with their own area of clinical expertise; expectations on the readiness of deployed technologies.

Fellows had expectations on what projects they would be working on which did not reflect reality on the ground (readiness of deployed technologies, availability of technical teams to pivot to fit one part-time fellow) and their own technical skill. They seemed to have an expectation that they would be able to be matched to their specialty, which was no realistic especially in specialties without any mature technologies or working projects. Supervisor

- Curriculum set out my faculty could be developed and communicated differently to help manage

fellow expectations, and help supervisors build appropriate project learning experiences for their fellows.

- For those working within mental health services, greater communication with and support from the faculty was noted as desirable. As it was, fellow projects were developed in what felt like isolation. Indeed, some supervisors interviewed as part of the evaluation corroborate this viewpoint - they felt more support from the faculty on what a fellow's learning experience should target would be helpful guidance.

Mental healthcare is still a little stuck out on a limb, in the sense that there don't seem to be any other partner sites involved, so we have had to design projects according to our own needs and resources with not much input from the core AI training environment (or at least not as much as would be the case if we were in a physical healthcare specialty, I feel). Supervisor

There wasn't a great deal of connection with the organising team - I felt fairly much on my own as a supervisor and disconnected. I don't feel that mental health data science is particularly strongly built into the scheme, which tends to focus on acute care specialties. Supervisor

8.2. Fellows' academic outputs

At the time of writing, fellows have contributed to the academic outputs listed below (fellows identified in bold text).

1. Kraljevic, Zeljko & Bean, Dan & Shek, Anthony & Bendayan, Rebecca & Au Yeung, Joshua & Deng, Alexander & Baston, Alfie & **Ross, Jack** & Idowu, Esther & Teo, James & Dobson, Richard. (2022). *Foresight - Generative Pretrained Transformer (GPT) for Modelling of Patient Timelines using EHRs*. 10.48550/arXiv.2212.08072. (Preprint)
2. **Miller R**. *A Surgical Perspective on Large Language Models*. *Ann Surg*. 2023 Aug 1;278(2):211-213. doi: 10.1097/SLA.0000000000005896. Epub 2023 May 3. PMID: 37132392. (Accepted)
3. Au Yeung J, Kraljevic Z, **Luintel A**, Balston A, Idowu E, Dobson RJ and Teo JT (2023) *AI chatbots not yet ready for clinical use*. *Front. Digit. Health* 5:1161098. doi: 10.3389/fdgth.2023.1161098
4. **Miller R**, Farnebo S, Horwitz MD. *Insights and trends review: artificial intelligence in hand surgery*. *J Hand Surg Eur Vol*. 2023 May;48(5):396-403. doi: 10.1177/17531934231152592. Epub 2023 Feb 9. PMID: 36756841.
5. M.E.W.M. Silkens, **J. Ross**, M. Hall, H. Scarborough, A. Rockall. 2023. The time is now: making the case for a UK registry of deployment of radiology artificial intelligence applications. *Clinical Radiology*. 78 (2023) 107-114. doi.org/10.1016/j.crad.2022.09.132.