Laidlaw Cohort 2025 - University of Leeds

Summer One Reflective Report

Evaluating Current Methods for Enhancing CT Imaging Using Contrast Agents

Author: Aminah Javeed

Supervisor: Dr James Warren
School of Medical and Biological Engineering

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Research Conducted

Over the six-week research period, I conducted a structured literature review on contrast agents used in Computed Tomography (CT) imaging. CT is a widely used, non-invasive diagnostic technique that enables three-dimensional reconstruction of tissues, making it one of the most prevalent tools in modern medicine. In the NHS alone, 7.2 million scans were performed between 2022 and 2023, highlighting the scale of its importance. However, the ability to visualise soft tissue depends heavily on contrast enhancement, as many structures remain indistinguishable without it. My project therefore aimed to systematically review and categorise the agents currently employed worldwide, with a focus on those applicable to microscale imaging and with strong potential for innovation and eventual clinical translation.

I began by building a foundation in understanding CT technology and the mechanisms by which contrast agents improve image clarity. From this starting point, I explored a wide range of agents with varying properties of composition, viscosity and osmolality. Contrast Agents can also be ionic and non-ionic, which changes how they operate within the body. The main aims of a successful contrast agent are to improve visualisation by at least 2x, remain in the body during the duration of a scan, be readily soluble, a suitable PH, successfully target the area without affecting other areas and be non-toxic and leave the body quickly i.e. within 24 hours. This is usually achieved by engineering agents that have high water solubility with low osmolality and viscosity. It must also contain a high molar percentage of the X-ray attenuating atom.

Over subsequent weeks, I applied critical reading and analysis skills to evaluate both clinical and experimental studies. The findings were collated into a detailed spreadsheet, which will later be refined into a final table for publication. This process not only enhanced my ability to handle complex academic material but also deepened my understanding of how physics-based technologies intersect with medical practice.

A key insight from my research was that many novel contrast agents remain prohibitively expensive or impractical for widespread clinical use, especially within resource-limited healthcare systems such as the NHS. As a result, there is a compelling case for exploring alternative strategies, such as repurposing discontinued agents already stocked within hospitals. This could reduce waste, improve resource efficiency, and increase diagnostic capability without the need for costly new developments.

Ultimately, this project highlighted how optimising contrast agents could enhance the clinical value of each CT scan, enable earlier diagnoses, and expand access to imaging in underserved settings. In addition to contributing to future publications, the experience strengthened my independent research skills and reinforced my motivation to pursue a career at the interface of physics, medicine, and healthcare innovation.

Impact and Importance

The importance of this research lies in its potential to bridge the gap between technological capability and real-world healthcare needs. While CT imaging is already central to modern diagnostics, its effectiveness is limited by the tools available to enhance soft tissue visibility. In many cases, patients undergo scans that could deliver far greater clinical value if contrast agents were better optimised for their purpose. By contributing to a systematic review of existing and emerging agents, my research supports the development of solutions that could make each scan more informative, cost-effective, and clinically useful. This ensures that advances in imaging science are not confined to theory or laboratory studies but are directed toward tangible improvements in patient care.

One of the most exciting implications of this research lies in the development of portable CT systems. CT scanners use compact X-ray cathode tubes, and improvements in design and engineering have made portable imaging systems achievable. Once paired with contrast agents that maximise diagnostic clarity, these systems could transform the way imaging is delivered. A single scan could not only aid in earlier diagnosis but also improve surgical planning and streamline treatment pathways, ultimately leading to better patient outcomes.

The broader significance of this lies in its potential to reduce health inequalities. At present, access to advanced imaging technologies is concentrated in large, well-funded hospitals, while patients in remote or resource-limited settings often face delays in diagnosis and treatment. Portable CT scanners, supported by optimised contrast agents, could extend high-quality imaging services beyond traditional hospital environments. This has the potential to bring timely and accurate diagnostic capability to rural clinics, mobile medical units, or regions with limited healthcare infrastructure. Together, these outcomes demonstrate how innovations in medical physics can translate directly into tangible societal benefits. The impact of this research is therefore not only scientific, in terms of advancing imaging techniques, but also humanitarian, by contributing to fairer and more accessible healthcare on a global scale.

To conclude, CT scans are ubiquitous in healthcare, forming the backbone of diagnostic practice across the world. Because they are used so widely and so frequently, even small improvements in their accuracy or efficiency can have an outsized impact. Enhancing the diagnostic power of a single scan has the potential to transform patient care on a massive scale. From enabling earlier detection of disease, to guiding more precise surgical planning and monitoring treatment outcomes. In this way, optimising or rethinking how scans are delivered does not just refine an existing tool, but opens the door to advancements in how medicine is practised globally.

Activities To Disseminate Research

To disseminate my research, I have already produced an academic poster which I will present at the annual Laidlaw Conference, an event that brings together scholars and attendees from across the UK. Creating this poster was an important part of my research process, as it required me to distil a large body of information into a clear and accessible format that highlights both the scientific detail and the wider significance of my work. Presenting at the conference will allow me not only to share my findings with other researchers but also to engage in valuable discussions that may spark new ideas or collaborations. The experience of communicating my work to a diverse audience will also enhance my ability to translate complex scientific material into language that is approachable and impactful.

In addition to the poster presentation, I will be publishing an academic paper as the first author by the end of Year 2 of the Laidlaw programme. This is a particularly exciting prospect, as it will allow my research to contribute more formally to the academic community and be of use to other scholars working on similar challenges. The process of preparing a paper for publication is also an important part of my development as a researcher, teaching me how to write with precision, justify my methods and conclusions, and situate my work within the wider field of medical imaging.

Beyond academic outputs, I will be promoting my research and the Laidlaw Programme itself to a wider audience. For example, I will be volunteering at the Global Opportunities Fair, where I will encourage new students to get involved with the programme, particularly those from underrepresented groups who may not always see themselves as researchers. By sharing my experience, I hope to inspire others to pursue opportunities that combine academia with leadership and impact.

Overall, dissemination is not simply about showcasing what I have done but about ensuring that the knowledge generated reaches those who can build on it, apply it, or be inspired by it. Whether through conferences, publications or outreach, I aim to make my research as accessible and meaningful as possible.

Personal Impact

Conducting research over the past few months has had a large impact on me, both academically and personally. Academically, it has strengthened my independent learning and critical thinking skills. I have learned how to read, analyse, and synthesise complex scientific literature, and how to approach a project methodically from initial background research to producing a structured output like a poster or paper. This process has given me confidence in my ability to tackle challenging problems and manage a long-term research project, skills that I know will be invaluable throughout my studies and future career.

On a personal level, the experience has reinforced my curiosity and motivation. Working on research that has clear real-world applications, particularly in improving diagnostic imaging and healthcare outcomes, has given me a strong sense of purpose. I have also developed resilience, learning how to navigate setbacks such as unclear methods in papers or conflicting data, and how to adapt my approach to overcome them.

Finally, conducting research has enhanced my communication and leadership abilities. Preparing a poster and planning for publication has taught me how to explain complex concepts clearly and engage a wider audience. Overall, the experience has made me more confident as a student, more thoughtful as a scientist, and more motivated to pursue a career where I can combine physics with meaningful contributions to healthcare.

Leadership Skills

During my research period, I developed leadership skills that span beyond skills I learnt during scientific work. Taking initiative was central to this growth, as I was responsible for designing and structuring my literature review independently. I had to decide which contrast agents to investigate, how to organise the material, and which sources were most relevant. This process required careful planning, self-motivation, and the confidence to make informed decisions without constant supervision, all of which are essential to leading a project effectively.

I also gained experience in managing a project over an extended period of time. Over six weeks, I set clear goals for reading, data collection, and collating results into a spreadsheet that will later form part of a publication. Keeping the work on track demanded organisation, adaptability, and resilience when challenges arose, helping me to lead the process with increasing efficiency and confidence.

The Laidlaw leadership training sessions provided another layer of development. They emphasised teamwork, listening to others, and recognising the strengths that different people bring to a group. I also took part in activities that pushed me outside my comfort zone, testing my ability to make decisions in new and demanding situations. These lessons fed directly into the way I approached research, giving me a more balanced and reflective leadership style.

Overall, the research period has shown me that leadership is not about authority but about initiative, responsibility, clear communication, and supporting others.

These are skills I will continue to build throughout my academic journey and beyond.

Future Career Plans

My future career plans are centred on becoming a radiotherapy physicist through the NHS Scientist Training Programme (STP). The STP is a highly competitive, fully funded pathway that combines paid clinical training with a master's degree, allowing trainees to develop both the technical expertise and professional accreditation required to qualify as clinical scientists. For me, this route represents the ideal combination of academic challenge, practical application, and meaningful patient impact.

Radiotherapy physics particularly appeals to me because of its direct role in cancer treatment, an area of healthcare with personal significance and global importance. Radiotherapy is used in the treatment of a large proportion of cancer patients, and ensuring that it is delivered safely, accurately, and effectively requires the expertise of physicists working alongside doctors, radiographers, and other healthcare professionals. The precision of treatment planning, the calibration of equipment and the development of new imaging and therapeutic techniques all depend on the unique skill set that physics brings. The idea that my work could directly influence patient outcomes, improving both survival rates and quality of life, is a powerful motivator for pursuing this career.

The training offered by the STP also aligns with my strengths and ambitions. The blend of structured education and hands-on clinical practice would allow me to deepen my understanding of medical physics while immediately applying it in a real-world setting. I value the multidisciplinary nature of the role, which requires collaboration, clear communication, and problem solving within diverse teams. Having already developed these skills through my research and the Laidlaw Programme, I look forward to applying them in a clinical setting where every decision carries significance and contributes to improving patient outcomes.

Another career pathway I am considering is qualifying as a patent attorney in physics. This would allow me to stay closely involved with innovation, helping researchers protect and commercialise their discoveries. It would be a way of ensuring that advances in physics and technology are not only developed but also brought into practical use. While this is an exciting option, my main ambition remains to follow the STP and establish myself as a radiotherapy physicist, where I can directly contribute to improving cancer care.

Ultimately, my career goals reflect a desire to bridge physics with human impact, applying my skills in ways that drive innovation, improve treatments, and deliver meaningful benefits to patients and society.