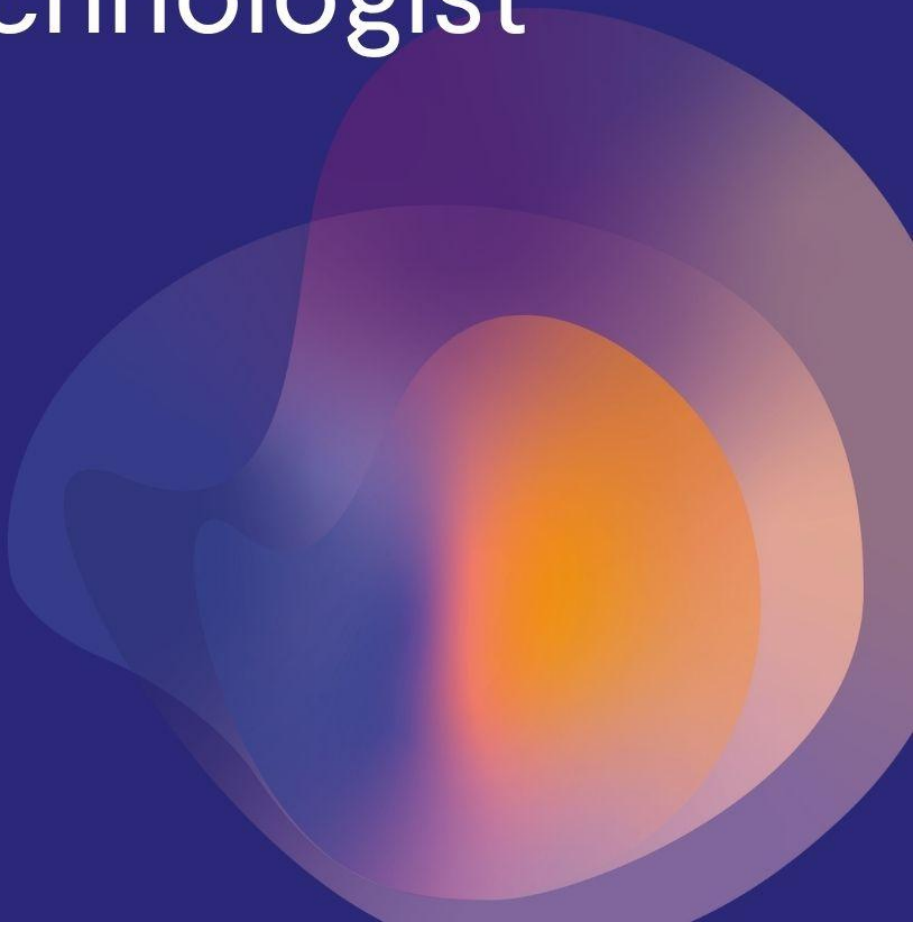
IPEM
Institute of Physics and Engineering in Medicine

Evidence of the immediacy and impact of risk to patients related to the lack of statutory regulation on modern Clinical Technologist practice



Submission to the Professional Standards Authority (PSA): Evidence for the need for Statutory Regulation of Clinical Technologists

26 June 2026

1. Executive Summary

This submission sets out the Institute of Physics and Engineering in Medicine's (IPEM) evidence that statutory regulation of Clinical Technologists is now necessary in the interests of patient safety, public protection and public confidence. It presents a strategic assessment against the Professional Standards Authority's criteria, supported by detailed technical evidence contained in Annex A.

The profession has become essential to the delivery of modern healthcare services. However, the complexity, autonomy and risk profile associated with practice have evolved significantly while the surrounding regulatory framework has not kept pace. This creates increasing challenges for preventative regulation and consistent system-wide assurance within high-risk healthcare environments.

The evidence demonstrates that current voluntary arrangements no longer provide sufficiently consistent, enforceable or system-wide public protection proportionate to the contemporary scope and complexity of Clinical Technologist practice. Registration remains voluntary despite practitioners undertaking high-risk clinical activity, leaving public protection heavily dependent on inconsistent local governance arrangements, with resulting variation in professional assurance both between employers and across the four nations of the UK, rather than nationally enforceable standards

Taken together, the evidence supports the conclusion that **statutory regulation is now necessary in the interests of patient safety, public protection and public confidence**.

2. Introduction and Context

The Register of Clinical Technologists (RCT) is a PSA-accredited voluntary register supporting professional standards, education, training and public protection across a wide range of healthcare specialties.

Since previous PSA assessments, Clinical Technologist practice has changed significantly. Advances in technology, increasing service demand, workforce shortages and the expansion of advanced clinical practice have materially altered both the complexity and responsibility associated with the profession.

Clinical Technologists now routinely undertake activities involving advanced hybrid imaging technologies, molecular radiotherapy, radiopharmaceutical administration, advanced reporting practice and increasingly autonomous clinical decision-making. In some settings, practitioners are undertaking work comparable to statutorily regulated professions while operating under fundamentally different regulatory

arrangements. Healthcare services are increasingly dependent on this workforce to sustain specialist diagnostic and therapeutic provision, particularly within Nuclear Medicine and Molecular Radiotherapy services.

At the same time, these services are becoming more technologically complex, more operationally pressured and increasingly reliant on hybrid imaging, molecular radiotherapy and advanced clinical practice roles involving autonomous clinical decision-making.

As Clinical Technologists undertake increasingly autonomous and safety-critical clinical responsibilities, the gap between the level of risk carried by these roles and the level of statutory assurance applied to them has become increasingly difficult to justify from a public protection perspective. Importantly, the regulatory framework surrounding the profession has remained largely unchanged despite substantial expansion in clinical autonomy, technological complexity and patient-facing responsibilities

The evidence also demonstrates that the current regulatory framework has become increasingly difficult to justify in practice. Clinical Technologists may administer radioactive substances and prescription-only medicines, undertake advanced imaging procedures and participate directly in clinical decision-making, yet registration remains voluntary and the title ‘Clinical Technologist’ is not protected.

This creates a situation in which practitioners undertaking highly specialised and high-risk clinical activity may be subject to entirely different regulatory arrangements despite working alongside one another within the same clinical teams and patient pathways.

3. Assessment against PSA Standard 1b(i): Benefits

3.1 Public Benefit of the Profession

Clinical Technologists play a critical role in the delivery of modern healthcare services across diagnostics, therapy, rehabilitation and clinical engineering. Within Nuclear Medicine and associated radiation sciences, practitioners routinely undertake highly specialised activities involving radiopharmaceutical preparation and administration, advanced hybrid imaging, molecular radiotherapy support and advanced clinical practice activities.

Clinical Technologists now contribute directly to highly specialised cancer, cardiac and neurological pathways through advanced hybrid imaging, molecular radiotherapy and advanced reporting practice. These services are increasingly central to earlier diagnosis, treatment planning and timely access to specialist care.

These services are now integral to modern patient pathways, contributing directly to earlier diagnosis, safer treatment pathways and improved access to complex diagnostic and therapeutic care.

The evidence demonstrates that many NHS services are heavily dependent on this workforce to maintain continuity of care and support increasingly specialised diagnostic and therapeutic provision. Without this workforce, many specialist diagnostic and therapeutic services would face significant operational and capacity challenges.

3.2 Workforce Contribution

The profession makes a substantial contribution to healthcare system resilience and service sustainability. Evidence provided through the IPEM Workforce Intelligence Unit demonstrates significant

reliance on Clinical Technologists across NHS services, particularly within Nuclear Medicine and Molecular Radiotherapy.

Over recent years the profession has evolved significantly in response to technological innovation, increasing service demand and wider workforce pressures. Clinical Technologists increasingly undertake advanced clinical practice activities including specialist imaging and reporting, cardiac stress testing, DXA reporting, radiopharmaceutical preparation and delivery of hybrid imaging procedures such as PET/CT and SPECT/CT.

In some specialties, Clinical Technologists now undertake advanced and consultant-level practice including independent reporting, cardiac stress testing and molecular radiotherapy delivery.

At the same time, the evidence highlights substantial workforce pressures, including persistent vacancy rates, limited training capacity and increasing reliance on overseas recruitment to maintain service continuity. The evidence strongly suggests that many services are now highly dependent on this workforce to sustain safe patient care and maintain access to increasingly specialised services.

3.3 Public Interest

Given the increasingly advanced and high-risk nature of modern Clinical Technologist practice, there is a clear public interest in ensuring that practitioners are subject to nationally consistent standards, oversight and accountability arrangements. This is particularly important in areas involving ionising radiation, advanced imaging technologies and prescription-only medicines, where patients are likely to assume that robust regulatory safeguards are already in place. The public would reasonably expect practitioners undertaking such activities to be subject to consistent nationally enforceable standards of competence, conduct and accountability.

4. Assessment against PSA Standard 1b(ii): Risks and Mitigations

4.1 Nature of the Risks

The evidence demonstrates that modern Clinical Technologist practice is associated with increasingly complex and high-risk clinical activity across diagnostic, therapeutic and engineering settings.

Clinical Technologists now routinely work in areas involving ionising radiation, radiopharmaceutical preparation and administration, molecular radiotherapy, advanced hybrid imaging technologies and complex medical devices and software systems. Many practitioners also work in high-risk clinical environments involving vulnerable patients undergoing complex diagnostic and therapeutic procedures. The evidence identifies risks associated with radiopharmaceutical maladministration, incorrect radiation exposure, contamination incidents, failures in competency assessment, inappropriate protocol selection and failures in emergency response to deteriorating patients.

Evidence submitted also identifies governance and competency concerns within independent sector provision, including regulatory enforcement action following contamination incidents involving radioactive substances and failures in training and competency assurance.

In some advanced practice settings, Clinical Technologists are also responsible for administering prescription-only medicines associated with significant risk profiles, including contrast agents and pharmacological stress agents, and may be required to recognise and respond to acute patient deterioration and anaphylaxis.

Recent regulatory inspection findings also demonstrate increasing system pressure within Nuclear Medicine services. The Care Quality Commission reported a 66% increase in notifications in 2023/24 compared with the previous year, including significant increases in incidents relating to radiopharmaceutical preparation, administration errors, incorrect patient positioning and failures in competency documentation.

Inspection findings also identified incomplete training records, failures to evidence operator competence and procedures that did not reflect current clinical practice or regulatory requirements.

Technological developments have significantly expanded both the technical and clinical responsibilities associated with the profession, with practitioners increasingly undertaking activities previously associated with statutorily regulated professions.

4.2 Current Mitigations

The evidence demonstrates that significant mitigations are already in place across many organisations and services. These include PSA-accredited voluntary registration through the Register of Clinical Technologists (RCT), employer governance arrangements, accredited education pathways, IR(ME)R and IRR regulatory frameworks, Medical Physics Expert oversight and local competency assessment processes.

Professional bodies and specialist organisations have also developed supporting infrastructure including curriculum frameworks, National Occupational Standards and advanced practice guidance.

4.3 Limitations of Current Mitigations

However, the evidence demonstrates that current mitigations are no longer capable of providing sufficiently consistent or enforceable public protection across the breadth of modern Clinical Technologist practice.

A central issue is that registration remains voluntary despite practitioners undertaking safety-critical activities. Approximately half of eligible Clinical Technologists remain outside the PSA-accredited register, while employers are not required to apply nationally consistent registration, training or competency requirements.

Consequently, a substantial proportion of the workforce may undertake safety-critical clinical activities without being subject to the professional standards, oversight and fitness-to-practise processes provided through the accredited register.

Evidence submitted demonstrates substantial variation in employer requirements regarding registration across NHS services and sectors. Some employers describe RCT registration as essential, others require only eligibility or working towards registration, while some identify registration as merely desirable. This inconsistency exists even within high-risk specialties such as Nuclear Medicine and Radiotherapy Physics and reflects the structural limitation that voluntary registration cannot be mandated consistently across employers and sectors.

Evidence from the Society of Radiographers also identifies employer confusion regarding whether voluntary registration may be mandated within employment requirements, further contributing to inconsistency in professional oversight and assurance.

In some specialties, increasing reliance on overseas recruitment further places competency assessment and equivalence arrangements within local employer governance rather than nationally enforceable regulatory frameworks.

These limitations are inherent to voluntary regulation. While voluntary registers can support professional standards, they cannot compel participation, prevent unregistered practice or provide universally enforceable safeguards across all employers and sectors. Individuals removed from voluntary registers may also continue practising without restriction, unlike under statutory regulation where removal from the register prevents lawful practice under a protected professional title. Evidence submitted also demonstrates wider limitations in the enforceability of voluntary regulation, including difficulties in information-sharing, inconsistent employer engagement and cases where practitioners may leave voluntary registers before fitness-to-practise processes conclude.

These inconsistencies also extend beyond individual employers to the wider healthcare systems across the four nations of the UK. The evidence demonstrates variation in workforce frameworks, regulatory expectations, governance arrangements and recognition of Clinical Technologist roles, resulting in different levels of professional assurance for patients receiving comparable services in different parts of the UK. Such variation is inconsistent with the principle of equitable public protection and further demonstrates that voluntary registration cannot deliver nationally consistent regulatory assurance for modern Clinical Technologist practice.

Historic HCPC evidence submitted to Parliament also identified limitations in employer information-sharing and difficulties maintaining oversight of practitioners operating outside statutory regulation.

The evidence also demonstrates increasing inconsistency between the complexity of practice and the level of regulatory oversight applied. Clinical Technologists may undertake identical or closely aligned clinical responsibilities to HCPC-registered professionals within the same departments and patient pathways, including administration of radioactive substances, advanced hybrid imaging and advanced clinical practice activities, despite operating under fundamentally different regulatory arrangements.

Evidence relating to sonography provides a particularly relevant comparator and reinforces that these concerns are not unique to Clinical Technologists but increasingly characteristic of healthcare professions undertaking autonomous diagnostic practice outside statutory regulation.

Modern sonographers frequently undertake autonomous real-time clinical decision-making, contemporaneous reporting and increasingly complex interventional procedures involving vulnerable patient groups, including early pregnancy, fetal medicine and cancer pathways. The clinical act is not limited to image acquisition; practitioners are required to acquire, interpret, communicate and act upon diagnostic findings that may immediately determine escalation, discharge, intervention or urgent treatment. Evidence submitted demonstrates documented cases of serious patient harm associated with inaccurate reporting, missed ectopic pregnancy and failures within unregulated or independently provided ultrasound services. At the same time, workforce shortages, expansion of direct-entry education routes, increasing independent-sector provision and reliance on international recruitment have increased dependence on variable local competency assessment and governance arrangements rather than nationally enforceable standards.

These issues closely mirror those identified across Clinical Technologist practice in Nuclear Medicine and advanced imaging. Importantly, the PSA itself has now recognised that sonography related risks may be “sufficiently high” and the potential patient impact “sufficiently great” to justify reconsideration of whether voluntary registration alone remains adequate. The PSA’s reasoning therefore demonstrates increasing consistency across professions: where practitioners undertake autonomous, safety critical diagnostic and therapeutic activity with significant potential for patient harm, reliance on voluntary participation and locally variable governance arrangements alone becomes increasingly difficult to justify from a public protection perspective.

The findings of the Kingdon Review of Children's Hearing Services further reinforce these concerns[1]. The review concluded that audiology had been treated as a low-profile 'Cinderella' service despite involving significant clinical risk and the potential for serious patient harm. Importantly, the review demonstrated how healthcare services may be perceived as lower risk than the reality of modern practice, resulting in governance and regulatory arrangements that fail to keep pace with increasing clinical complexity and patient safety requirements.

It identified the absence of a single professional register, lack of title protection, no consistent requirement for practitioners to hold professional registration, variable accreditation arrangements, fragmented professional leadership, limited external scrutiny and weaknesses in continuing professional development assurance. The review highlighted widespread confusion among employers, professionals and the public regarding professional oversight and accountability arrangements.

These findings closely mirror many of the challenges identified within Clinical Technologist practice. They demonstrate that voluntary and non-statutory arrangements may be insufficient where practitioners exercise independent clinical judgement, undertake specialised technical practice and work in environments where errors may result in significant patient harm. The Kingdon Review therefore provides contemporary independent evidence that accredited voluntary registers can support professional standards but cannot alone provide the consistent system-wide assurance and public protection required for increasingly complex and high-risk healthcare practice.

This inconsistency is particularly evident within Nuclear Medicine services, where practitioners may undertake activities involving ionising radiation, prescription-only medicines and advanced imaging procedures without mandatory statutory registration. At the same time, inspection findings and incident reporting identify recurring concerns relating to competency assurance, entitlement arrangements and governance oversight.

The evidence further demonstrates increasing operational inconsistency arising from fragmented legislative and governance arrangements. Closely aligned clinical activities may operate under entirely different legal and accountability mechanisms depending on professional background, introducing avoidable complexity and inconsistency into high-risk clinical environments.

Taken together, the evidence demonstrates that current safeguards rely too heavily on variable local governance arrangements to compensate for the absence of nationally enforceable regulatory standards. The consequence is that patients may receive high-risk diagnostic and therapeutic care without consistent assurance regarding practitioner competence, training or regulatory oversight.

4.4 Residual Risks to Public Protection

The evidence demonstrates that significant residual public protection risks persist despite the mitigations currently in place. These risks arise not because safeguards are absent, but because they are applied inconsistently and remain dependent on voluntary participation and variable local governance arrangements.

The evidence demonstrates that this variability is not incidental, but inherent to a voluntary regulatory model that cannot compel participation or enforce nationally consistent safeguards across all employers and sectors.

[1] https://www.gov.uk/government/publications/kingdon-review-of-childrens-hearing-services-final-report/kingdon-review-of-childrens-hearing-services-final-report

As a result, there remains no consistent mechanism to ensure that all practitioners undertaking high-risk clinical activities meet nationally recognised standards of competence, training and accountability.

Nor is there a consistent mechanism to prevent individuals who choose not to participate in voluntary registration from continuing to practise.

This limits the ability of the wider regulatory system to provide consistent preventative assurance before harm occurs, particularly in high-risk and increasingly complex clinical environments.

As the complexity and clinical responsibility associated with practice continue to expand, the gap between the level of clinical risk associated with these roles and the consistency of regulatory assurance applied to them has become increasingly difficult to justify.

The evidence demonstrates that the current voluntary model can no longer deliver sufficiently consistent system-wide assurance proportionate to the contemporary risk profile of practice. The issue is therefore not whether safeguards exist, but whether they remain proportionate and sufficiently enforceable for the contemporary scope and risk profile of practice.

5. Assessment against PSA Standard 1b(iii): Misleading Advertising and Statements

The current framework creates increasing risk that patients and the public may reasonably assume that individuals undertaking highly specialised and high-risk clinical activities are subject to statutory professional regulation when this may not be the case.

‘Clinical Technologist’ is not a protected title, despite practitioners undertaking highly specialised and high-risk clinical activity. This means individuals may undertake highly specialised clinical activity associated with ionising radiation and prescription-only medicines without any legal restriction on use of the professional title. Patients may reasonably assume that professionals administering radioactive substances, operating advanced imaging systems or delivering molecular radiotherapy are subject to statutory regulation equivalent to other clinical professions working in the same environment.

This distinction may be particularly unclear where NHS roles are advertised interchangeably to HCPC-registered Radiographers and RCT-registered Clinical Technologists for the same patient-facing activities, including radiopharmaceutical administration, imaging, therapy and dosimetry. The public-facing and employer-facing signal is that both routes provide comparable forms of professional assurance, despite one being statutory and the other voluntary.

For example, Clinical Technologists in Nuclear Medicine may administer radioactive substances delivering radiation doses substantially greater than those associated with standard diagnostic radiography, despite not being subject to mandatory statutory regulation.

This inconsistency is particularly significant where professionals undertaking comparable clinical responsibilities may be subject to entirely different legal protections, registration requirements and accountability arrangements.

However, statutory regulation, voluntary registration and entirely unregistered practice may currently coexist within the same clinical teams and patient pathways. This creates increasing risks relating to public understanding, professional accountability and confidence that individuals undertaking high-risk clinical activities are subject to consistent regulatory oversight and nationally enforceable standards.

6. Conclusion

Clinical Technologist practice has evolved significantly beyond the limits of the current voluntary regulatory framework. Practitioners now undertake complex and safety-critical clinical responsibilities across a number of healthcare settings.

While important safeguards exist, current arrangements remain dependent on voluntary participation and variable local governance. This has resulted in substantial variation in competency assurance, accountability and regulatory oversight across sectors and organisations.

Taken together, the evidence demonstrates that the current voluntary model no longer provides sufficiently consistent or enforceable public protection proportionate to the modern scope, complexity and risk profile of Clinical Technologist practice. As the complexity and safety-critical nature of practice continue to expand, the gap between the level of risk carried by these roles and the level of statutory assurance applied to them has become increasingly difficult to justify from a public protection perspective.

Statutory regulation is therefore now necessary to provide consistent system-wide assurance, nationally enforceable standards and public protection proportionate to the realities of modern Clinical Technologist practice and the risks associated with contemporary healthcare delivery.

Annex A: Evidence of the immediacy and impact of risk to patients related to the lack of statutory regulation and modern Clinical Technologist practice

Context: This document will set out the immediacy and impact of the risks associated with modern Clinical Technologist practice. Its intended audience is a Professional Standards Authority Expert Panel who will score the arguments herein according to their merits. This document is not intended for lay persons, and therefore not for public circulation.

Contents of Annex A

Section One: Nuclear Medicine / Dual-Energy X-ray Absorptiometry Clinical Technologists

The Institute of Physics and Engineering in Medicine (IPEM) has its own Workforce Intelligence Unit (WIU). IPEM reports that, “Half of the UK’s Clinical Technologists are therefore able to practice unregistered, even though their work can involve serious risk to patient safety and wellbeing, for example through the use of radiation in diagnosis and treatment; and can continue to practice even if removed from the voluntary register or sanctioned by their employer.” [1] For context, this means that 50% of those eligible to join don’t, as it is voluntary and employers do not require it.

This contrasts with Health and Care Professions Council (HCPC) registration, which states that its regulation allows employers and service users to see that practitioners actively demonstrate their ability to conduct safe and effective practice in their profession. It promotes patient safety as the HCPC can act if professionals on the register do not meet the required standards.

Radiographers are HCPC registered due to risks commensurate with the use of ionising radiation and the potential consequences of negligence or malpractice either in diagnostic or therapeutic practice. Nuclear Medicine roles can be undertaken interchangeably by Clinical Technologists and Radiographers; the Society of Radiography is clear that “each has the same level of skill and knowledge”. [2]

Radiographer is a protected title with prescribed routes into the profession, settled education career frameworks, and within Nuclear Medicine is explicitly considered Enhanced Practice with Education Career Frameworks (ECF) for Clinical Technologists and Radiographers. [3] Enhanced Practice by definition relates to development beyond practice level (see ECF definitions), based on their clinical competence and knowledge, skills and attributes; normally underpinned by level 7 qualifications or modules. In contrast Clinical Technologist is not a protected title. Employers open themselves to challenge by requiring registration with a voluntary Professional Standards Authority (PSA) register. While training routes exist in the Practitioner Training Programme and IPEM Clinical Technologists Diploma in Technology – leading to registration with a PSA accredited register - there is no requirement for employers to use these schemes to hire a ‘Clinical Technologist’.

In addition, HCPC registration and maintenance is costly, and there may be no requirement to maintain registration, for example, a Radiographer in NM could work without the Health Care Professions Council (HCPC) protected title “Radiographer” as a Clinical Technologist while being unregistered. British Nuclear Medicine Society (BNMS) data demonstrates a mixed workforce with a deepening crisis in supply of trained operators making overseas recruitment vital for service continuity; “27% of post holders are non-UK citizens, double the rate found though out the NHS as whole”. [5] A recent Care Quality Commission (CQC) report documents issues with internationally trained radiographers needing additional training, “although registration with HCPC requires equivalence checks, new international

recruits may still need additional support. New international recruits may be less aware of requirements under relevant UK regulations and may not always have confidence in challenging more senior members of staff where there are concerns." [6] The Society of Radiographers has provided teaching and training materials for overseas Radiographers e.g. "The role of the Radiographer in the UK" which outlines a radiographer's requirements under HCPC, the career structure, the other professional staff groups they may encounter and other professional differences. Similar issues exist with overseas requirement of Clinical Technologists, compounded by the lack of HCPC equivalence checks or professional body resources to support transition. While equivalence routes to registration with a PSA accredited register exist, they are not mandatory, and employers must make their own assessment of competency. Recent data from 2023, supplied by IPEM WIU, confirms a 14% vacancy rate for Clinical Technologists in NM. In addition, "Nuclear Medicine departments are just about managing to provide an adequate service…Time for necessary activities such as training, and research and development, is also limited…It is currently challenging for Nuclear Medicine departments to recruit experienced staff: many need to recruit at lower bands, and train staff to the level they require. The current workforce climate in Nuclear Medicine is unsustainable and must be urgently addressed. Increased support for training and apprenticeships, particularly for Clinical Technologists, is required to reduce vacancies." [7] Limited time for training and an urgent need to recruit is coloured by a juxtaposition of 2023/24 CQC data, "There has been a substantial increase in the number of notifications compared with previous years (128 notifications, a 66% increase compared with 2022/23). The number of notifications related to diagnostic nuclear medicine examinations has more than doubled compared with 2022/23 (up from 23 to 59 notifications). [6] Notifications, "relating to incidents when preparing or administering radiopharmaceuticals has more than doubled" while some of that increase may be due to new recording stipulations the report recommends, "a need to ensure that staff have enough time and support to carry out a thorough second check of all doses." and records "time pressures" as being one of the factors attributed to errors. It also states, "There were also more operator errors relating to incorrect use of equipment and incorrect patient set-up, positioning, or selection of protocol." [6] Notifications include: failure to check history/details, failure to check pregnancy/breastfeeding, radiopharmaceutical administration and preparation errors, wrong patient position/set-up/protocol and wrong use of equipment. This resulted in improvement notices and recommendations under but not limited to:

- Regulation 17 & 17(4): regarding training records when and how they were deemed competent at each practical aspect they perform.
- Regulation 8: Implementing a study of risk for radiotherapeutic exposures, arrangements for clinically significant accidental or unintended exposures and notifying the enforcement authority.
- Regulation 6(2) and 6(4) ensuring written procedures are accessible to duty holders and that they comply with them, and that written clinical protocols contain enough information.

Improvement notices detailed were training records were incomplete, and operators could not demonstrate their competence to undertake practical aspects they performed. Where there was no study of the risk of accidental or unintended exposures for therapeutic NM procedures and where many procedures, protocols and policies did not reflect clinical practice or referred to out-of-date regulatory terms. [6] Registration entails a structured, assessed and documented record of competency across a scope of practice coupled to a standardised training base, accompanied with the need for accredited courses and ongoing continuing professional development which may have helped address some of these issues. Inspection reports from the devolved nations document similar themes involving clarity around entitlement, documentation of training and competence, “all staff who act as a referrer, operator or practitioner outside the nuclear medicine department are appropriately entitled to do so.” [8] The need for “confirmation of their entitlement to confirm what duties they can perform.” [9] and the need for “learning and shared information between...sets of employer’s procedures relating to nuclear medicine, medical physics and radiopharmacy.” [10] Reports frequently highlight the need for evidence of competence and that, “entitlement is underpinned by evidence of training and competency in line with individual scope of practice” [11] and also that “entitlement is under the current IR(ME)R regulations and there is a clear well defined scope of practice outlined.” In this context, it is clear that implementation of a registration scheme would provide a mandatory framework for training, competence and continuing professional development that would benefit departmental governance as well as patient, staff and public safety [12] As well as concerns around the preparation and administration of radiopharmaceuticals, specifically the need for, “workforce planning to ensure a second person is always present to carry out independent checks when administering radiopharmaceuticals.” [13] This is also borne out by fitness to practice findings from the RCT e.g. maladministration and recording of a radioisotope. [14] These themes may reflect the not only the stresses on the workforce but a lack of consistency in standards of training which may only be addressed through statutory regulation, as training schemes linked to voluntary accreditation are optional.

Approximately half of the UK Operator workforce in NM do not have a Radiography background. [15] Differences between the professional groups in multi-disciplinary teams may lead to inter-professional hostility and there is evidence of discord between the two groups in NM. This hostility “may emanate from a perception of inequality due to Radiography being statutory regulated.” Technologists on a PSA voluntary register have expressed that the status of their register undermined their professional status. [15] The combination of a high national vacancy rate, a reliance on oversees workers, a mixed workforce featuring mandatory, voluntary and no regulation, a lack therefore of consistency regarding education, training, assessment, and inconsistent regulatory frameworks with differing documentation requirements are exposing patients to a cocktail of risk. Standardisation of education and training routes that lead to statutory registration, and hence a unified legislative framework is required to support a workforce that

continues to adapt to rapid changes in Technology and clinical practice of increased complexity, and to support service delivery and therefore patient safety.

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What do Nuclear Medicine Technologists do?

For context, Radiographers must by law have statutory registration for administering the small doses of ionising radiation associated with the plain film x-ray modality. Clinical Technologists in NM administer significantly higher doses of ionising radiation, in the form of radioactive substances. A plain film chest x-ray dose is typically 0.02mSv while a Nuclear Medicine myocardial perfusion scan using Thallium-201

(^{201}Tl) gives 18mSv (a factor of 900). [2]A useful comparison may be made between a Computed Tomography (CT) scan of the chest at 8mSv and a NM myocardial perfusion scan using ^{201}Tl (a factor of 2). 18mSv equates to a lifetime additional risk of fatal cancer per examination of 1 in 1100. [1] Clinical Technologists routinely administer intravenous prescription only medicine (POM), perform Single Photon Emission Computed Tomography (SPECT) & CT scans and Positron Emission Tomography (PET) / CT. They operate under a Statutory Instrument, The Human Medicine Regulations 2012 to give POM. Including radioactive POM which they prepare and administer via a variety of routes though mostly intravenously. [2] Specifically, there is provision in Regulation 240 for IR(ME)R operators to administer POM required as part of the NM procedure e.g. diuretics for a Renogram or cardiac stress agents for myocardial perfusion scan. [3-5] A wide variety of non-radioactive POM are given by Clinical Technologists in NM, many with potential adverse effects including but not limited to: hypotension, tachycardia, bradycardia, angina, or respiratory depression, acute coronary syndrome, bronchoconstriction and anaphylaxis. [6-10] Clinical Technologists acquire and process the images from advanced hybrid scanners and are responsible for monitoring the patient to obtain quality diagnostic images across a broad range of medical conditions, many of which present challenges and risk across vulnerable groups [11] such as: paediatrics, patient with suspected dementia and Alzheimer's disease and during pregnancy. [12-15] Common risks from poor Clinical Technologist practice include misdiagnosis, extravasation injures which may lead to large, localised radiation doses and related tissue damage [16-20] and similarly equipment misuse can lead unintentional high doses of ionising radiation in brief time frames. [21 - 22]

To give context to the risk authoritative sources state, "that even the lowest dose of ionising radiation, whether natural or man-made, has a chance of causing cancer. The extra cancer risk from very low doses will be extremely small and, in practice, undetectable in the population. However, the extra cancer risk at higher doses may be detectable using statistical methods." This is a stochastic process; where the probability of excess cancers being induced increases with the dose of radiation received, but the severity of the effect is independent of the dose; essentially meaning that even low doses of radiation can potentially cause cancer, but the likelihood of it happening is low and increases proportionally with the dose received. [22-23] This is opposed a deterministic effect; which are health effects that occur at high doses of radiation, where a significant number of cells are killed or damaged, leading to observable tissue damage and impaired organ function, and are characterised by a threshold dose below which no effect is seen, with the severity of the effect increasing with the dose above that threshold; essentially, the higher the radiation dose above the threshold, the more severe the tissue damage will be. [24]

[2] ARSAC notes for guidance state an equivalent dose of 11.2mSv, a factor of 560. Notes-for-guidance-on-the-clinical-administration-of-radiopharmaceuticals-and-use-of-sealed-radioactive-sources.pdf (publishing.service.gov.uk)

As registration is not required by law, with education and training routes that are varied and not specific, standardised competence and continuing professional development to maintain competence is an ongoing risk that may be mitigated via statutory regulation leading to a protected term e.g. Nuclear Medicine Technologist from approved accredited education providers.

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Risks associated with the manufacture and dispensing of Radiopharmaceuticals

Radiopharmaceuticals are essential for medical imaging and therapy in NM. Good Manufacturing Practice (GMP), systems of quality assurance and control both internal and external are routinely employed to ameliorate the risks associated with their production and administration. However, guidelines on good radiopharmacy practice for the preparation on radiopharmaceuticals note the important role personnel play in avoiding adverse product quality. Specifically, there must be sufficient personnel with the necessary education and appropriate training and experience. [1] Risk from poor practice and training includes: particulate and bacterial contamination; mix ups resulting in inappropriate radiochemical synthesis, chemical purity or QC testing resulting in inappropriate release of medicine, which is particularly critical when labelling blood products from multiple patients for subsequent reinjection. For most radiopharmaceuticals, it is often impossible to obtain results from specific tests,

such as sterility testing, prior to the release of the product. Nonetheless, these tests are essential for monitoring the preparation process. [1] It is crucial to highlight that, in the case of diagnostic radiopharmaceuticals, the risk of microbial contamination significantly surpasses the risks associated with radioactivity.

Adverse events with the use of radiopharmaceuticals do occur, although it is assumed in literature that they are rare in comparison with other pharmaceuticals. This can be attributed to the low doses —mostly in the order of micrograms—and the absence of pharmacologic effects for most radiopharmaceuticals. [2] In a systematic review, a reported median frequency of 1.63 adverse events per 100,000 administrations based on 22 studies of diagnostic radiopharmaceuticals. [3] However this may be an underestimate based on the method of reporting. A recent study demonstrated that the frequency of patient-reported adverse drug reactions to diagnostic radiopharmaceuticals is significantly higher, reported to be 2.8% in sample of 1002. [2]

Studies also demonstrate that a large proportion of maladministration's are due to errors in radiopharmaceutical production. [4] The highest risk is in the maladministration of therapeutic radiopharmaceuticals with clinically significant consequences e.g. unintended hypothyroidism. Research indicates that practitioners, such as Technologists, are directly involved in a large proportion of maladministrations. [5] The preparation of radiopharmaceuticals has been highlighted as a particular vulnerable task with errors attributed to deficits in training as well as unpredictable workloads in a dynamic environment. [6]

The use of multi-dose vials in NM: this involves the manufacture of radiopharmaceutical kits. Often multi-dose vials may be split between more than one site – for example, a lung imaging kit may be manufactured and then an aliquot transferred into a second sterile nitrogen-filled vial. [7] These are often used in NM e.g. a preparation in a multi-dose vial used throughout the day depending on the patients' arrival time. Risk arises from the fact that the product will be sub dispensed to multiple patients. Therefore, the effect of error in preparation could affect multiple patients or even multiple patients across multiple sites. Compliance with hygiene recommendations and GMP in the radiopharmacy has been reported to be difficult to achieve because of the challenges associated with radiation protection. [8] Consequently, patient safety depends upon compliance with all the relevant hygiene safety measures e.g. strict aseptic techniques, having staff trained in order to avoid any contamination during the preparation of a radiopharmaceutical, as well as during the dispensing dose for a patient. [8] Non-compliance rates with matters of hygiene and radiation protection have been studied, with remedies focused on training to better promote patient-centred care in NM. [9]

It has also been demonstrated that risk of unnecessarily irradiating Paediatric patients is linked to the skill and experience of the staff preparing and administering the radiopharmaceuticals. Significant deviation, greater than ten percent of the prescribed radioactivity, being a likely occurrence. [10]

This document has already demonstrated a crisis in supply of trained operators in the UK, a high reliance on overseas recruits, a persistently high vacancy rate for Clinical Technologists, coupled to limited time available for training and a correlating increasing rate of notifications to inspectors with specific concerns noted around the preparation and administration of Radiopharmaceuticals.

Training schemes that instil patient centred care, externally test and document the practitioner's skill base and underpinning scientific knowledge that led to registration on a voluntary PSA register e.g. IPEM Clinical Technologist Training scheme. However, they are not compulsory and exist in within a workforce that features mandatory, voluntary and no registration with inconsistent education and training routes.

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Risk to patients through complex and inconsistent regulatory frameworks, leading to uneven service and associated risk

Clinical Technologists are hampered due to the legislative frameworks only open to Allied Health Professionals, for example, they cannot use Patient Group Directives (PGD) [1]. Which would be useful for giving IV CT contrast. Regarding IV contrast, the dose of ionising radiation may not be said to relate directly to the injection of radioactive POM, therefore Clinical Technologists are not authorised to operate under the normal statutory instrument. Instead, they must operate under a Patient Specific Directive (PSD). This inconsistency within the workforce is a source of confusion and can lead to delays to diagnostic scans. Radiographers can and do use IV contrast under a PGD. The undesirable situation arises where both groups on the same work floor must operate under two separate systems of work for the same endpoint for the patient. In addition, to be a Practitioner under the Ionising Radiation (Medical Exposure) Regulations 2017 (IRMER), one must be a registered health care professional e.g. on a HCPC register. This can have a deleterious impact on the patient journey, for example, while acting as an operator, if it was obvious that a patient required an additional exposure, Radiographers may act as an IR(ME)R Practitioner and justify the exposure, while Clinical Technologists cannot, as current IR(ME)R legislation does not recognise PSA registers. They may only function as Operators under IR(ME)R. [2] Similarly, Clinical Technologist working as Advanced Clinical Practitioners (ACP) e.g. administering Molecular Radioligand Therapy, while they may have Fellowship as part of the UK National Cancer and Diagnostics programme, and / or an ACP accredited Masters, they cannot act as a referrer under IRMER. They routinely give exceptionally large, therapeutic doses of ionising radiation yet they cannot ask for a plain film chest x-ray required as part of their role for contributing to MDT meetings. These inconsistencies in the workforce all introduce confusion and delay with its subsequent risks into the patient journey.

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Risk from unsealed radioisotopes to skin re-evaluated

Risk from doses of ionising radiation to the skin from radioisotopes commonly used in NM e.g. ^{99m}Tc or ^{18}F radiopharmaceuticals have been re-appraised recently, demonstrating that much higher doses to skin take place from mishandling even small amounts.

Risk from doses of ionising radiation to the skin from unsealed sources have been known about for some time. [1] However updates from the Health & Safety Executive (HSE), based on new understanding & modelling, have resulted in enforcement actions if doses exceeded 150mSv. [2] As a result the UK has seen a mass-classification of Clinical Technologists and Radiographers dispensing or administering radiopharmaceuticals to comply with Ionising Radiation Regulations (IRR 2017) Regulation 21. [3-4] Direct skin contamination from mishandled droplets of unsealed radiopharmaceuticals can often lead to percutaneous absorption. [5-6] New modelling has demonstrated that even low activities from mishandled droplets of common radiopharmaceuticals can lead to unintentional high radiation exposures to skin. Percutaneous absorption of 1.5MBq of ^{99m}Tc or 0.23MBq of ^{18}F can lead to 500mSv to the skin. [7-10] For comparison, activities commonly used in the NM environment by Clinical Technologists are routinely, ^{99m}Tc 800MBq and 400MBq ^{18}F when imaging the myocardium. [11] In addition, therapeutic radiopharmaceuticals such as ^{223} Ra, ^{212} Pb & ^{225} Ac have been assessed as being able to deliver 500mSv for activities as low as 9 – 177Bq for the trunk, face, arm, legs, wrist & hand. [12] For reference, UK Gov provide a comparison of doses from exposure. [13]

Mishandling of unsealed radioactive pharmaceuticals, even in low activities, or regarding therapeutic agents, extremely low activities can lead to unintentional high ionising radiation exposure to patient's skin. This has serious implications for the training of staff. For example, a private healthcare company was recently fined "£120,000 and ordered to pay costs of £11,382 at Leeds Magistrates' Court on 29 September 2022" due to incidents with contamination where the skin dose received was more than the annual dose limit as defined by the Ionising Radiation Regulations. [14] The Society of Radiography noted, "This Health and Safety Executive (HSE) report highlights the need for the radiographic workforce using radioactive material to be adequately trained and for staff requiring supervision to be appropriately managed." Recent CQC reports that 32% of all notifications in NM were from independent healthcare providers. [15] While national programmes exist for the assessment and certification of skills associated with defined Scope of Practice in NM for Clinical Technologists, which are linked to Registration with PSA registers, neither the training nor registration is mandatory either for the NHS nor for private healthcare providers.

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Risk from the rapid development and deployment of hybrid imaging techniques including the use of power injectors and IV contrast

Risk to patients has been elevated by recent technological advancements in NM that have outstripped a co-ordinated response in guidance, standards, and the provision of suitable education. The rapid evolution and deployment of modern multi-detector Computerised Tomography (CT) scanners in NM and therefore hybrid techniques have already redefined working practice in the multidisciplinary team. [1] Guidance produced by the Society of Radiographers (SoR) in 2016, called for the appropriate development of the scope of practice of Nuclear Medicine Technologists to perform this aspect of their

work as CT examinations have the potential to deliver high doses of ionising radiation in brief periods. [2] The knowledge and skillset to practice safety in both PET / CT and SPECT / CT was captured in new National Occupational Standards (NOS) that defined competency in the field in 2019. [3-4] IPEM Professional Standards Council (PSC) responded by updating their Diploma in Technology to reflect the needs of a rapidly evolving workforce in 2022. [5] IPEM provides a primary training route that aims to satisfy these NOS and certify the skillset of Clinical Technologists, which leads to registration with the RCT, a PSA accredited register. However, these programmes and registers are not compulsory.

It has been 20 years since clinicians began to consider the benefits of IV contrast enhanced PET-CT. Increasingly NM departments in the UK are incorporating the use power injectors & IV contrast in standard operating procedures e.g. parathyroid Sestamibi SPECT-CT combined with 4-dimension-CT, for example, for preoperative localisation of parathyroid adenomas or hyperplasia. [6] The SoR actively support their members; providing outlines and certification for Higher Education Institutes (HEI) as it relates to competence in skills such as administering IV injections and specifically IV contrast. [7] Radiographers differ from those who train directly as Technologists; as Health and Care Professional Council (HCPC) registrants they are enabled to use Patient Group Directives (PGD). Nuclear Medicine Technologists, having voluntary Professional Standards Authority (PSA) accredited registers, currently must work under a different medico-legal framework e.g. Patient Specific Directives. To support the rapid evolution of the Clinical Technologist practice in NM, IPEM piloted a skills workshop for the Framework of IV contrast in NM in 2024. [8] The workshop had excellent uptake from centres across the UK and is expected to run annually. The risk to patients from the use of power injectors are well documented; the potential for very high pressures generated from injectors (300 – 325 PSI), the risks of extravasation of IV contrast media – reported incidence 0.1 – 0.9% which can rarely lead to compartment syndrome, skin ulceration and tissue necrosis, with air embolus from large amounts of air possible. [9-11]

The use of IV contrast media also has well documented risks; the most serious of which is anaphylaxis, but other risks also include acute kidney injury, bronchospasm, bradycardia, and hypotension.

11% of fatal anaphylaxis in the UK is caused by contrast media. [12] Anaphylaxis is a serious systemic hypersensitivity reaction that is usually rapid in onset and may cause death. Where anaphylaxis is fatal, death usually occurs soon after exposure to the trigger [13]. Deaths caused by IV medication occur most commonly within five minutes. [14] It is therefore essential that Clinical Technologists are trained to administer intramuscular adrenaline (the definitive treatment for anaphylaxis). [15]

Adrenaline is a prescription-only medicine (POM) and as such has restrictions around who can administer such drugs. According to Regulation 238 of the Human Medicines Regulations 2012 Clinical technologists may be entitled to administer POM for the purpose of life saving in an emergency, but

robust training programmes and systems to demonstrate skill equivalence are essential for working in this capacity.

It is essentially that Clinical Technologists be able to recognise a deteriorating patient, assess and respond to adverse physiology e.g. have access to oxygen, IV fluids, atropine, and nebulisers. [17-18]

The IPEM course for IV contrast recommends nominating centres consult with their Resuscitation Officers regarding specific Clinical Technologists suitability for UKRC Immediate Life Support courses as its content covers the recognition and assessment of the deteriorating patient and the treatment of anaphylaxis. [8] As already stated, there is no mandatory requirement for Clinical Technologists to use professional body training programmes to certify skills, nor to obtain any form of registration – entry to which does at least tests across a defined scope of practice and requires continual professional development.

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Risks from NM Technologist Advanced Clinical Practice

Advanced Clinical Practice (ACP) in NM by Clinical Technologists is a mature and internationally recognised field. [1 – 5] As Technologists advance in their career they may manage the quality control programme of imaging equipment, give intradermal and subcutaneous injections for lymph node localisation for breast, head and neck, melanoma and gynaecological cancers. [6] NM Technologists may become advanced or even consultant practitioners with specific areas of expertise. [6] Three areas of ACP are notable; leading cardiac stress tests for myocardial perfusion, reporting (including of DXA) and molecular radiotherapy.

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Cardiac Stress Testing for Myocardial Scintigraphy is an example of established advanced practice delivered in the UK by Clinical Technologists. Simple, non-pharmacological, stress testing has a well-defined risk profile and established clinical consensus documents around 1 death and 4 major complications per 10,000 tests. Major complications include Myocardial Infarction (MI), pulmonary embolism, cardiogenic shock and significant dysrhythmias. [1]

Quantified Risk

The skill level of non-medical staff undertaking a medical task should be commensurate to that of a doctor. [2] Stress testing for myocardial scintigraphy is commonly complicated by the use of pharmacological stress agents e.g. IV POM. Specifically, these include vasoactive agents such as Adenosine, Regadenoson or inotropic and chronotropic agents such as Dobutamine and Atropine. Risk of MI or serious arrhythmia from Adenosine stress is higher than that of simply exercise with an incidence rate of 7%. [2] Dobutamine is similarly higher with an incidence rate of MI or serious arrhythmia in 4.2% of tests. [3] MI, Acute Coronary Syndrome (ACS) and symptomatic ST elevation of >1mm has similarly been documented with Regadenoson stress with an incidence rate of 0.2 -1% [4] Regadenoson commonly causes rhythm and conduction abnormalities, 26% incidence. However, second degree AV block and ventricular conduction abnormalities are less prevalent, 0.1% and 6% respectively. [5-6]

Guidelines therefore clearly state, "Clinical competence in the care of the acutely ill patient is an essential skill for non-medical staff that are training to perform myocardial perfusion stress tests whether exercise or pharmacological". [2] The required skillset includes: physical assessment of the cardiovascular and respiratory systems coupled to structured communication techniques. Guidelines are specific; "Experience and understanding of inspection, palpation, percussion, and auscultation are skills,

which are not included in the basic training of a number of non-medical professionals. Existing guidelines however do include this level of skill as a necessary competency of non-medical staff that performs stress tests. In English law, non-medical staff that adopt a medical responsibility will be compared to the usual practice of a doctor performing the same responsibility." [2]

Knowledge of comorbidities and associated polypharmacy and its impact on stress testing is essential. 12 Lead Electrocardiograph interpretation with knowledge and expertise associated with the ECG changes associated with the mode of stress selected. [2, 3, 6, 7]

Patient specific selection / justification of a suitable methods of stress is required. As it the recognition of the deteriorating patient and selected use of therapies, for example, POM, to immediately correct potentially life-threatening adverse physiology, for example, ACS, brady and tachy arrhythmias. Immediate Life Support (ILS) to Advanced Life Support (ALS) training in resuscitation is required with ILS being suitable only, "provided that there is rapid access to personnel trained in ALS and that appropriate assistance and emergency support is available." [2]

Training for Clinical Technologists in this specific area of advanced practice has been delivered via numerous routes; FHEQ Level 7 15 credit modules e.g. via Salford University or previously Guys and St. Thomas (Representative of City University London).

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Reporting by non-medical professionals, specifically Technologists & Radiographers, is an established and evolving field of advanced practice that has revolutionised the cost-effectiveness and time management of patients. [1-9] Practitioners (Reporters) work within an agreed extended Scope of Practice which may encompass the summation of information from: multiple related scans / procedures; pre-test clinical assessments, exercise tolerance electrocardiography and physiology data as well as the patients' clinical history to form salient assessments of risk with recommendations. Practitioners (Reporters) must gain skill and knowledge in: applied anatomy, physiology, and pathological processes for several body systems, understanding of normal patterns of uptake, normal variants, and appearance of pathology vs artefact, relevance of findings to patients' management as well as understanding the moral and ethical principles related to image interpretation. Higher education institutes offer training and assessment programmes to Clinical Technologists in this area, normally associated with 15 credits at FHEQ level 7. [10 – 11] The RCR define risk regarding reporting as "the possibility of incurring loss or injury or injury as a consequence of medical care". As an example of the risks associated with reporting: false positive myocardial perfusion scan may lead to patients undergoing unnecessary invasive coronary angiography which has a 1 in 100 chance of causing death or myocardial infarction. A false negative may lead to a diagnosis of non-cardiac chest pain which accounts for a third of those who die within 5 years of follow up (3 in 100). [12-13] Registration entails a structured, assessed and documented record of competency across a scope of practice coupled to a standardised training base, accompanied with the need for accredited courses and ongoing continuing professional development which address some of these issues.

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Dual Energy X-ray Absorptiometry (DXA)

Nuclear Medicine Technologists across the UK regularly include DXA as part of their routine practice. The RCT also has a dedicated Scope of Practice for those Clinical Technologists for whom DXA is their singular focus.

The Care Quality Commission (CQC) require staff to be qualified, competent, skilled, capable and experienced as part of their regulations, Clinical Technologists who act as DXA operators can enter this profession via a multitude of pathways, many of which do not always have a mandatory level of educational qualification or training, this means these requirements are not always met.

The safety and wellbeing of patients and staff should always be the top priority for any healthcare provider. It is imperative for all staff members working with ionising radiation to undergo rigorous training and

continuous education to ensure they are well-equipped to undertake examinations effectively and safely. Failure to provide adequate training and support in this regard is a clear violation of Ionising Radiation Regulations [IRR] [1] and Ionising Radiation (Medical Exposure) Regulations [IR(ME)R] [2] There are instances where staff with no training have performed scans which has resulted in formal grievance being pursued by Unite. (See **supplemental material - Primary grievance letter – redacted**) The CQC received four formal notifications regarding DXA in 2023/2024. [3] Their recommendations included that 'Employers need to ensure that procedures, protocols and guidance for staff are up-to-date and effective, and to improve processes when investigating incidents'. Also, IRMER Regulation 17 states the need to have up-to-date training records available as evidence of adequate training.

A key element of DXA practice is consistency and accuracy, with evidence-based recommended best practice, produced by the Royal Osteoporosis Society (ROS). [4] The reliability of DXA scan results is very dependent on the skill of the operator therefore a rigorous approach is essential to deliver quality requirements. Unreliable measurements are obtained if, for example, the patient is not positioned correctly, incorrect analysis and inclusion / exclusion of appropriate vertebrae for reasons including degenerative changes, fractures, artefacts etc.

Although the DXA images are not diagnostic in themselves, Clinical Technologists do require a broad knowledge of what normal anatomy is and when to highlight pathology. Clinical Technologists acquire and analyse the data produced by the DXA scanners and are responsible for ensuring they obtain quality images. Patient population can present challenges in terms of acquiring the scan, for example, elderly patients with multiple co-morbidities including debilitating illnesses causing reduced mobility, breathing issues (for example orthopnoea) and dementia patients.

76% of operators have accredited training [6]. The majority of this training was through the ROS' National Training Scheme for Bone Densitometry [5], which is not supported by any government funding, so has cost implications for departments. It is also not mandatory, and Technologists have a requirement to have already gained scanning experience before attending the course. This means that local training programs are paramount to ensure that the staff are suitably trained and supervised prior to being assessed as competent to scan solo and unfortunately this is not always the case, which results in in-experienced staff scanning without supervision.

The ROS All-Party Parliamentary Group (APPG) DXA facilities report showed only 12% of DXA services are accredited by UKAS. [6] Lack of accreditation this means that the quality of services being delivered are not assured.

Many DXA centres also lack clinical supervision. Clinical concerns can normally be raised and discussed with an appropriately trained clinician, therefore ensuring that correct policies and procedures are produced and adhered to. This also ensures that appropriate referral reasons are present and an appropriate time frame since previous scans has been achieved to prevent unnecessary radiation exposure. Nearly half of DXA services in the UK do not meet the clinically recommended 6-week timescale for referral to scan. Furthermore, significant numbers of services are in breach of their national diagnostic standards. Similarly, nearly one third of services in the UK (notably, 50% in Wales) are not delivering reports within the clinically recommended three-week timescale. These cumulative delays result in a delay in treatment for many patients who, if they have just had a fracture, are at their highest risk of having another one. [6]

Wes Streeting, Secretary of State for Health and Social Care, has reiterated his commitment to delivering universal Fracture Liaison Services (FLS) across England by 2030. This will impact on services as FLS assessment will lead to an increased number of referrals for DXA to assess those who have already suffered a fracture, with an aim to prevent further fractures. Increasing demand may further increase wait times, leading to further underqualified staff being utilised to meet the demand for scan acquisition and reporting.

Reporting DXA again has no formal requirements, although would fall under IR(ME)R as clinical evaluation and is a statutory requirement of IRMER Schedule 2, and there is a significant difference in the content and advice given in DXA reports between centres. The reports however rely on the scan analysis being correct and with some centre's reports produced by non-DXA professionals it falls to the Technologists to ensure the information provided to the reporter is accurate. Clinical management decisions are based on this information and analysis which can impact on a patients fracture risk and overall outcomes and management.

The ROS does have a quality standard for reporting DXA in adults. [7] It states a healthcare professional reporting DXA scans must be adequately trained and entitled to act as an operator in accordance with IR(ME)R, with a clearly defined scope of practice and have completed post registration level 7 education and training to support DXA reporting, undertake regular audit of their practice and work within a multidisciplinary team and engage in continuing professional development (CPD). The Health Education England standard is that professionals undertaking this should be from a regulated professional group.[7]

An increasing number of Clinical Technologists are now reporting DXA scans, but many centres do not require approval by trust ‘Advance in Practice’ boards to ensure the trust is aware of this reporting and are satisfied with the training and audit processes in place. Derby University currently offer the only formal reporting training via their ‘DXA Reporting for Clinicians –PG Cert’ [8] qualifications but this is often

oversubscribed and not all staff who report have undertaken this or a local process of equal robustness. The ROS Primary Care Inquiry found that GPs had low levels of confidence in evaluating fracture risk, interpreting DXA results and communicating them to patients. They relied heavily on the expert DXA report. [6]

The Royal College of Radiologists and the Society and College of Radiographers recommend that all reports generated from a radiological examination must be 'actionable' for the referring clinician – meaning that they contain recommendations upon which a clinician can take clinical decisions. [9] This is in accordance with the IR(ME)R 2017 which states that a clinical evaluation (the report) must be recorded for each radiation exposure. [2] However a Freedom of Information (FOI) request by the ROS in 2023 showed 47% of services did not include individualised management advice in their reports to referring clinicians and 47% of centres did not include a statement defining the patient's fracture risk. Only 31% of reporters (medical or non-medical) have received accredited reporting training. There is clearly a significant gap in appropriate training, and this could be addressed by formal registration. [6]

As DXA scanners are also used outside of the NHS the issues seen also pertains to the private sector and research settings where conformity and adherence to regulations, appropriate policies and procedures and adequate training may not have the same priority. For example, reports are often not produced; with the patient provided only with the scanner image and result printouts. (Supplementary document 2)

By including DXA Technologists on a statutory regulated register this would ensure that all centres performing DXA scans will have appropriately trained staff who adhere to the registers code of conduct, which requires all registrants to work within the limits of their knowledge and skills. This would providing safe working practices and accurate reporting thus ensuring the safety of the public when scans are performed and reported.

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Molecular Radiotherapy (MRT), and the risk from extravasation of therapeutic isotopes

In certain departments across the UK, NM Clinical Technologists serve as the leaders for therapy services, taking on the role of operators for the administration of therapeutic radiopharmaceuticals. Which if mishandled, could expose patients to harmful ionising radiation, resulting in severe health issues such as radiation burns, increased cancer risks, or incorrect diagnoses.[1]

To help put the doses used in this rapidly expanding and evolving field into perspective, the radiation dose from a standard chest X-ray is around 0.02mSv, whereas the NM diagnostic scans associated with patient work up e.g. a whole Body FDG PET/CT scan delivers approximately 7.6mSv, a factor of 380. An equivalent dose would be given from a CT of chest, 8mSv. [2,3] Administering an incorrect dose of FDG in PET/CT could result in either excessive radiation exposure or poor-quality images, potentially causing harm to patients or leading to inaccurate diagnoses. The same principles apply to treatments like Lutetium-177 (^{177}Lu) therapy for neuroendocrine tumours; errors in calculating radiation doses could lead to ineffective treatment or excessive radiation to healthy tissues, raising the risk of long-term complications, including potential severe tissue damage such as skin desquamation and necrosis. [4,5]

Extravasation occurs when a radiopharmaceutical, intended for intravenous administration, leaks into surrounding tissues instead of remaining in the blood vessel. This is particularly dangerous in Molecular Radiotherapy, where therapeutic doses involve elevated levels of radioactivity, such as in ^{177}Lu therapies. Some cases of tissue damage following the extravasation of diagnostic radiopharmaceuticals have been reported, which may result in significant localised radiation exposure to surrounding tissues leading to radiation burns, necrosis, pain, and long-term complications such as fibrosis or poor healing. [4,6] For example, extravasation of Radium-223 (^{223}Ra) can lead to severe injuries, including tissue necrosis.[7] It is also important to consider the concomitant drugs, especially amino acid infusions, which are commonly administered to safeguard the kidneys from radiation exposure. The extravasation of these solutions or other infusion drugs may result in skin complications due to their hyperosmolarity, necessitating careful monitoring and follow-up. [8] Furthermore, the intended therapeutic effect may be compromised if the full dose does not reach the target tissue, leading to treatment failure. [1]

Quantified Risk of extravasation

Several studies have connected dose values of ionising radiation to the effects that were observed. Some studies have demonstrated that a threshold dose of 20 Gy is required to identify radiation-induced damage resulting from the extravasation of radiopharmaceuticals into interstitial tissue. Furthermore, additional research has noted skin injuries and desquamation occurring with doses between 20 and 40 Gy during the extravasation of Yttrium-90 (^{90}Y) Ibritumomab Tiuxetan. The International Commission of Radiological Protection (ICRP) has reported a threshold of 3 to 6 Gy for deterministic effects on the skin. [9] The International Atomic Energy Agency (IAEA), defines a deterministic effect as, “a health effect that requires a specific level of exposure to ionizing radiation”. [10]

Technologists require multi-system advanced clinical skills, including physical assessment, cognitive and communication skills to consult with and assess patients, obtain consent, perform risk assessments, liaise with the IRMER Practitioner licence holder, Medical Physics Expert (MPE) and the Multi-Disciplinary Team (MDT). This may include organising appropriate imaging / pre-therapy biochemistry, delivery of therapy and adjuvant POM with associated clinical examination and management of side effects, through to discharge of the patient with organisation of restrictions. Post therapy procedures, for example, Somatostatin analogue injections and post therapy imaging, with its associated interpretation. As necessary, in tandem with the MDT, refers to other modalities, including hospice. Examples of the type of deleterious outcomes from one therapy ^{223}Ra Xofigo, apart from extravasation, include commonly (1 in 10) osteonecrosis, leukopenia, neutropenia, and pancytopenia. Less commonly (1 in 100) osteonecrosis of jaw or lymphopenia. [11]

MRT is expected to have an increasingly significant role in a rapidly evolving oncology landscape. Effective delivery of MRT in the UK is dependent upon having “sufficient, highly trained workforce who understand and adhere to appropriate ionising radiation regulations.” [12] NM Technologists are already at the forefront of service delivery and are an integral part of a workforce that is attempting to tackle the current challenges of inequitable service delivery in the UK. [13]

CQC data from 2023/24 highlighted concern in specific areas relating to pregnancy and molecular radiotherapy. [14] An investigation was triggered following an administration of a therapeutic doses ^{131} Iodine to treat benign thyroid disease to a patient in their third trimester of pregnancy and a prohibition notice against the service was issued – as pregnancy in this case is an absolute contraindication. In this case there was no training records to show how the operator had been deemed competent to complete any aspect of the practical aspects associated with treatment. There were notifications of three similar incidents involving administration to pregnant patients. The report highlighted the need to ensure

“operators involved in administration are trained, competent and entitled to council patients at risk, understand the risks involved and administer the radiopharmaceutical safely”.

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Advanced Clinical Practice (ACP) Accreditation and Registration

Regarding ACP, there are schemes to accredit practice in England & Wales either via an accredited ACP Masters or via an equivalent eportfolio route. These are currently being utilised by a portion of the Clinical Technologists workforce in NM. [1-3] No four-nation approach exists and therefore it cannot be considered as a surrogate for statutory registration. Indeed, HCPC has taken the position that outside statutory regulation “the case for additional regulation of advanced practice had not been made.” [4] However this position does not address Clinical Technologists within the NM workforce. Those that are on a PSA accredited register have demonstrated knowledge, skills and understanding at the point of registration e.g. early career and certainly not at enhanced, advanced or consultant level of practice. Those on a PSA register will at least have the requirement to record continuing professional

development. Once again, none of these schemes are compulsory or required by law, as is the case with statutory regulation.

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Regarding Nuclear Medicine Clinical Technologists (NMCTs), the lack of statutory regulation for presents significant risks to patient safety due to inconsistencies in education, training, competency assessment and regulation, regulation and systems of work. Despite the high levels of responsibility NMCTs hold, their role remains unprotected by law, unlike their Radiographer counterparts who are regulated under the Health and Care Professions Council (HCPC). This lack of standardisation and mandatory registration across the workforce introduces variability in service quality that may compromises patient care. Risk of using inappropriately trained staff is compounded by workforce shortages, reliance on overseas staff, and inconsistent professional development pathways with around a third of notifications to regulators coming from the non-NHS facilities.

The need for statutory registration is clear, particularly given the rapidly evolving technological landscape and advances in Clinical Practice of Technologists within Nuclear Medicine. Advanced imaging techniques, the use of IV contrast, and the administration of high-dose therapeutic radiopharmaceuticals require practitioners to have up-to-date skills and knowledge. Without a regulatory framework ensuring ongoing competence and safety, both patients and practitioners are exposed to unnecessary risks, including misdiagnosis, extravasation injuries, and improper radiation handling resulting in high skin doses.

To address these challenges, mandatory registration for NMCTs is imperative, ensuring that all practitioners meet consistent standards of education, training, and ongoing professional development. This would not only safeguard patient safety but also enhance the professional identity of NMCTs, providing them with the recognition and regulatory support that reflects their critical role in healthcare. This may be important to address conflict within mixed teams and subsequent negative spill over onto patients. Standardisation through statutory regulation will ultimately ensure that the Nuclear Medicine workforce is equipped to meet the demands of an increasingly complex and essential field of practice.

Supplemental DXA source material - primary grievance letter - redacted

- I have done my utmost to ensure the integrity of the clinic, as well as creating a safe working environment for all members of staff and patients, in accordance with IRR and IRMER17

- When it comes to health and safety within the workplace, there is very little to no flexibility where radiation is concerned, and radiation regulations should be followed meticulously to ensure the safety of all personnel inside the clinic. The safety of staff, patient and visitors is paramount.

- I have produced DEXA training materials and DEXA staff training sign off forms that have received extremely positive feedback from Dr [**REDACTED**] (RPA) after his radiation audit in December 2023.

- I have expressed my concerns over staff training in DEXA scanning to the management team, which unfortunately has been disregarded.

- This has meant new inexperienced operators have been allowed to scan on the days I am not in work and having checked the analysis and positioning of these scans it has become apparent that both new operators require further training.

- I have approached the deputy manager on occasions regarding the errors in her positioning and analysis both in writing and through verbal communication to which she stated verbally that she was too busy to go over this with me.

- We eventually had a short positioning session where the deputy stated she had “winged it”

- We discussed again that I wanted staff to be fully trained and competent in scanning before scanning independently.

- We have plenty of opportunity to train staff in DEXA positioning and analysis on the days I am on duty and whilst the number of clients booking is quite low, I would deem this the perfect opportunity to train staff further and in time for when scan bookings increase.

- In this way new operators will be fully competent and confident in scanning and paid clients will get accurate results to take away and accurate follow up scan results to ensure precision.

- The reputation of the clinic relies on reliable results, and a good client experience.

- It is a service whereby clients should not receive substandard care.

- I have recently reached out to the RPA as RPS of [**REDACTED**] regarding training requirements for new operators.

- RPA agreed with my concerns and that a robust training scheme would be the best way moving forward.

- This would only be a temporary circumstance while we train up staff to the required standards.

- I would also like to note that the Care Quality Commission (CQC) expects staff to be qualified, competent, skilled, capable, and experienced as part of their regulations.

- It is important to mention this as I am lacking support from management to make departmental decisions in training staff. I am also having to reach out to advocacy organisations for advice, information, and guidance due to management disregarding the DEXA experience and qualifications I hold.

Supplemental DXA material - Grievance Appeal Letter

[REDACTED] redacted *response that "A new business isn't always going to get everything right,teething problems will happen" involving Ionising radiation is not acceptable and is deeply concerning;*

• Adherence to regulations governing the use of ionising radiation is paramount. The Ionising Radiation Regulations (IRR) and Ionising Radiation (Medical Exposure) Regulations (IRMER) are put in place to ensure the safety and wellbeing of both patients and healthcare professionals. Therefore, any lapse in following these regulations can have serious consequences.

• **[REDACTED]** *has a legal and ethical obligation to comply with IRR and IRMER regulations. As a healthcare clinic working with ionising radiation, it is not only a legal requirement but you also have a moral responsibility to ensure the highest standards of safety and care for all individuals. Any deviation from these regulations not only puts the company at risk of legal repercussions but also undermines the trust and credibility of the institution as a whole.*

• It is imperative for all staff members working with ionising radiation to undergo rigorous training and continuous education to ensure they are well-equipped to handle the equipment safely and responsibly. Failure to provide adequate training and support in this regard is a clear violation of IRR and IRMER regulations and must be addressed promptly. I notice that although it is stated that the clinic manager thought I would be in charge of such training, she made this incredibly difficult for me by booking scans in on the days I do not work. I also note that this clearly was not the case, as to my knowledge scans have continued to go ahead in my absence by staff who have not been signed or declared competent.

• I am concerned that a patient/client who attended for scan left with inadequate scan results. The hip was missing the hip global box (ie; area of analysis was too small as the scan started to high up the femur) this would result in this patients bone density for the hip being lower than it truly is, which is an incorrect result. The spine scan was also incorrectly analysed and not enough of the spine had been scanned. The client then left with incorrect DEXA results and to my knowledge was not informed. As I didn't supervise all scans performed within the business or quality checked them as results are given to the patient immediately after the scan I am extremely worried this could have happened to other patients

• It is policy to perform an express scout scan to determine accurate positioning in a lower dose mode with the final scan performed in array mode. Two scans were performed in array mode on the same client as above. This shouldn't happen as the positioning is determined by the lower dose express mode. As RPS I felt a duty to raise this with the RPA and although this didn't mean the incident was reportable to CQC it also shouldn't be dismissed and raises the need for further training.

•[**REDACTED**] *states "My meeting with Professor* [**REDACTED**] *(director) certainly confirmed that he has checked what the practice is at private clinics he worked at and that they would be fine with patients coming in at this point of the 3-month cycle date but not much more than that." Radiation regulations involving the duration required between scans should be followed and advice should not be sort from other private healthcare companies or their employees. That is why there is an RPA employed by the radiation employer* [**REDACTED**] *and they are there to advise the company on complying with the Ionising Radiation Regulations 2017 (IRR17). (In relation to them bringing a patient back early for a scan when I had said not to - and then scanning that patient).*

• The safety and wellbeing of patients and staff must always be the top priority for any healthcare company and any deviations from regulatory standards cannot be tolerated, despite what other businesses may or may not be doing.

Section 2: Radiotherapy Clinical Technologists

Executive Summary

Statutory regulation is crucial for Radiotherapy Clinical Technologists (RTCT's) for public safety, public expectation and trust in NHS/HSC professionals, alongside ensuring high standards of care are upheld. Their role within the Healthcare Science specialty directly aligns and overlaps with those of Therapeutic Radiographers and Clinical Scientists, both of which require HCPC statutory registration to practice in the UK. RTCT's work as part of multidisciplinary team alongside these staff daily, with inherent responsibilities within the patient care pathway for complex tasks. The current non-statutory voluntary registration approach presents significant risk of harm to patients during their radiation cancer treatment pathway as well as being the cause of inequalities in the workplace across the UK.

Radiotherapy by its very nature requires staff trained via an accredited academic route who are accountable, aware and compliant with regard to clinical governance and legislation, in addition to specialists in the use of medical devices and radiation. The complexity of this field demands staff with the right knowledge, skills, experience and professional standards to deliver safe, high quality, state-of-the-art treatments, as well as support advanced practice in this field. All healthcare science staff groups are instrumental in driving cutting edge treatment developments, providing cost effective services to support and improve patient outcomes.

The unintended consequences of leaving RTCT's without statutory registration increases the risk of radiation patient errors and incidences which directly impact of patient prognosis, life expectancy, physical and emotional wellbeing, institutional reputation and public trust. Equally it would leave a 'patient facing' workforce without a mandatory framework to ensure ethical standards are upheld and validation processes to assess practitioners' continuing fitness to practice.

A fractured workforce landscape and the vital role of Clinical Technologists in Radiotherapy

Radiotherapy Clinical Technologists (RTCTs), often referred to as 'Dosimetrists' in the radiotherapy community, represent a blended 'professional skills' workforce approach. Staff who hold the title of Dosimetrist may come from either a Therapeutic Radiographer (referred to as radiographer onwards) background or a physics / applied science training background. Despite Radiographer and Dosimetrists performing the same role, a significant issue is apparent: Radiographers are registered with the HCPC, whereas those from a physics background may be registered with The Register of Clinical Technologists (RCT) or hold no professional registration at all. Moreover, once in a Dosimetrist role, a Radiographer can choose to deregister from the HCPC, as employers do not uniformly require registration across the UK and its devolved nations for this role. This disparity creates a fragmented workforce, affecting career

opportunities and reputation with inconsistent training and regulatory standards, putting patient safety at risk due to the absence of consistent regulatory oversight. It undermines the patient & public expectation and trust that all professions involved in their radiation therapy specialist treatment require statutory registration. This review will evidence the necessity of statutory registration to ensure patient safety by elucidating the required skill base and expertise of RTCT's and hence the immediacy and impact of this modern workforce.

RTCT require a blend of technical expertise, scientific knowledge, leadership and interpersonal skills and are crucial members of the multidisciplinary team throughout a patient's journey. [1] Their role in delivering compassionate, high-quality care across the UK is essential, and their expertise makes them invaluable in the evolving patient pathway. Lack of statutory regulation of this profession within radiotherapy, combined with the ongoing advancements in radiotherapy, characterised by state-of-the-art technology increases the immediacy and impact of the risks associated with modern practice. RTCT's play a central role in ensuring the safe and effective delivery of radiotherapy treatments.[2-3] They are responsible for a wide range of tasks, including patient immobilisation and setup for multi-modality imaging, as well as advanced technical planning of treatment with the precise calculation for the administration of radiation doses necessary for effective patient treatment. In contrast to diagnostic Radiographers, who must have statutory registration to administer ionising radiation for lower risk imaging processes, RTCTs manage much higher doses of radiation for therapeutic purposes. For example, a thoracic imaging CT administered by a Radiographer will have an effective dose of approximately 6.1mSv to the patient. An RTCT will plan the delivery of SABR (Stereotactic Ablative Radiotherapy) to a thoracic tumour, which can deliver 54Gy in three fractions or 54,000mSv in three fractions, almost 9,000 times the amount of absorbed dose to the patient. Errors in this process would have catastrophic consequences for a patient. This was apparent when a patient in 2006 had an unintended overexposure of 58% and this unfortunately resulted in fatality to the patient. [4] In 2015, a patient received 100% more than the intended dose of radiotherapy again with catastrophic consequences to the patient and the team involved. [5]

Cancer care has become more complex and the effects of errors in treatment has become increasingly severe. [6,7] Thus statutory regulation is not only advisable but essential for paving the way for future innovations and improving patient-centred care. [8, 9, 10]

Recent findings from the UK Health Security Agency (UKHSA) [11] highlight a concerning trend: reported radiation incidents and near misses have doubled over the past five years, with a 14.4% increase alone since the last reporting period in 2024. A total of 4,305 reports were received between December 2024 and March 2025 - a monthly average of 1,074 Radiotherapy Error (RTE) reports. Of the RTE reports, 96.3% (n = 4,123) were minor radiation incident, near miss or other non-conformities (levels 3 to 5). Of the remaining 3.7% (n = 158) of reports, 3.2% (n = 138) were the most serious and reportable to the

appropriate enforcing authority (level 1). The most frequently reported process sub-codes remain consistent with the previous analysis, with the addition of ‘preparation of data for planning systems’, ‘use of gating’ and ‘accuracy of data entry’. There were 138 level 1 reports submitted by 30 providers to the voluntary system for this reporting period, and these level 1 represent SAUE - Significant Accidental or Unintended Exposure – to a patient.

Each incident serves as a reminder of the risk patients face during treatment, due to uncertainties within the healthcare system, with often life-altering consequences.

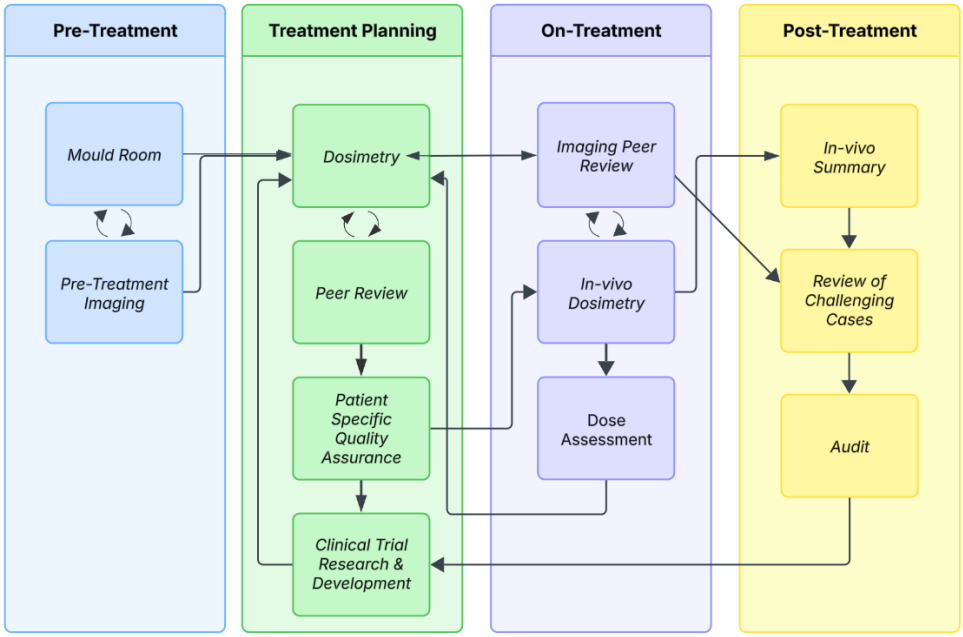
Modern radiotherapy benefits greatly from research in cancer biology, physics, and innovation, along with the personal experiences of patients. RTCT’s play a crucial role in turning scientific knowledge into personalised, safe and effective treatments. For example, delivering precision radiotherapy to a patient with complex multi-dose level head and neck disease involves multiple steps: designing a custom immobilisation mask, conducting multi-modality imaging sessions while ensuring proper immobilisation, utilising advanced mathematical models to understand tissue responses, and employing sophisticated treatment planning software to create a highly accurate treatment plan. [12,13] Achieving the right balance between administering a therapeutic dose to the tumour while sparing critical organs (Organs at Risk, or OARs) is a time-consuming process that requires the sustained dedicated focus of the RTCT. Ongoing equipment validation and quality assurance of both the final treatment plan and the linear accelerator used for delivery are essential to ensure the plan can be executed effectively. During treatment an RTCT also conducts in vivo dosimetry assessments to verify that each treatment fraction is delivered as intended. [14, 15]

Despite the complexity and associated risks associated with the role, the regulatory framework in the UK is inconsistent.

Responsibilities across the Radiotherapy Pathway

Figure one provides a visual representation of the tasks and responsibilities of RTCTs, illustrating their involvement in every step of the patient's radiotherapy journey.

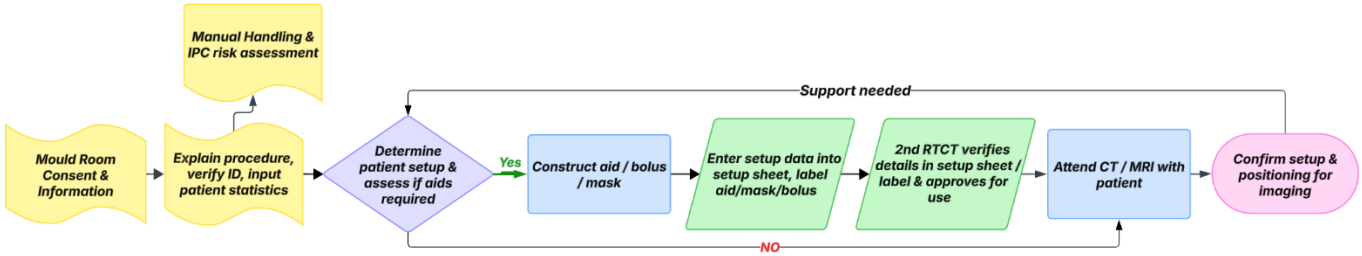
Figure 1: Radiotherapy Patient Pathway



Pre-Treatment: Mould room consent, patient information and assessment of condition

'Pre-treatment' responsibilities can be further broken down into the task's illustration in Figure Two.

Figure 2: Pre-Treatment Section of Pathway



The initial interaction a patient has in the radiotherapy pathway often sets the tone for their entire cancer journey. [16] Unfortunately, there is a prevalent misconception that RTCTs are 'non-patient-facing' and instead only perform 'behind-the-scenes' technical work. Typically, the RTCT is the first technical expert a newly diagnosed head and neck (H&N) or Brain patient meets during the Mould Room visit, and this can be within 24 hours of the patient receiving the news that they require radiotherapy for treatment of their cancer. At this crucial stage, their responsibilities encompass several vital aspects.

Patient education & consent for setup: The RTCT bears a significant duty of care to articulate the risks associated with radiation, the objectives of treatment, and the use of complex devices and patient immobilisation methods, including thermoplastic masks, vacuum bags, and body moulds, in a

comprehensible manner. [17, 18] Visual aids are often used to enhance understanding. The RTCT plays a crucial role in evaluating the patient's understanding, addressing psychological barriers, and determining the patient's readiness for the treatment preparation process. [17, 19].They must communicate with empathy, helping patients navigate unfamiliar procedures, alleviating concerns related to immobilisation or radiation exposure, and ensuring that informed consent is obtained correctly. Additionally, RTCT's guide patients through intricate imaging processes, ensuring that each step adheres to both technical and clinical requirements for meticulous planning. Their emphasis on technical excellence is coupled with a strong commitment to safety and precision, which is vital when even minor errors could yield significant and lasting deleterious consequences. Educating the patient on their treatment delivery is recommend in Advancing Safer Radiotherapy. [21] Actively engaging the patient appropriately, helps to prepare them for what to expect and enable them to understand the importance of their positioning and to highlight to their treatment radiographer if something is different during their treatment i.e. if they normally have a mattress or support wedge, which if omitted needs rectified promptly e.g. patient advocacy. Patients should be encouraged and supported to be active and vocal participants in their treatment and care and initial interactions between the patient and the RTCT helps to facilitate this.

The RTCT's must adapt communication in special situations e.g. they must foster patient comfort and support across various demographics and clinical circumstances. For example, patients with advanced laryngeal cancer may experience anxiety due to concerns about restricted breathing or coverage of their tracheostomy with the mask. The majority of H&N patients feel claustrophobic when wearing a mask for treatment. The RTCT's ability to reassure and guide the patient—sometimes through gradual rehearsals of mask placement to build confidence—can notably enhance the success of the setup and the patient's willingness to proceed with imaging and on to treatment and hence the outcome of the planned therapy. This adaptability in communication and holistic patient centred approach is vital to ensure that each patient's unique needs are met, fostering a sense of understanding and trust early in the patient pathway and hence minimise the risks while maximising the chances of meeting the therapeutic aims.

Construction of immobilisation aid, patient specific bolus, lead shielding

In the Mould Room, RTCT's are responsible for implementing patient immobilisation techniques and conducting thorough pre-treatment assessments. They ensure that informed consent is obtained correctly and create essential immobilisation devices, such as custom thermoplastic masks. Creating a well-fitted thermoplastic mask requires exceptional manual dexterity, as it is essential to achieve a balance between patient comfort and the millimetre precise positioning needed during critical imaging processes, such as CT and MRI scans. [20, 24] The inherent risks associated with this process underline the need for stringent safety measures, education, regulation and ongoing professional development. The UKHSA

commissioned the guidance, ‘Safer Radiotherapy: Radiotherapy error and near miss reporting – the unseen pathway’ which looked specifically at RTE’s in pre-treatment tasks. [23]

Figure three, shows the breakdown of the most serious RTEs categorised as level 1 errors within pre-treatment. [23]

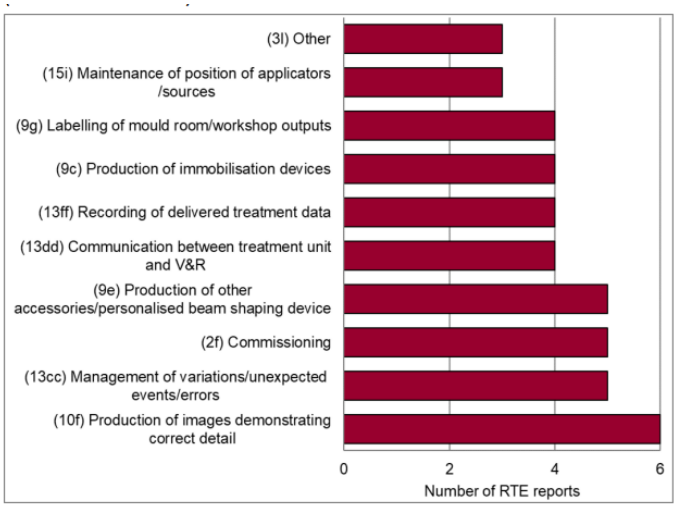


Figure 3: Radiation Therapy Errors breakdown

An inaccurate mask fit can lead to a geographical miss of the target area, compromising treatment efficacy and potentially impact the patient's prognosis negatively. Such inaccuracies will necessitate additional imaging sessions, raising the patient's exposure to radiation and the risk of secondary cancers.

Furthermore, any delays in overall treatment due to necessary revisions of the radiotherapy plan can adversely affect a patient's prognosis and quality of life, reinforcing the importance of making patient safety an inherent aspect of every stage of care.

A non-reportable radiation incident (level 2) is defined as a radiation incident which has potential clinical significance. Patient positioning and onset imaging are again the most common errors reported at this level. [11, 23]

The use of appropriate and suitable equipment during the pre-treatment phase is not just crucial, but it is the cornerstone of the patient care pathway. The role of the RTCT in this process is pivotal to the success of treatment delivery.

When using a bolus (skin equivalent material) to ensure adequate dose is delivered (Build-Up) for a superficial tumour, the RTCT's precision in conforming to the clinically marked area is of utmost importance. Their knowledge and experience are key in determining the necessary thickness to achieve the desired radiation dose to the skin depending on the treatment technique which would be most appropriate and in identifying the type of bolus that can be easily reproduced and consistently applied during treatment.

Additionally, the patient-specific bolus must be appropriately labelled, and its orientation should be annotated along with a patient-specific setup sheet. These also feature as a common level 1 and 2 RTE.

[23] Neglecting these factors during scanning, treatment planning, and treatment delivery can significantly impact the accuracy of the dose delivered to the tumour, potentially altering the patient's outcome due to an under or overdose of the tumour volume, in addition to worsening the acute and late side effects experienced by the patient during and after the radiotherapy treatment. It has been shown that this is a common 'good catch' in radiotherapy error analysis; however, it has the potential to have a hugely detrimental effect on patient outcomes if not taken into account at planning or delivery. [23]

Case vignette - Bolus Omission

A patient attends the mould room for a thermoplastic mask to be made. A patient-specific bolus is also required and produced to sit on the patient's mask. The bolus is produced as per clinical mark up and the patient setup sheet is annotated accordingly. Setup photos are taken with the bolus in place. The bolus is wrapped, a patient ID label is affixed and the orientation noted. This is checked and confirmed by a 2nd RTCT attending the patient encounter. The RTCT attends CT and MRI, and the patient is confirmed as having been scanned with a bolus in place. An RTCT notes the setup sheet and instructions, as well as the bolus in place during planning; as such, it is planned with a bolus to the primary lesion. At treatment, the bolus was omitted despite numerous prompts in the system. At fraction 15 of 30, this omission is noted during weekly checks. An MPE and Principal RTCT are informed. An RTCT conducts a dose assessment, taking into account the omission of the bolus from the initially planned dose, and presents to the treating clinician the difference between the intended dose and the dose delivered. The clinician is concerned about local control of the primary tumour given superficial involvement. An RTCT performs a BED to determine a new 'dose per fraction' for the remaining 10 fractions, ensuring the effective treatment is as originally intended for the patient's welfare. This is a complex calculation, which then prompts a rapid re-plan with the new dose per fraction to avoid an unnecessary delay, as this could further impact the patient's prognosis. This represents the reality of daily practice for an RTCT, where unexpected errors occur, and they must apply their experience and learning to resolve an escalating situation. At any point, however, in the BED calculation and the subsequent re-plan, another error can occur due to the pressure and additional stress on the RTCT team.

Imaging and Simulation Procedures: Maintaining Accuracy and Consistency

Accurate imaging and reproducible setup are paramount for safe therapy, which must be delivered within millimetre precision. The RTCT is responsible for several key components:

Simulation Sessions: The RTCT team collaborates with clinical oncologists, clinical scientists, and radiographers to ensure scan accuracy, patient comfort, and minimal movement during imaging procedures. The RTCT assesses patient setup and provides advice on necessary aids and adaptations to ensure a reproducible position for the patient, one that allows for the optimal beam arrangement and efficiencies in delivery time. The presence of an RTCT is crucial during challenging setups, as they have the expertise to determine the most appropriate positioning. Research indicates that when RTCTs are not involved, risks of setup errors and inappropriate positioning increase, leading to potential need for another planning CT in an alternate position or re-planning either early in treatment or on the first day a patient is

due to attend. The importance of RTCTs and their good practice in this process is invaluable to avoid unnecessary additional radiation dose to a patient. [20]

Continuity of Care: As patients begin their treatment journey, having often attended the mould room for setup up/immobilisation aids with the RTCT they establish a trusted relationship. The RTCT's ongoing presence during CT and MRI scans can reassure the patient and reduce positional uncertainty. This familiarity aids in smoother patient setups, as the RTCT is aware of any setup challenges and can promptly communicate with the team to mitigate any anxiety the patient may experience. [17, 18] The RTCT can address immobilisation issues, provide reassurance, and facilitate prompt modifications if a patient becomes too anxious to maintain setup for imaging and treatment.

Image Quality Assurance: The RTCT evaluates CT and MRI scans for anatomical accuracy and artefact detection. Poorly executed scans can result in treatment delays or geographic misses. RTCTs are called to CT / MRI to assess patient scans, particularly in cases where Deep Inspiration Breath-Hold (DIBH) has been shallow as the tracing is critical for treatment to reduce cardiac dose which may lead to long-term cardiac morbidity. The RTCT can determine if the heart is adequately out of field using their experience of where they would arrange beams, or if additional DIBH coaching would be beneficial for the patient.

A common query for an RTCT is a breast patient presenting with a seroma in the treatment area following surgery. The RTCT must evaluate the situation, determining whether the patient requires intervention such as draining the seroma or should the patient return for a scan at a later date when the seroma has resolved or stabilised. The RTCT employs their expertise to advise the multidisciplinary team on the best course of action, thereby benefiting the patient and reducing the need for unnecessary rescans that would expose the patient to additional radiation exposure. [20]

Adaptive Imaging: With technological advancements and best practice guidance such as On Target directing the use of daily image guided radiotherapy, such as cone-beam computer tomography (CBCT) the RTCT must be able to adapt workflows. [22] With increased awareness of setup and anatomical changes via daily CBCTs there is increased responsibility to act on this information. This adaptation often involves making urgent, time critical decisions about patient preparation and protocol compliance, tumour progression or advancing co-morbidities or patient repositioning and therefore associated risks. [24]

Electron endplates and lead shielding

In electron treatments, the role of the RTCT is key, their initial task is to manufacture a customised electron end plate that attaches to the linear accelerator gantry, directing the electron beam to the treatment area. This end plate, made from a molten lead composite alloy, presents a significant occupational hazard to the RTCT and colleagues, underscoring the importance of the RTCTs role.

Before working with lead, and in compliance with ‘Control of Lead at Work' legislation, the RTCT must have their baseline blood lead concentration levels checked. [25] This will be reviewed annually or if any adverse event occurs. It has been shown where legislation has not been followed staff can have significant health issues. In 2023-24 over 5000 staff were under surveillance for lead levels in their blood, 12% or 600 of whom worked with lead containing alloys, the risk of which can affect motor and neurological functioning. [26] Personal protective equipment (PPE) must be worn, and a designated area with specialised tools for lead work should be established to limit cross-contamination and reduce risks to other staff. It is essential for the RTCT to fully understand the safe working practices related to lead before beginning any lead-related tasks. The health of staff, patients and visitors can be detrimentally affected by practices which do not follow Safe Working with Lead legislation. Not only is there a risk to health, but the reputation of the Health Care Trust can also be put in jeopardy, and large fines may be imposed. Therefore, it is imperative that the Principal RTCT ensures education, training and compliance of all staff working with lead and understands the risk it can pose.

To ensure adequate shielding of healthy tissue, the RTCT produces a custom end plate to modify the shape and size of the electron beam. Reflecting the clinical area to be treated, the accuracy in transcription from the patient surface to the insert is essential. Once a template is created the molten alloy is poured around it to create the electron end plate. Once cooled the alloy end plate is smoothed to remove any rough surfaces that could injure radiography staff, and a lacquer is applied to prevent lead contamination (due to additional occupational hazards the lacquer is applied in a vacuum cupboard). Once dry, the end plate is checked, annotated with the correct patient ID and orientation and independently checked by another RTCT to confirm that it is an accurate treatment aid. If the orientation is labelled incorrectly the patient may receive an underdose to target and unintended dose to normal tissue. If the end plate is labelled for the wrong patient it could have serious implications and be reportable RTE level 1 incident, as shown in figure three. [23]

Additionally, a RTCT is responsible for calculating the required monitor units for the electron beam therapy. This calculation considers a factor determined by the RTCT at the linear accelerator, taking into account the attenuation caused by the patient-specific end plate compared to an open applicator of the same size. While this technique is considered one of the simpler treatment methods human error occurs, the clinical RTCT is heavily involved in the construction, assessment, calculation, and quality control of both the end plate and the treatment delivery. [23]

A patient may also receive superficial kV treatment, which requires an RTCT to construct a precise lead shielding device for their treatment. Although this is a relatively straightforward technique, errors do arise. The shielding must be very precise and the RTCT must use their expertise to select the appropriate lead thickness.

To help shape the lead shielding, a plaster of Paris mould may be required for the patient. This procedure can be complex and may involve an extended period in the mould room, with the plaster of Paris over the patient's face, which takes time to set. The RTCT needs to show empathy to ensure and support the patient throughout this process while also working quickly and accurately to capture a good outline of the patient's features in the area near the treatment site. Once the mould is removed, a stone plaster will be mixed to create a solid impression of the patient. From this impression, the RTCT will shape the lead mask.

It is crucial to remember that improper shielding of sensitive areas, such as the eyes and thyroid, can lead to overexposure or unnecessary radiation exposure to healthy tissue resulting in severe tissue damage to healthy organs and long-term health conditions, such as cataracts and hypothyroidism. If the mask is not fitted or designed correctly, it could result in uneven radiation distribution, leading to burns and treatment failure which can affect the patient's quality of life and their long-term prognosis.

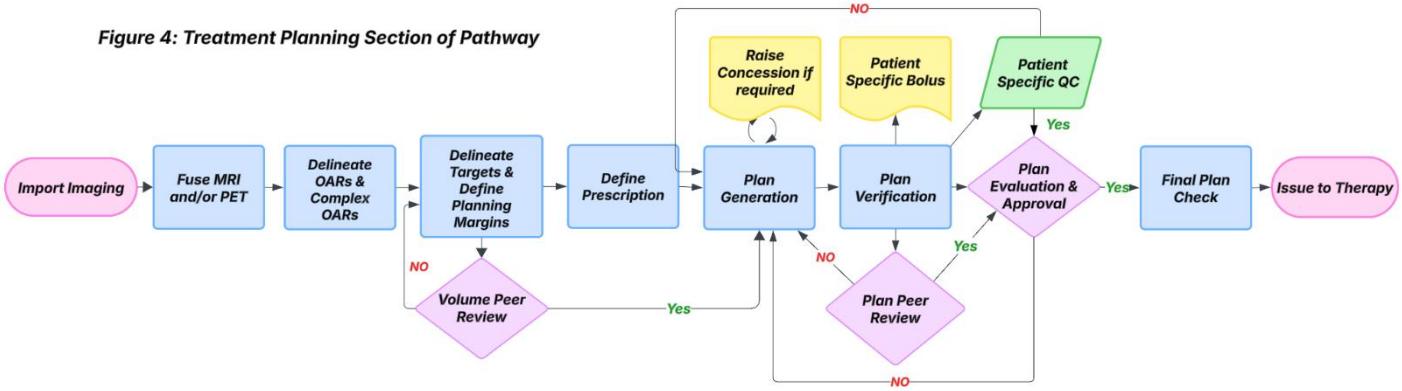
Radiotherapy Treatment Planning: Technology & Science at the Heart of Patient Care

The World Health Organisation Radiotherapy Risk Profile looked at all incidents worldwide (N = 4616) 9% of which were within planning (N=420), 35% were incidents that occurred in the categories of prescription, simulation, patient positioning and 38% (N=1732) were related to the transfer of necessary treatment information. [27]

The treatment planning aspect of a patient's journey is highly complex and outlined in Figure 4. Many 'checks and balances' are required within each task, and many are decision activities which can cause a re-plan or further investigation for patient safety and to ensure treatment efficacy.

At each step there will be an RTCT involved.

Figure 4: Treatment Planning Section of Pathway



Import Imaging / Fusion Tasks: The RTCT acting as an 'Operator' under IR(M)ER, (the same occupational professional status as a Radiographer or Clinical Scientist) will assess the CT scan, noting

any artefacts, and the need for reconstructed artefact reduction technology will be evaluated as appropriate. Due to the experience of an RTCT in viewing CT images incidental clinical findings related or unrelated to the proposed cancer treatment may also be observed and highlighted to the Clinical Oncologist for further investigation and consideration.

Additional scans, such as PET and MRI, required for delineating organs at risk (OAR) and target volumes, will be sourced from the relevant patient repository and fused with the correct patient's images. It is essential to note that these additional images may have been taken in different orientations; for example, an MRI might be taken with the patient in a feet-first position and supine, while the CT scan could be taken with the patient in a head-first position and supine. The RTCT will use their anatomical and physics knowledge to ensure accurate fusion before beginning the delineation process. Poor quality fusion can lead to incorrect outlines, which even by a small amount, may adversely affect the dose delivery to the OAR and tumour during treatment planning which is planned and will be delivered to millimetre precision. From a ‘patient experience’ stance inaccuracy in fusion will impact the size of the target volume defined thereby increasing or decreasing the size of the area treated which adversely impacts on the patient disease control or normal tissue / OAR complications.

ARs and Complex OAR Delineation: RTCT’s utilise all available imaging and patient history to delineate all OARs, including complex OARs accurately. Their anatomical experience is crucial, as each patient's anatomy can differ from 'textbook’ expectations. Precise outlining of the organ or structure is imperative for safe radiotherapy treatments. Understanding and interpretation of the CT dataset and the impact of appropriate windowing, or iodine contrast effects can significantly impact the accurate delineation. The potential consequences of incorrect structure delineation can cause direct patient harm, ranging from quality-of-life side effects to fatal spinal cord radiation myelopathy, leading to potential paralysis. The significant impact on the resultant treatment plan and patient outcome cannot be underestimated when weighing the RTCT's responsibility in ensuring accurate and precise delineation.

Target Delineation: While an oncologist can perform target delineation, it is commonly completed by an RTCT in many cancer centres, as an entitled IR(ME)R operator. The RTCT will delineate the gross and/or clinical target volume using diagnostic and planning imaging, then apply a margin to establish the Planning Target Volume (PTV). This margin accounts for both inter- and intra-fraction motion, ensuring that the clinical target volume receives a tumoricidal dose. Accuracy in target volume definition reduces the overall volume being exposed to the high dose radiation and the expertise of the RTCT is essential in minimising the risk of under-dosing the target while preventing overdosing of healthy normal tissue.

Plan Generation: The RTCT is responsible for enhancing treatment precision, protecting critical structures, delivering the desired ‘uniform’ or ‘ablative’ dose to tumour volumes and ensuring safety and

robustness in treatment plans; essential in tumour/disease control and for reducing the complication rate for patients. They use their technical skills, judgement and knowledge of advanced planning software to develop an optimal plan, understanding and accounting for numerous variables to create 'fit for purpose' patient individualised treatment plans. In high-pressure situations, the experienced RTCT relies on their extensive knowledge to create the most efficient and effective treatment plan. They are responsible for confirming the dose prescription aligns with nationally defined, safe clinical protocols, or as required will identify and request the clinician to raise an 'off protocol' concession to ensure any deviation is clinically and technically acceptable and approved by Heads of Service.

In complex patient setups, the RTCT collaborates with the lead treatment Radiographer to review the situation and inform the wider team, possibly scheduling additional imaging assessments during the weekly peer review meeting. If the RTCT determines that tissue equivalent build-up is needed to ensure the correct dose is delivered to a superficial lesion, they will create this on the planning system and create it ahead of treatment following the same process as previously described. If the bolus is complex the RTCT may need to assess the patient in the treatment position ahead of their new start appointment and work quickly and accurately to create the bolus to enable treatment to progress swiftly and avoid delays to other scheduled patients. It has already been shown that bolus configuration and placement are a common cause of errors in planning (fig 3), with human error a large contributing factor. [23]

Plan Verification: Once a clinically appropriate plan has been developed, an independent RTCT will verify the quality of the plan, its adherence to clinical criteria, and the accuracy, of all available information. This verification process is crucial as it ensures a further independent check that the plan is safe and effective for the patient. If the RTCT believes a more effective plan can be achieved, they will initiate a re-plan; alternatively, they may use their judgment to decide if a minor change is warranted, considering the potential impact on the treatment start date. Ultimately, the RTCT will prioritise the patient's best interests and justify a re-plan / re-optimisation if it is deemed necessary to enhance treatment standards and improve patient outcomes.

Volume and Plan Peer Review: By following evidence-based protocols and guidelines, RTCTs must ensure that every aspect of the proposed treatment plan meets safety, efficacy, and clinical standards. An RTCT will lead the peer review process, involving the multi-disciplinary team, to evaluate both the target volumes and the resulting plan according to local procedures. This is best practice as recommended by the Royal College of Radiologists (RCR) and ensures consistency at a local level. [28] It provides an opportunity for the team to reflect and improve its performance. The RTCT's attendance at these meetings is crucial, as they can advise on the implications of recommendations that affect the planning pathway. For example, a clinician might suggest a slight adjustment to a PTV with the assumption that it will bring an OAR within tolerance. The RTCT can assess the plan and dose gradient at the proposed level of

change and inform the clinician whether it will achieve the desired effect or whether a compromise is needed to ensure organ sparing. This process can reduce unnecessary re-plans and delays to the patient starting treatment and instead allow the team to focus on more urgent cases or necessary adjustments. This can lead to efficiencies in staff utilisation, resources and streamlining within the 31-day and 62-day cancer access targets, which are key within the NHS for timely cancer care and to reduce unnecessary risk from delays to the patient. [47]

Patient-Specific Quality Control (QC): Once an appropriate plan has been created, the RTCT will conduct thorough QC checks, including independent monitor unit verification. Depending on the plan's complexity, it may be delivered to a phantom for an independent dose calculation to confirm the modelling of the radiation dose within the patient, reducing errors, confirming treatment deliverability, verifying the accuracy of the results and identifying any delivery issues before the plan is administered to a patient. This QC process ensures the highest level of accuracy and patient safety when performed by competent and experienced RTCT staff.

Plan Evaluation and Approval: After passing QC, the plan will be approved by an oncologist or an independent RTCT, who will assess the dose distribution to ensure that the clinical goals and tolerance for OARs specified in the protocols have been achieved. While the oncologist will have a general understanding of the planning process, they will rely on the RTCT to have balanced the doses to the PTV and OARs to the best of their ability. Dose distributions produced must be in accordance to Ionising Radiation (Medical Exposure) Regulations, IR(ME)R and IRR Guidance to ensure no harm comes to the patient and unnecessary dose is kept as low as reasonably practicable (ALARP). [29, 30] In many centres, the plan approval will be delegated to an RTCT, who then assumes responsibility for the approval under the authorisation guidelines set forth in the IR(ME)R guidance. Along with target and OAR delineation this is a significant responsibility and should be performed by appropriately educated, experienced and competent RTCT's to avoid misadministration of radiation to patients.

Final Checks: This final review by another independent RTCT ensures each step of the treatment planning pathway has been properly followed, providing a last opportunity to identify any errors before issuing the plan for radiotherapy delivery. An experienced and competent RTCT must complete each step in the planning process, including these final checks, to confirm the highest quality of the plan before administering it to the patient. The required independent checks to validate each stage indicates the need for adequate staffing within the RTCT team. The greatest source of errors in radiotherapy is through human error and 'slips and trips' and this is more likely to happen if an RTCT believes they have already checked information at an earlier stage by performing more than one check within the patient care path. [11] For example, one RTCT may complete the plan generation and final check assuming the independent verifier

will have noticed any errors in process. This is not ideal but will happen in centres with workforce difficulties with having adequate numbers of staff and trained and assessed as competent to complete tasks.

Navigating Challenges in Treatment Planning Delivery; providing 'unplanned' advice to the MDT

Patients undergoing radiotherapy may experience significant changes during treatment, such as tumour shrinkage or fluctuations in weight. These changes can render initial treatment plans ineffective and potentially unsafe if used for the entirety of the treatment. Without robust protocols and adequate time for adaptive imaging, patients may receive suboptimal plans, thereby risking tumour recurrence or accidental over or under dosing. When a patient experiences a significant body contour change between the initial planning phase and treatment, a rescan and re-plan may be necessary to account for these anatomical changes. [31] An experienced RTCT can manage such technical processes and review daily imaging and in vivo results to gather the history. They may determine whether additional imaging is needed for dose assessment or if the daily CBCT scan for image-guided radiotherapy (IGRT) can be used as a substitute for a new CT scan to evaluate the current situation and thus negate the need for a patient to undergo a full repeat CT with the associated radiation dose. It is known that every dose to normal tissue can lead to radiation induced secondary cancers and all imaging used should be within set optimisation protocols to ensure a patient does not receive an unnecessary radiation dose. There must be justification for the additional dose under IR(ME)R Regulations [29] and the RTCT assists with this justification by analysing discrepancies and plan validity with imaging already available through normal IGRT processes wherever possible.

A dose assessment evaluates how anatomical changes impact dose delivery and helps decide if a rescan or re-plan is warranted. A key finding from the American Association of Physicists in Medicine (AAPM) Task Group 75 emphasised the necessity of meticulous clinical evaluation at every stage of the radiation treatment process. [32] This involves a detailed and thorough assessment of the patient's condition and the treatment plan to ensure optimal outcomes and patient safety. As shown in figure three, most common level 1 RTE reported is the management of variations, unexpected events. [23] It is critical that the workforce is adequately trained and experienced staff deal with such episodes to ensure patient safety, and the correct course of action is taken.

The RTCT communicates the findings of their dose assessment and advises on the current status of the dose delivered to the patient and what changes are necessary. This information is actively discussed during peer review that includes the clinical oncologist, physicists, and radiographers and the way forward agreed based on the RTCT assessment. This process ensures that a new treatment plan will be actioned and prepared as quickly as possible, preventing unnecessary interruptions in the patient's treatment and avoiding the continuation of an ineffective plan while awaiting the implementation of the new one.

In re-plan situations, the RTCT must repeat the steps detailed in a time pressured condensed care pathway to carefully outline, plan, conduct quality checks, and ensure the safe verification of the new treatment plan with efficiency and precision. In addition, if circumstances dictate that a break in treatment is necessary, the RTCT performs a complex radiobiological equivalent dose calculation to determine whether additional treatment fractions are required to compensate for the treatment break or if an increased dose per fraction would be more appropriate. This ensures that any disadvantages to the patient from extending the total treatment time beyond the optimal length are minimised. [33]

The AAPM Radiation Therapy Committee Task Group 53 focused on QA for clinical radiotherapy treatment planning, providing guidelines and recommendations for establishing and sustaining comprehensive QA programs in radiotherapy. [34] These recommendations emphasise the human element and the staffing levels necessary to support the complexities of modern treatment planning. It highlighted that effective QA is not merely about technology; it also relies on the skilled professionals who implement and oversee these critical processes. Consequently, there is a significant risk associated with having an unregulated workforce without common standards of education and training, knowledge, and mandatory continuing professional development pathways.

Case Vignette: Cardiac Toxicity in SABR Planning

One significant risk associated with Stereotactic Ablative Body Radiotherapy (SABR) is cardiac toxicity, particularly when treating centrally located lung tumours. The potential for error in these situations is significant, underlining the need for utmost precision.

In a notable UK case, inadequate contouring of the heart and a failure to adapt the treatment plan as the tumour regressed resulted in the heart tissue receiving a much higher dose of radiation than intended. This led to the patient developing pericarditis and cardiac arrhythmias. A review of the case identified several issues, including limitations in imaging technology, a failure to adapt the workflow, and insufficient adherence to protocols by the professionals involved. Strict adherence to protocols is crucial to prevent similar incidents.

The investigation recommended that to mitigate these risks, only appropriately trained and validated staff must be responsible for planning and approving high-stake cases such as this. The RTCT's role in patient safety is paramount thus implementing statutory registration and enforcing competency requirements can help ensure safer practice across the UK.

Quality Assurance in Radiotherapy

According to the WHO Radiotherapy Risk Profile, QA in radiotherapy should encompass all procedures that ensure the consistent and safe fulfilment of medical prescriptions. [27] This ensures that the prescribed dose is delivered to the target volume as intended while minimising exposure to normal tissue, reducing personnel exposure, and providing adequate patient monitoring to evaluate the treatment's effectiveness. [35]

Implementing proper QA measures is crucial to reducing the likelihood of accidents and errors, as well as to enhancing the recognition and correction of any errors that may occur. The issuance of guidelines specific to radiation treatment quality assurance by several global organisations, such as the WHO, International Atomic Energy Agency (IAEA), and the International Commission on Radiological Protection (ICRP), provides a secure framework for practice.

Radiation safety protocols should be strictly followed throughout all stages of radiation treatment delivery. This includes tumour localisation, patient immobilisation, field placement, daily patient setup, dose calibration and calculation, treatment delivery and verification, as well as equipment commissioning and maintenance. All health professionals involved in radiation therapy are recommended to possess the necessary skills and competencies in radiation protection and work within departmental protocols in line with the recommended guidance.

Radiation protection encompasses a framework that ensures the safety of patients, staff, and the public, including adherence to international radiation safety standards, ensuring the safety and accuracy of equipment, understanding radiation hazards in radiotherapy facilities, performing dosimetric and geometric measurements for accuracy, possessing knowledge of radiobiology and radiation risks, and implementing treatment planning to optimise radiation dose delivery. It also involves the safe use of various radiation sources in radiotherapy, preparedness for radiation emergencies, and the physical protection and security of radiation sources. [36]

Quality initiative reports published by ESTRO recommend that QA should extend beyond the physical and technical aspects of treatment to encompass all activities within a radiation oncology centre, from the moment a patient arrives until their departure. [37]

Every year, numerous quality checks conducted by RTCTs play a crucial role in identifying errors that could lead to serious misadministration of radiation doses.

Daily Linac Quality Assurance

RTCTs perform morning run up QA to ensure a linac is performing within expected physical and dosimetric levels and is a key responsibility before patient appointments commence for the day to determine any issues with delivered dose, the same role as also undertaken by Radiographers and Clinical Scientist. If a result is misinterpreted or improperly measured by an RTCT it could have significant consequences on the absorbed radiation dose received by a group of patients treated. It is imperative that RTCTs involved in QA are trained and aware of the responsibility they have for patient care.

If anomalies are detected, a further series of checks and consultations may initiate machine down time. This could lead to rapid rescheduling and communication with patients and care teams. If a linac needs to be taken out of service for some time i.e. for a replacement part, it may fall on the RTCT team to adjust treatment plans for an alternative machine, particularly if the linacs differ in terms of radiation output and functionality. In these situations, the RTCT team faces significant pressure to develop and validate new 'alternate' plans for affected patients, requiring coordinated actions and timely decision-making.

In Vivo Dosimetry

IGRT is well established across the UK with the utilisation of on-board detectors and portal imaging to assess each treatment fraction. RTCTs evaluate in vivo dosimetry for each fraction, assessing patient setup any deviations in the delivered plan from the initial treatment plan. They then determine the need for interventions and the safety of continuing with the existing treatment plan, collaborating with the multidisciplinary team to address any challenges related to patient setup and immobilisation equipment.

Specialised Advanced Techniques

Brachytherapy

In the specialised field of brachytherapy, RTCTs are experts in accurately positioning applicators in various urgent clinical scenarios, including those that require anaesthesia administration. Their role is crucial, as they ensure that applicators are precisely aligned with the target treatment area, which is essential for delivering an accurate and effective dose of radiation. In some Radiotherapy departments, as services have developed and staff with specialist skills, knowledge and experience have been retained within Brachytherapy sections, RTCTs deliver brachytherapy treatments. This role requires interacting with patients for purposes of identification and reassurance, for ensuring appropriate delivery parameters and patient/equipment set up, and for being confident and competent in enacting complex and time sensitive emergency procedures if required.

RTCT's work collaboratively with clinical scientists, clinical oncologists and radiographers to implement advanced image fusion workflows, integrating diverse imaging modalities such as CT, MRI, and ultrasound. This teamwork values the expertise of each professional and enables a comprehensive visualisation of the treatment site and surrounding structures. This thorough visualisation serves as a testament to the precision of treatment planning, ultimately enhancing the accuracy of the treatment.

RTCT's play a key role in preventing errors in brachytherapy. [38] They verify calculations related to the dwell time of radioactive sources, a vital process for maintaining the correct dosage and treatment duration. Fastidious attention to detail is required to identify discrepancies and make adjustments if a radioactive source shifts from its intended position. This vigilance is essential for minimising risks to adjacent healthy tissues while maximising treatment efficacy, thereby maximising the potential for positive patient outcomes.

However, reported treatment delivery errors in brachytherapy demonstrate that misadministration's do occur, with events often having multiple causes. These errors can be categorised into direct and contributing causes. Direct causes include the lack of policies and procedures for staff, insufficient oversight by radiation safety officers, inadequate training and experience, poor supervision, errors in judgment, lapses in communication and hardware malfunctions. Contributing factors may involve changes or unique situations, organisational influences, labelling issues, hardware incompatibilities, and deficiencies in workplace support and training of staff. [39]

Total Skin Electron Therapy (TSET) / Total Body Irradiation (TBI)

This highly specialised and complex therapy is planned by RTCT's. The procedure typically involves treating the whole body, with Mycosis Fungoides and non-Hodgkin T-cell lymphoma of the skin being the most common indications. [40] Patients usually receive approximately 36Gy over six fractions of 6Gy in a complex setup that requires patient rotation for full skin coverage.

Comprehensive quality control, a key responsibility of RTCT's, must be conducted through in vivo dosimetry using thermoluminescent dosimeters (TLDs) or other "pinpoint" detectors, which are positioned at reproducible points on the patient to closely monitor the dose received ensuring this is reported between patient fractions. The patient's eyes must be shielded to reduce the dose to less than 15% of the prescription, employing eye shields placed beneath the eyelids with a paraffin coating to prevent backscatter into surrounding tissues. Additionally, protection should be provided for the fingernails and tops of the feet. RTCTs play a key role in ensuring that these quality control measures are implemented and maintained throughout the treatment process. Ensuring diodes and nanodots are cleared and

annealed as appropriate so that accurate accumulation of dose to the patient is presented to the treating clinician for review.

In specific scenarios, administering boosts may be essential to address regions that tend to receive an underdose due to their location and positioning of the patient as above. These regions include the inframammary area, perianal region, inner buttocks and thighs, perineum, and areas with significant thick cutaneous involvement. It is essential to acknowledge, although often overlooked outside the field of medical physics that a lethal dose of radiation for the entire body typically ranges between 3 and 5 Gy. [41] In radiotherapy, large doses are usually targeted to very specific areas. It is during total body irradiation (TBI) or total skin electron therapy (TSET) that the risk of patients receiving a lethal body dose could occur without appropriate oversight and robust checks. Accurate calculation, ongoing assessment and validation of the delivered dose, along with the meticulous addition of boost doses throughout the cumulative treatment, represent critical patient risk areas. These tasks depend heavily on the education, competence and professionalism of the RTCT's involved who as registration is voluntary may lack registration entirely. Statutory regulation with its necessity for consistent education and training, associated assessment of competency and mandatory continuing professional development is therefore vital to ensure patient safety.

Advancing Research, Education, and Technology

RTCT's play a key role in leading and participating in research and technological initiatives. Their practical experience and contribution are evident in the comprehensive evaluation of innovative QA protocols, the development of advanced imaging and treatment workflows, and the exploration of integrating machine learning into treatment planning processes to enhance precision and safety. Often bringing a more patient centric view to discussions by applying their experience of what is possible for the majority of patients.

Their responsibilities include assisting with the commissioning of linacs, integrating and auditing new equipment such as surface guidance systems, managing the safe incorporation of artificial intelligence into customised treatment planning workflow, the reviewing of site-specific clinical protocols and supporting the introduction of clinical trials. Ongoing education and collaboration are essential in the rapidly evolving radiotherapy field, highlighting the importance of sharing knowledge and best practices and having a common level of understanding across the workforce.

Emerging artificial intelligence technologies in OAR contouring and automated dose optimisation offer some benefits but also present significant risks, such as misidentifying anatomical features and suboptimal plans. [42] For example, AI may either overestimate or underestimate a structure; a notable example is when AI fails to accurately delineate the optic nerve for a patient with head and neck cancer, which can

result in vision loss, if not detected by an RTCT. These errors underscore the necessity for competent RTCTs to supervise AI-generated structures and treatment plans.

Mandatory continuous professional education is required to assist in the upskilling of a workforce that is adapting to rapid technological change. This is required to ensure patient safety in the deployment of new technologies.

Patient experience – supporting the patient along the carepath

Patient experience in the NHS refers to how patients feel about the care they receive, encompassing their interactions with healthcare professionals, facilities, and processes. It is a crucial aspect of quality, alongside clinical excellence and safety, and focuses on the 'how' of care delivery. The RTCT supports the core principles and goals defined in all aspects of patient experience in their radiotherapy journey:

- Patient-centred values: Respecting patients' preferences, cultural needs, dignity, and involvement in decision-making through the face-to-face pre-treatment sessions and the production of their individualised treatment plans.
- Communication and information: Ensuring patients understand and have the appropriate information in regard the pre-treatment session(s) and about their treatment. Have ownership over decisions throughout their pathway. RTCT's often see patients recently diagnosed with cancer and provide support and reassurance at a vulnerable time within the radiotherapy journey. They adapt their communication style to ensure patients with cognitive issues or concerns with claustrophobia are heard and understand the processes.
- Coordination and integration of care: RTCTs support smooth transitions between the different stages of the patient pathways. Skilled in, patient immobilisation, treatment planning and advice of treatment acceptability.
- Physical comfort: During the pre-treatment session RTCTs ensure a technically optimal, but comfortable, sustainable position is achieved to immobilise patients accurately throughout their treatment. Creating comfortable environments for patients.
- Emotional support: As the first professional for many head & neck, and brain patients, the RTCT provides reassurance and alleviates anxiety for the patient and their family. They have the experience and knowledge of the whole process to clearly explain all aspects of the patient's pathway stages.
- Accessibility and convenience: RTCTs affords easy access to specialist staff services, appointment scheduling, and clear communication.

- Staff training and development: RTCTs ensure that healthcare professionals have the skills and knowledge to provide person-centred care.

- **Continuous improvement:** From a clinical and scientific background the RTCT is strategically involved in ongoing monitoring, evaluation, and adjustments based on patient feedback and data analysis. Key to improving patient experiences and developing services.

Regulatory Landscape and Workforce Dynamics

Other countries, such as America (AAPM) and Western Europe, have implemented comprehensive registration systems for RTCT's. However, the regulatory landscape for RTCTs in the UK presents a stark contrast. Only individuals with a background in diagnostic and therapeutic radiography are required to hold statutory registration with the HCPC to practice. For those with a science background, registration is voluntary.

The 2025 RTCT Workforce survey revealed a diverse set of training backgrounds among the workforce: with nearly half of the professionals trained as radiographers, while the remainder entered the field through clinical technologists, physics or other pathways, as displayed in figure five. [44]

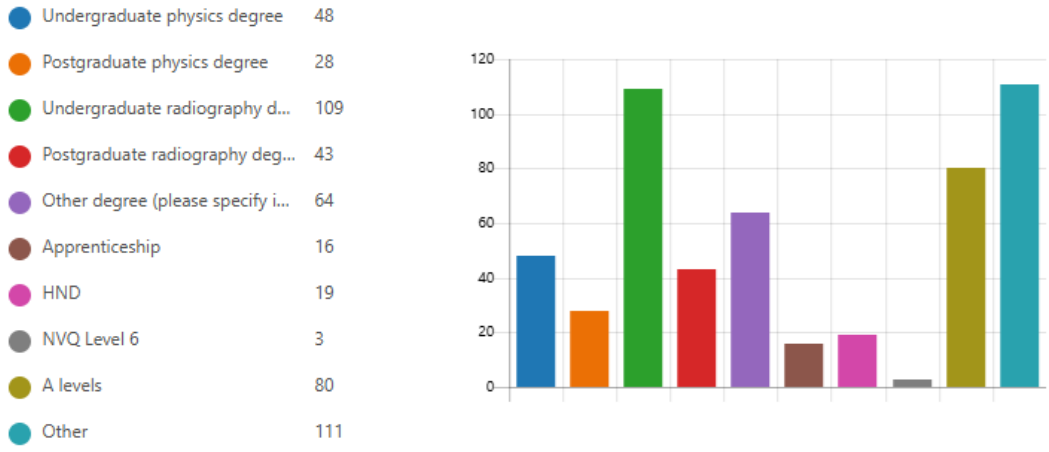


Figure 5: Workforce diversity [44]

This diversity highlights the need for a more unified approach to training regardless to how staff come to the profession. This lack of mandatory registration has led to more than half of the RTCT workforce remaining unregistered.

In the most recent Head of Physics survey around 33% of the workforce are registered and this is not acceptable for current practice in a rapidly evolving field. [44]

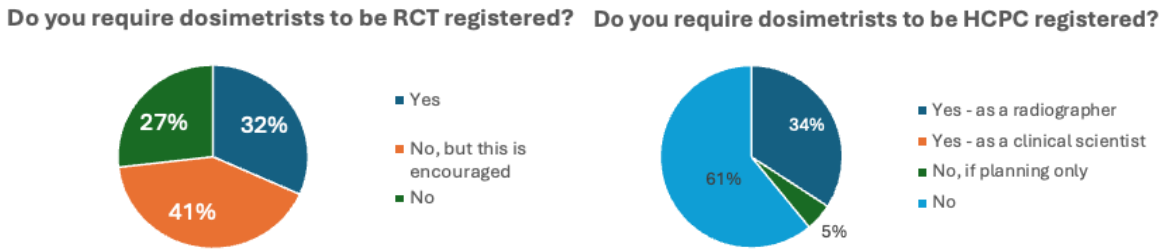


Figure 6: Registration requirements for Dosimetrists. [44]

A key finding of the RTCT 2021 Workforce study was that 29% of respondents stated they were not involved in any CPD scheme. [43] This is due largely to the unique background profile of the UK radiotherapy workforce as already outlined. The lack of CPD among a substantial portion of this workforce raises concerns about ensuring safe and effective clinical practice. Towards Safer Radiotherapy Guidance states all radiotherapy professionals must maintain up to date CPD records along with appropriate ongoing training. [53] This is particularly pertinent for radiotherapy professionals due to the 'fast pace' of change in radiotherapy as new techniques and equipment are introduced, thus appropriate training must be in place and evidenced. This situation strongly supports the argument for mandatory statutory registration for all RTCT's, and mandatory CPD audit submissions to adhere to regulatory guidance as a crucial step towards ensuring the adequate standards of patient care.

Urgent Workforce Crisis and Demographic Gaps

The profession is facing a notable increase in retirements in the coming decade, which will consolidate the impact of significant risk already outlined. The most senior and experienced RTCT's, are essential for clinical leadership, mentoring programs, complex troubleshooting and enabling succession planning.

In the 2023 Workforce Census undertaken by IPEM there was a 7% deficit in WTE (whole time equivalent) staff already, with 70% of Centres reporting they did not have enough RTCT staff in post. It is reasonable to assume this trend will have continued over the past two years. In addition, 31% of centres responded with that they do not currently support Clinical Technologist training. [45] This may be due to the pressure and time requirements associated with training, and the lack of structured mandatory education underpinning mandatory registration.

This is echoed in the 2025 Head of Physics Workforce survey which states that 63% of responding Centres are currently unable to facilitate the IPEM Clinical Technologist Training Scheme as they were not accredited by IPEM to do so. [44] A similar percentage, 69%, stating they need support from IPEM to enable them to do so.

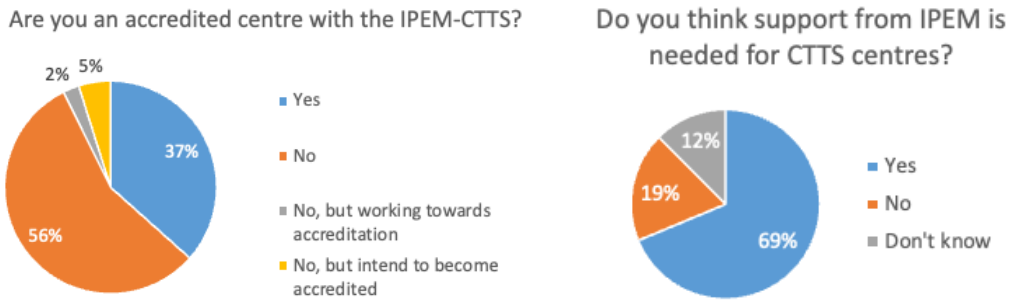


Figure 7: IPEM Clinical Technologist Training Scheme uptake. [44]

Recruitment into the profession is hindered by the lack of mandatory registration and the associated education and training programmes, with associated uncertainty regarding career progression, and limited adoption of advanced practice roles compared to mandatory regulated professions. Training is also hindered by the lack of recognition / mandatory need for education in the context of funding constraints.

The latest edition of the IPEM Radiotherapy Workforce Calculator was released in July 2024. [46] It estimated, last year, that to allow the current workforce to function and expand effectively, the current numbers of RTCT staff in post would need to increase by 24%. As stated there is no nationally funded supernumerary training route as already exists with other radiotherapy professional group peers - Radiographers and Clinical Scientists – who have a statutory and therefore mandatory framework.

Unfortunately, while the UK is unable to provide sufficient new recruits into the field there are also limited options to recruit internationally. Candidates encounter challenges such as unclear equivalency and recognition processes. It is crucial to establish clear and transparent processes to guarantee that no positions remain unfilled and ensure the UK would be seen as an attractive option to relocate.

A statutory mandatory framework is required to support Clinical Technologist training, to harmonise skill sets and competence and maintain consistency. It is urgently needed to counteract the ongoing trend in the workforce shortfall which will lead to increased risks to the patients and may be a contributing factor to increased levels of RTE's.

The report illustrates the current workforce is not sustainable without an effective plan of action. An unsupported RTCT workforce will ultimately compromise patient care and safety. This has been shown to already be happening, with the deterioration in the 31-day access target for radiotherapy. The UK operational standard for this measure is 96%.

In April 2025, 91.3% of patients waited 31 days or less. This is consistent with April 2024 which was 91.1% then there is a steady decline from 91.9% in 2023 and 92.8% in 2022. [47]

The increase in patients requiring radiotherapy due to the 1 in 2 lifetime risk of cancer, the impact of government 'diagnosis early' screening schemes, along with the continuing fallout of the pandemic on complex and advanced cases and delays in diagnostic reporting ultimately create a bottleneck. Alongside this is the introduction of SABR advanced radiotherapy delivered in a shorter treatment interval which is indisputably beneficial to patients. However, the pressure within the 31-day pathway moves directly into the planning stage overseen by the RTCT workforce. All of these factors place further pressure on radiotherapy planning departments as the final gatekeepers to a patient starting their treatment. It is the 2/3-week carepath (Figure 4) which the RTCT is responsible for which sees the most pressure to effectively counteract delays in the prior diagnostic and clinical workup.

Effects of Inconsistent Guidance on Competency, Training & Professional Standards

The lack of mandatory / statutory registration and the limited available enforcement of voluntary schemes result in gaps in legal protection for professional titles, continuing professional development, and ultimately professional discipline. This leads to inconsistencies within the workforce and varying training standards.

Differences in regulatory requirements can lead to RTCTs in neighbouring trusts and indeed across the UK having varying levels of qualifications and training. Employers, lacking enforced standards, may be confused about the optimal skill mix for their teams and uncertain about how to recruit and train RTCT's, as well as how to ensure current and ongoing comprehensive competency. As shown in Figure seven, Heads of Radiotherapy Physics across the UK are unsure how to tackle this issue within their own teams. This inconsistency heightens risks for staff, patients, and the reputation of healthcare science services. In some centres, two RTCT's performing identical roles may have vastly different qualifications and no requirement regarding ongoing training or competency assessments. The need to move forward together with advancing technology and techniques indicates that it is critical that harmonised minimum standards are found to build a common foundation, helping to ensure a unified competent workforce for the future.

Fatigue and Staffing Pressures

Chronic staff shortages, increasing patient volumes, and limited career development opportunities have also introduced risk, ever more apparent since navigating a global pandemic and ongoing pressures on cancer services. Understaffing has long been shown to lead to burnout, fatigue and increased levels of occupational stress which are major contributors to errors such as missed QA steps, rushed plan checks, or inadequate handovers. [48, 49]

The role of an RTCT is physically and emotionally challenging. As demonstrated, the staff perform many varied and complex tasks across the patient carepath. Research underscores the importance of addressing compassion fatigue specifically within a patient facing workforce, as it can impact the well-

being of RTCT's and thus the quality of care provided to vulnerable cancer patients. Further investigation into effective coping mechanisms is warranted. Improving morale by increasing the need for mandatory continuing professional development and minimum education and competence standards that underpin professional recognition will help greatly with this.

Additionally, the growing number of retirements and recruitment challenges for senior RTCT positions has resulted in reduced mentorship and increased workloads for remaining staff, creating an environment prone to near misses and adverse events. Teams are understaffed and trying to maintain a service while pushing to meet governmental cancer access targets, implementing and managing new techniques and equipment and providing quality care to their patients. RTCT's are human and thus vulnerable without appropriate education, oversight and support. [47] This has been demonstrated to be heterogeneous at best and will remain so without a statutory mandatory framework to underpin the workforce.

Rising Error Reports

The latest IR(ME)R Report from the CQC for 2023/24 revealed 244 SAUE notifications, 44% of which were in the planning and image verification category. [50] 168 were IR(ME)R operator related with 52 related to immobilisation and patient setup instructions given. 32 within the planning process with incorrect patient history, inappropriate plan generation and verification, and incorrect planning data used. Each report unfortunately highlights a patient whose care was impacted to some extent, along with a team that is undergoing self-examination and systems review.

Many incidents have a component related to communication failure. Inconsistent handover processes and a lack of shared language or standards can result in critical patient information - such as unique patient anatomy, psychosocial risk factors, or previous adverse events - being overlooked. Centres that lack a robust incident learning culture are particularly vulnerable to repeating mistakes, as lessons from near misses are not shared or systematically incorporated into improved workflows.

RTCT staff working within the private section within the UK is also a concern, as although they adhere to the overarching governance within the legislative IR(ME)R and IRR regulations, they may not be required to report all Towards Safer Radiotherapy defined levels of incidents, although this can be undertaken on a voluntary basis vital learning may not be transferred to the workforce. [53]

Professional Parity, Professional Identity and Patient Confidence

Statutory registration establishes consistent ethical, educational, and fitness-to-practice standards for RTCT's, ensuring accountability and aligning their practices with other regulated health professionals including those in performing exactly the same roles. Consistency would enhance patient trust, facilitate

effective management of complaints and incidents, and aligns and harmonise our UK wide practice with international accreditation standards for oncology services. It would also provide equity and recognition to a professional group who are integral to the delivery, safety, and development of the cancer patient pathway.

RTCT's would be recognised within and beyond the field of oncology as essential, highly trained practitioners. Statutory regulation would boost morale, provide a framework for interdisciplinary education, and create clearer pathways for career advancement and leadership.

Standardisation and Modernisation

Given the rapid pace of technological advancements, the collective RTCT workforce must be able to proactively address new technological demands by staying up to date and adapt their practice safely to emerging methods to ensure optimal patient outcomes and maximise safety. The first step is to create a sound foundation for the current workforce with consistency across the UK. Statutory regulation would require regular revalidation and mandatory continuing professional development, ensuring that the RTCT workforce remains current, competent and prepared for future developments.

Technical Safeguards

Every RTCT would be re-validated on essential or advanced competencies for their scope of practice, reducing the risk of errors from outdated practices and facilitating safe, planned upskilling for innovation. Currently to gain entry to the RCT register the candidate will be assessed against the Scope for Radiotherapy Physics Technologists which is basic entry to the profession. [51] It has not been updated to reflect the enhanced and advanced practice that is already present within the workforce. Also, it does not represent modern techniques e.g. it only covers basic planning operations. As such there are currently no safeguards to assure competence of modern radiotherapy planning and the demands of the role.

As adaptive planning advances there is a narrow window in which to determine an updated scope of practice to ensure the most experienced treatment planners i.e. the RTCT workforce is united to take this development forward into standardised care. The 2025 workforce survey shows that RTCTs are already heavily involved with such but there is no regulated oversight into the training undertaken to perform this advanced role. [44]

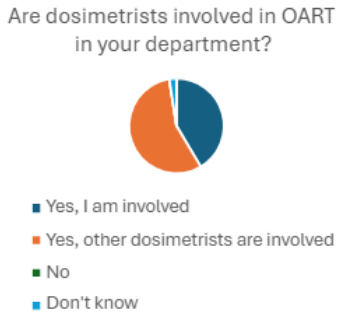


Figure 8: Involvement of RTCTs in OART. [44]

Recognition of Advanced and Consultant Level RTCT Roles

There is an identified need to develop the RTCT career pathway to align with the career advancement of Radiographers and Clinical Scientists. This has been recognised in Scotland the recent "Redefining the Workforce" publication from Scottish Government. These staff groups are colleagues, working side by side and contributing to the same patient care path, and when assuming the same level of responsibility with associated risks to the patient, there should be no distinction in statutory registration status. The 2025 Dosimetrist Workforce Survey indicated that most responding staff members are already working at an advanced level (NHS Employers, Agenda for Change, Band 7). [44] However, the fact that half of these staff are neither regulated nor registered with a professional body, nor do they engage in regular CPD, clearly highlights the need for these measures to be implemented.

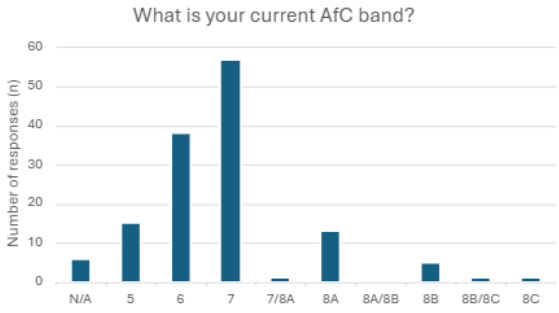
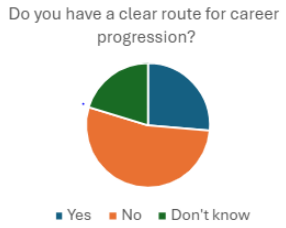


Figure 9: AfC banding for RTCT [44]



The 2025 Workforce Survey [44] notes the significant experience of many respondents, up to 45 years with the mean being 13 years in role. Sadly, out of these respondents, 75% felt they have no clear route to progress in

their role with a glass ceiling evident at AfC band 8a which is a management role rather than an advanced clinical role.

Years post-qualification	
RANGE	0 – 45 years
MEAN	13.79
MODE	8
MEDIAN	12

Figures 10 & 11: RTCT routes to career progression. [44]

Unlike their colleagues who can progress to AfC band 8a and band 8b for Advanced and Consultant Clinical Roles as statutory registered staff. There is a crucial equality at e.g. a HCPC registered Radiographer and an RCT Technologist can be in the same role but the radiographer who may have less experience that the technologist can progress because of their registration. A detriment to recruitment and retention in a workforce vital to deliver cancer services in the UK.

Curriculums such as the Non-Surgical Oncology Advanced Practice Framework and Towards Safer Radiotherapy call for advanced practitioners to hold statutory registration and thus can be seen to actively discriminate against advanced practitioners from a Technologist background and deter Heads of Physics from developing their RTCT workers due this complexity. This ultimately affects morale, reduced staff retention and interest in the field. [52] [53]

Long term Workforce Planning and Resilience

A further benefit from RTCT statutory registration would be improved workforce planning and the ability to provide real-time insights into staffing levels, upcoming retirements, and critical shortages, allowing for proactive recruitment and training strategies.

Partnerships with universities and professional body training providers could be utilised as accredited options, to ensure workforce planning and training stays consistent with modern radiotherapy practice and knowledge requirements. These obviously exist for statutory registered professions. Confusion around PSA accredited registers and their voluntary nature does not foster the same level of support. Initiatives should be developed to educate patients and the public about the essential roles of registered RTCTs, to foster confidence and understanding of the profession, as well as to raise awareness of this rewarding career option among students in schools and universities.

Conclusion

Challenges in the UK radiotherapy planning carepath arise from increasing clinical and technological complexities, inconsistent regulatory frameworks and obstacles, leading to and exacerbating workforce instability. Incidents including: fatal significant adverse and unintended exposures, adverse toxicity such as severe GU, cardiac and thoracic complications in SABR cases, and quality assurance failures highlight the urgent need for robust statutory registration of RTCT's. The complex and diverse tasks which the RTCT workforce completes within their role are critical to the flow of the patient care path yet are unseen and unknown to those outside of the radiotherapy sphere.

Patient safety is defined by the World Health Organisation as *"the absence of preventable harm to a patient and reduction of risk of unnecessary harm associated with health care to an acceptable minimum."* [27]

Within the broader health system context, it is *"a framework of organised activities that creates cultures, processes, procedures, behaviours, technologies and environments in health care that consistently and sustainably lower risks, reduce the occurrence of avoidable harm, make error less likely and reduce impact of harm when it does occur."*

It is clear that there is an urgent need to protect patients through ensuring minimum, certified levels of competence, knowledge and skills that can only be provided through statutory regulation. [46]

Unified statutory registration of *all* members in this workforce is vital for recognising the important contributions of RTCT's. These professionals are crucial for ensuring the reliability of cancer services in the UK and for supporting safe innovation in the field.

The evidence clearly indicates the pressing need to address these challenges and enhance patient safety in radiotherapy. It is time for a collaborative effort to establish statutory registration for RTCTs as an essential aspect of radiotherapy practice in the UK.

By advocating for RTCT's and supporting statutory registration, we can create a safer future in radiotherapy that prioritises patient well-being, raises the standards of care, and moves towards a healthcare system where patients are more secure with assured levels of cared.

Such reforms promise to improve patient-centred care, enhance treatment outcomes, and create a resilient, skilled RTCT workforce, which is essential for maintaining and advancing oncology therapy in the UK.

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Section 3: Radiation Engineering Clinical Technologists

Overview

Radiation Engineering is a specialist area within the Clinical Engineering profession, focused on delivering technology services that ensure the safety, compliance, and clinical effectiveness of medical equipment used in diagnostic and therapeutic procedures involving ionising radiation. [1] Across the UK, approximately 400 Radiation Engineering Clinical Technologists (RECT's) work in hospitals. The majority are embedded within multidisciplinary radiotherapy services, often as part of radiotherapy physics teams. A smaller proportion support radiology services in diagnostic imaging departments.

Currently RECT's in this field do not have statutory registration and therefore the underpinning standardised pathways of education, training and testing of competence and a requirement for ongoing continuing professional development. There are therefore disparate levels of education and training and a lack of registration among a workforce who repair and calibrate complex radiation therapy and imaging systems with its obvious associated risks to large groups of patients across the UK and the overall provision of cancer care and diagnostic imaging services. Lack of statutory registration leads to employers not having mandatory national standards of education and training, therefore most of the training in the UK is carried out "in-house" although technologists do also receive device specific OEM-certified training. This in-house training is not recognised by equipment vendors nor professional bodies such as IPEM as its quality cannot be validated. The introduction of statutory registration would compel employers to ensure all staff have completed a training scheme to ensure minimal levels of competency, ongoing professional development in a rapidly developing field and the assurance of fitness to practice processes.

RECT's currently practicing, as PSA registration is not mandatory, do not need adhere to any CPD structure for their role which is both a detriment to workforce capability, cancer care pathways and diagnostic imaging services in the UK, and is a risk to large groups of patients.

In radiotherapy departments, RECT's, sometimes referred to as radiotherapy engineers, Linac engineers, or radiotherapy biomedical engineers, are core members of the multi -professional team including Clinical Scientists, Radiotherapy Clinical Technologists, Radiographers, and Clinical Oncologists that plan and deliver radiotherapy treatments. Explicitly, radiotherapy risks to patients include but are not limited to radiation burns, necrosis secondary to overexposure, in some documented incidences leading to paralysis of limbs or death. [2] As an example, at North Staffordshire Royal Infirmary it was discovered that 1000 cancer patients had received incorrect doses of radiotherapy for nearly 10 years. This occurred due to new computing systems being introduced for certain cancer

treatments. Consequently, a manual adjustment was erroneously and repetitively made to the data, changing the dose of radiation delivered. The error only came to light when technology was being updated a decade later – resulting in 1,000 cancer patients being incorrectly dosed. [3]

Core Responsibilities

Medical Equipment Management

Radiotherapy and radiology environments are among the most technology-intensive areas in healthcare. Equipment is highly complex, integrated, and subject to frequent technical interventions by multiple stakeholders, including original equipment manufacturers (OEM), estates engineers, and contractors. Radiation Engineering Clinical Technologists play a critical role in coordinating and managing these activities, ensuring compliance with standards, guidelines, and legislation while safeguarding patient care. [4] They provide specialist knowledge to ensure interoperability of multi-vendor equipment within clinical workflows, to release the full benefits of this technology for patients. Operating within certified Quality Management Systems, they deliver continuous improvement through audits, incident investigations, and feedback analysis. They also contribute to research, clinical audit, service development, and user training.

Procurement, Installation, and Commissioning

Radiation therapy and imaging systems are high-value, complex technologies requiring bespoke environments. These technologists are central to equipment selection, evaluation, and procurement, often leading installation projects. They coordinate OEM engineers, contractors, estates teams, and clinical staff to ensure installations are safe, compliant, and fit for the clinical purpose. They also manage risks during installation and support regulatory duties alongside Medical Physics Experts (MPEs) and Radiation Protection Advisors (RPAs), enabling acceptance testing and commissioning.

Maintenance, Quality Assurance, and Calibration

Radiation therapy and imaging equipment require ongoing maintenance and rigorous quality assurance. For complex systems such as linear accelerators, technologists receive OEM-certified training to perform preventive and corrective maintenance locally. Over a typical 10-year lifespan, they conduct planned servicing, fault repairs, and calibration, all under strict quality processes. They also perform independent QA checks with Clinical Scientists and Radiographers to guarantee patient safety and act as designated operators under IR(ME)R regulations. [5]

Updates, Upgrades, and Lifecycle Management

Keeping technology current involves managing software updates, hardware upgrades, and system-wide changes. Technologists often project-manage these processes, coordinating stakeholders and validating equipment post-update to ensure safety. At equipment end-of-life, they oversee decommissioning and disposal, ensuring compliance and supporting replacement planning. There are multiple articles over a long period of time documenting the risk from these aspects of practice that have resulted in the death of patients, or overexposure in large patient groups e.g. 5000 [6,7,8]

Innovation and Device Development

Radiation Engineering Clinical Technologists also contribute to clinical innovation, designing and manufacturing bespoke devices under MHRA and IPEM guidelines. [9] Regulatory reforms are expected within the next 12 months and they will be instrumental in providing compliance with the new legislation. [10] The risks associated with innovation, including mismanaged upgrades – including software, failures in engineering control, resulting in patient's overexposure and death has been well documented. [11, 12]

Summary

Radiation Engineering Clinical Technologists are essential to the safe and effective delivery of radiotherapy and diagnostic imaging. Their expertise spans equipment management, compliance, project leadership, and innovation, ensuring that critical medical technology performs reliably throughout its lifecycle. The risk associated with their practice requires the assured education structure and assurance of ongoing CPD underpinning professional practice that only comes via statutory regulation.

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Section 4: Diagnostic Radiology (DR) Clinical Technologists (Radiation Physics)

The Ionising Radiation (Medical Exposure) Regulations 2017 govern the safe and effective use of ionising radiation in diagnosis and treatment. Clinical Technologists provide the technical expertise required to ensure that healthcare providers are working within the requirements of this legislative framework. Historically, the focus of this work has been the technical performance of x-ray equipment, but as medical exposures become more frequent and less centralised, and equipment and procedures become more complex, the Clinical Technologist workforce is taking on more advanced roles. Examples of this are the provision of training, audits of legislative compliance, and assessment of the radiation dose and risk associated with medical exposure. In these and many other scenarios, Clinical Technologists work in a similar way to HCPC registered Clinical Scientists in supporting the work of certified Medical Physics Experts (MPEs).

DR Clinical Technologists play a vital role in quality assurance and optimisation of radiation exposure in many of the most-used imaging modalities including CT, interventional fluoroscopy and diagnostic X-ray imaging. The Clinical Technologist workforce is also heavily involved in the breast screening programmes where performing quality assurance and optimisation of radiation exposure is of particular importance when screening a healthy population.

As the equipment used in diagnostic radiology continues to rapidly increase in complexity, the skills and knowledge of the Clinical Technologist workforce have of necessity been likewise developed to keep pace with technical advancements.

Medical exposures are carried out by HCPC registered Radiographers using equipment that is set up and monitored by Clinical Technologists. Radiographers rely heavily on the technical knowledge and expertise of the Clinical Technologist workforce to keep patients safe.

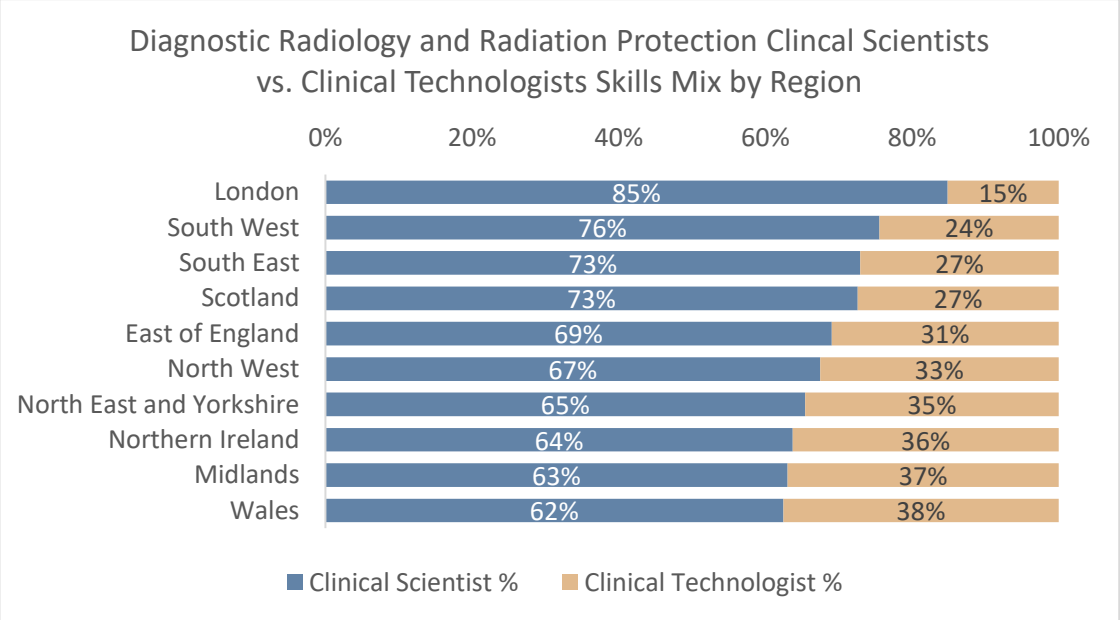
A case example has been collated from DR Clinical Technologists (DRCTs) in Southeast Wales, DRCTs are responsible for the development, maintenance and testing of software which underpins the measurements, analysis and documentation throughout the radiation protection service. Reliable programming and well-structured data collection tools are crucial for analysing diagnostic radiology equipment testing and radiation protection activities. Well-designed software ensures ease of use and accurate data processing thereby minimising human error and ensuring safety and regulatory compliance.

DR Clinical Technologist Workforce (IPEM workforce survey)

The Institute of Physics and Engineering in Medicine (IPEM) carried out a survey of the UK Diagnostic Radiology and Radiation Protection (DR & RP) workforce in May and June 2024. The scope of this survey is broader than the patient safety role for which statutory registration is required – the same workforce ensures the safety of staff and the public, as well as patients.

The data below is extracted from the full report to highlight the size and spread of clinical technologist workforce in DR & RP. This report also raises the speed and size that the workforce should expand at over the next five years to meet the current and projected desirable numbers of WTE posts as well as the difficulty filling vacant posts.

The estimated establishment of Clinical Technologists in DR&RP is 167.6 WTE, with a 13% vacancy rate. Vacancy rates in DR & RP are higher than in other Medical Physics specialisms (though unsustainably high vacancy rates are present across specialisms). Respondents were asked to indicate the number of staff that they felt were desirable for running safe and effective services. The number of Clinical Technologists currently in post is approximately 55% of total desirable staffing levels; 81% of centres report too few Clinical Technologists. On top of this, the report predicts the need for an additional 25-50 WTE Clinical Technologists to ensure safety in the planned expansion of NHS imaging capacity.



The figure above shows the variation in the relative proportion of clinical scientist and clinical technologist posts in the UK DR&RP workforce, ranging from 15% in London to 38% in Wales.

Nationally, there are some senior technologist roles that overlap the role of the clinical scientist in several areas. Respondents highlighted the risks associated with a Clinical Technologist establishment that is too small. Clinical Technologists may be under-utilised, particularly if many of them feel that the only way to progress is by becoming a Clinical Scientist. This may introduce inefficiencies into the DR & RP workforce, if Clinical Scientists must complete tasks that can be done by Clinical Technologists. Within the financially constrained context of the NHS, these inefficiencies impact on patient safety.

Ionising radiation is an invaluable tool in the diagnosis and treatment of disease. However, its use is not without risk. Staff in DR & RP are responsible for supporting employers to have sufficient management and governance processes in place for the safe use of ionising radiation. Inadequate DR & RP staffing introduces risks such as delivering unsafe radiation doses to patients. Inappropriate management of radiation safety can result in higher radiation doses to patients and staff resulting in increased risk of stochastic effects such as cancer.

Inadequate DR & RP staff may negatively impact the quality of medical images produced. Clinical work is reliant on high-quality, accurate imaging: if this is affected, the risk of missing a diagnosis, or delivering an inaccurate diagnosis, greatly increases. This delays and disrupts timely delivery of patient care, which directly impacts health outcomes. More broadly, missed and inaccurate diagnoses erode trust in health services from patients and the public, which introduces further disruptions to patient care.

Current staffing shortfalls exist at a time with an increasing amount and complexity of medical equipment and increasing numbers of scans being performed. This combination is likely to negatively impact staff morale. Lack of capacity to provide an optimal service to patients is discouraging to staff; work-life balance is also affected by staffing shortfalls. This may lead to burnout and difficulties with staff retention. Historically, staff retention across all Medical Physics disciplines has been high. However, the DR & RP profession may not be able to take this for granted in the current professional climate. Preliminary evidence taken from IPEM's first State of the Profession survey suggests that substantial numbers within DR & RP – as well as across Medical Physics and Clinical Engineering – have considered leaving their current workplace. This will make it more difficult to attract new staff into a profession that is already experiencing a workforce shortage.

Evidence of work performed by the Clinical Technologist workforce

As the workload has increased, it is the Clinical Technologist workforce who have been at the forefront of understanding the operation of this ever more complex equipment and its technical performance. The oversight that Clinical Scientists were once able to provide is now impossible, and Clinical Technologists are working with a significantly greater degree of autonomy.

Of the 804 test events 204 (25%) resulted in remedial fails where the manufacturer engineers were needed to rectify performance faults with equipment that could lead to poor image quality and therefore repeat imaging and therefore an increased risk of cancer induction to the patient or misdiagnosis of patients. 80% of these faults were found by Clinical Technologists.

An additional 70 (8.7%) test events resulted in a suspension fail where the faults were so significant that the x-ray units had to be immediately removed from clinical use. This action will have protected patients from considerable harm if the x-ray units continued to be used. It is important to note that these units were in clinical use until the faults were discovered. 92% of these faults were discovered by Clinical Technologists.

There were also 112 new pieces of x-ray equipment that were commissioned, where intensive testing was performed to ensure the equipment was performing as stated, and safe for clinical use including setting the correct dose levels of equipment. 78% of this testing was done by Clinical Technologists. There were 105 test events after engineers had repaired faulty x-ray equipment, requiring high level decision making on the performance and safety of the equipment. 76% of this testing was done by Clinical Technologists.

For the Welsh Breast Screening Program, there were 209 tests of which 45% were performed by Clinical Technologists. Quality assurance is vital in a screening service, and hence the equipment QC intervals are 6 monthly to reflect the harm that could be done to the healthy population screened if the whole imaging chain is not closely monitored.

Evidence of importance

With the large number of diagnostic exams taking place each year even a small error by a Clinical Technologist during the setting of dose levels or a missed fault during the QA, could have a detrimental effect on a very large number of patients. To illustrate this, the data in the following table is taken from the published NHS England imaging activity statistics for the year 2023/24.

Modality	**Examinations for the Year 23/24**
Computerised Axial Tomography	7,681,150
Fluoroscopy	912,195
Plain Radiography	22,576,650
Total	31,169,995

As another example, the following table shows activity from a screening service where Clinical Technologists play a vital role in ensuring quality and safety. This data was taken from the Breast Test Wales Annual Statistical Report 2021-22.

Welsh Breast Screening Service	**Examinations for the Year 21/22**
Breast Screening Activity	108,179

Evidence of potential harm

Clinical Technologists identify faults in imaging systems. If undetected, these faults could lead to a failure of diagnosis or to inappropriate treatment. As imaging systems become more complex and software-driven, the technical expertise required to identify these faults has increased.

Clinical Technologists provide the technical expertise to calibrate and monitor automatic controls of radiation exposure. If a suspension-level fault in one of these controls in an X-ray room went undetected and doses were 50% higher than intended for a year, it is estimated that there would be an additional 1 in 100 chance of an individual developing cancer due to this miscalibration.

In interventional fluoroscopy, high radiation doses to the skin result in skin injuries (e.g. erythema, hair loss, and desquamation). Clinical Technologists are responsible for checking the dose rates (including before first use of these systems) and failure to do this properly could lead to unnecessary injuries. In some cases, skin injury is an acceptable side effect of life-saving intervention, but appropriate management of patients at risk of these effects requires accurate quantification of the skin dose. Clinical Technologists assure the calibration of the measurement systems which are used to determine patient management.

During the financial year the Clinical Technologist team found several errors in X-Ray rooms across Southeast Wales where the automatic exposure control (AEC) systems were not working correctly, or the dose calibrations had failed. Examples are:

- An orthopaedic clinic room that saw twelve thousand patients a year. Here, the AEC system had failed and was giving hugely variable doses to each patient. This would have meant that some patients would receive a higher dose than necessary and others may have had to have examinations repeated due to poor image quality.
- An AEC safety back up had reset to factory settings, with the safety backup dose setting being over ten times the intended value. In this case, had there been a problem with a patient x-ray, the radiation dose received by the patient would have been over ten times higher than the usual safety backup.

- Multiple occasions where equipment was not producing the setting requested by the user. Undetected, this could have resulted in image quality problems and consequent unnecessary repeat x-ray exposures.
- Errors found in the beam alignment of units that meant that patients were receiving additional dose to areas of their anatomy where no diagnostic data was being collected. One of these was in a vascular interventional room where the x-ray beam was far greater than the size of the image produced. This meant that there was over exposure to the patients and possible exposure to staff due to the beam being larger than they could visualise on screen.

Outside of this case study there are multiple authoritative sources documenting harm e.g. notifiable IR(ME)R incidents.

- **Mammography after service work**: multiple patients received mammograms with incorrect exposure factors because the unit was left in manual mode rather than AEC *after a tube change*; this wasn't picked up by QA or pause-and-check and only later spotted by an operator. [1]

- **Inadequate equipment testing**: across 15 diagnostic imaging inspections in 2023/24, CQC's most common non-compliance included Reg. 15(3): failure to undertake adequate testing of equipment, i.e., poor checking/QA that directly elevates patient-harm risk; CQC also issued an Improvement Notice to an independent provider citing weaknesses in the equipment QA programme. [1]

- **Equipment faults** in breast imaging leading to SAUEs – Healthcare Inspectorate Wales' anonymised analysis for 2023/24 shows mammography notifications caused by equipment malfunction (nine notifications in that cohort), contributing to unintended exposures in diagnostic radiology (80 patient notifications; 73% of all). One incident in Wales met the clinically significant threshold that triggers duty-of-candour to the patient.[2]

- **Paediatrics are a group particularly at risk:** CQC paediatric inspection programme (specialist children's hospitals, England), documented gaps in equipment quality assurance in paediatric services (QA often carried out by radiographers without a dedicated QA role; reliance on IPEM 88 acceptance/constancy tests but with patchy local routine testing/monitoring), and poor understanding/usage of paediatric DRLs, both of which increase the risk of inappropriate dose to children if protocols/equipment are not set or checked correctly. The report documents that children are more radiosensitive, so failures in optimisation/QA disproportionately risk harm. [3] The report stresses the need to increase scrutiny of routine QC and maintenance, to manage equipment falling below performance standards.

- 2024/25 diagnostic imaging section shows **~18% of notifiable incidents were equipment-related**, with specific learning from detector selection errors causing repeat exposures (a scenario that commonly occurs in extremity and erect bucky workflows used in children). IR(ME)R annual report 2024/25 Diagnostic imaging - Care Quality Commission (Accessed 24/10/2025).

The broad range of diagnostic modalities and the rapid advancements in technology within diagnostic radiology emphasise the importance of continuing professional development (CPD) for Clinical

Technologists. Robust requirements for CPD are essential to keep their skills and knowledge up to date, thereby ensuring patient safety. With no requirement for registration, this safeguard is absent.

The absence of statutory registration leads to hesitancy in fully utilising the Technologist workforce, as there is less confidence in the assurance of competency. This has resulted in Clinical Scientists performing tasks they may not be adequately trained for e.g. within Clinical Technologists scopes of practice and unnecessary supervision of Clinical Technologists. Given the current challenges in training, recruitment, and retention within the Clinical Scientist workforce, this situation is both impractical and exacerbates the strain on the system, increasing the risk of patient harm.

As highlighted by the exposure data, even small errors in the setup of diagnostic equipment can have a significant impact on patient safety both individually and at the level of a populace. Ensuring confidence in the expertise and quality of the Clinical Technologist workforce is vital. The most effective solution to address these concerns is the establishment of a statutory register for Clinical Technologists. Such a register would ensure that Technologists participate in ongoing professional development, which is essential for maintaining their crucial role in diagnostic radiology. Ultimately, it would serve to protect the millions of patients who undergo diagnostic scans annually.

State registration for DR Clinical Technologists is not only critical for patient safety but also for tackling issues related to recruitment, retention, and career development which ultimately determine the ability to field effective and safe patient services. It would contribute to a clear pathway into the profession, attracting skilled individuals who value professional recognition. With state registration, employers can offer structured career development opportunities, enhancing job satisfaction and reducing turnover. Additionally, it ensures continuous training and development, enabling Technologists to keep pace with advances in the field. In setting minimum mandatory certified skill levels, state registration of Clinical Technologists will foster a standardised, safe workforce, harmonising competence with a requirement for ongoing continuing professional development and therefore reducing the risk of harm to the large body of patients they serve.

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Section 5: Non Ionising Radiation Clinical Technologists

Clinical Technologists in Non Ionising Radiation work in one or more of the following areas including Optical Radiation, Ultrasound, and Magnetic Resonance Imaging (MRI). They are involved in ensuring the quality and safety of equipment used in patient treatment and diagnoses including Ultra Violet (UV) Phototherapy, Surgical and Ophthalmic Lasers, Ultrasound and MRI scanners.

Currently, Clinical Technologists in Non Ionising Radiation scopes are not statutory registered, with potential for patient harm due to lack of mandatory standardised training programmes, associated with profession regulation and ongoing continuing development.

Statutory registration ensures that registered staff are knowledgeable and competent to carry out their role by meeting a mandatory nationally defined set of minimum standards. A HCPC register would establish the professional status of Clinical Technologists in Non Ionising Radiation, supporting the case for funded training and creation of much-needed additional posts to address the significant workforce shortages in the Non Ionising Radiation sector. Recent IPEM workforce reports identified that a current increase of approximately double the existing workforce would be required to meet desirable staffing levels. The lack of structural support associated with voluntary registration is exposing patients to unnecessary levels of risk.

Poorly trained Clinical Technologists in Non Ionising Radiation or inadequate staffing can put patient, staff and public safety at risk through the delivery of poor-quality services. Some case examples of how Clinical Technologists in Non Ionising Radiation can impact patient care are detailed.

Non Ionising Radiation Clinical Technologists currently do not have agreed Scope of Practice, nor an option to register with a PSA accredited register such as the Register of Clinical Technologists. This underscores the current level of heterogeneity in standards of education and training as well as requirement for ongoing CPD. IPEM PSC has oversight of an active work group that is working with RCT partners to address this issue.

UV Phototherapy

Narrowband UVB (NB-UVB) Ultraviolet Phototherapy and psoralen-ultraviolet A (PUVA) photo chemotherapy use hazardous Ultraviolet (UV) light to treat skin conditions including psoriasis, eczema, and vitiligo. Patients receive a course of phototherapy or photo chemotherapy in fractionated sessions. In order to deliver a particular dose, it is necessary to determine the irradiance (power per unit area) of the phototherapy unit. [1,2]

The British Association Dermatology (BAD) standards and guidelines provide clear recommendations that all phototherapy devices should be evaluated, and safety checked by Medical Physics.[2,3] The service standards set out responsibilities in section 5 including regular calibration that is traceable to national standards, and regular checks to ensure equipment remains within safe limits. It is explicit that a Medical Physicist, or appropriately trained staff member, should be designated by each centre. The physicist will oversee measurements and ensure that local treatments are delivered to an acceptable level of accuracy.[3]

Clinical Technologists often perform and oversee the routine dosimetry measurements on both NB-UVB and PUVA devices. These measurements directly impact the dose the patient receives, and where the measurements are carried out incorrectly or there is an error in the calculations it can have unintended consequences, including reduced efficacy of phototherapy treatments or overdosing the patient, increasing the likelihood of moderate to severe erythema.[1,4,5] Overdosing a PUVA patient may also increase the risk of PUVA therapy –induced skin cancer due to the correlation between dose and increased risk.[5] It is important that the designated staff overseeing the measurements understand treatment dosimetry and its impact on clinical care through mandatory minimum standards for training and competence.

Ultrasound

Ultrasound scanners are a vital part of various screening programmes within the UK, including Foetal Anomaly, Breast, and Abdominal Aortic Aneurysm screening programmes. Quality assurance (QA) of ultrasound equipment is essential to ensure safety, correct functioning of equipment, and the accuracy and reproducibility of electronic calliper diameter measurements. [6,7,8,9,10] It is important that the Clinical Technologists undertaking Medical Physics QA testing of Ultrasound scanners are knowledgeable and competent in their roles, as studies have shown that defective ultrasound transducers can have an impact on clinical image quality and increase the risk of misdiagnosis.[12] Misdiagnosis can have very serious consequences, for example during a foetal anomaly scan where 11 physical conditions are screened [9]; a misdiagnosis may result in inappropriate clinical management of the pregnancy. Callipers are used to measure foetal abdominal circumference, head circumference, femur length etc. If the calliper calibration is out of tolerance this may result in inaccurate results, which in turn could lead to incorrect pregnancy pathway, unnecessary stress and recommendation of the abortion of a viable pregnancy.

Ultrasound safety monitored using the measurable safety indices such as Thermal Index (TI), mechanical index (MI) indicates potential of causing thermal and mechanical hazards during scans, and there are specific BMUS guidelines with limited tolerances for sensitive scans such as eye scanning and

obstetric scanning. Medical Physics tests monitor the MI and TI values for all clinical pre-sets and ensures that they are well within the allowed exposures to ensure no potential thermal or mechanical hazards will results during the scan.

There is also significant 'real world' risk from not having sufficient workforce to deliver routine physics QA testing of ultrasound systems. A 2019 Regulation Quality and Improvement Authority (RQIA) report found that during an audit of 127 Ultrasound systems in a region with no ultrasound QA in place, a fault rate of 61% for systems and 34% for probes tested was found. There were systems with issues, such as severe probe dropout or serious noise/interference that could potentially have a direct clinical impact.[11]

Appropriate regulated and trained Clinical Technologists would be able to advice on the quality of the ultrasound equipment and whether it is fit for clinical use being reliable stood up to existing know risks.

MRI

MRI is one of the most hazardous working environments in the hospital, with the ever-present strong magnetic field that extends well beyond the scanner limits and sometimes into other floors and rooms. Additionally, there are rapidly changing magnetic field and radiofrequency pulse that can also potentially cause harm to patients and staff. There have been serious injuries and fatalities associated with the electromagnetic fields in MRI. Clinical Technologists working in MRI must be aware of these hazards and work appropriately to ensure the safety of themselves and others. [13,14] The MHRA MRI safety guidelines offers clear guidance on training for anyone working in MRI. Clinical Technologists carry out a number of roles in MRI, which can include image acquisition and analysis for quality assurance purposes. A poorly functioning MRI scanner could lead to misdiagnoses and potentially patient harm. Regulation of Clinical Technologists would ensure a minimum standard of training and competence to work in this area.

Statutory regulation protects patients by ensuring a mandatory level of qualification and competence and ongoing development. This provides confidence in healthcare professionals and reassures patients that they are receiving high quality diagnoses and treatments with improved safety and efficacy. Regulation of Non Ionising Radiation Clinical Technologists would ensure a minimum standard of training and competence to work in area with known and significant risks from diagnostic and therapeutic procedures.

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Section 6: Medical Engineering Clinical Technologists

The uptake for RCT registration among Medical Engineering Clinical Technologists (MECTs) is markedly low. A case example comes from Scotland, where there are approximately 300 staff in post with only 25% registered. Most of those registered are experienced yet ageing e.g. nearing the end of their career. Within Scotland, less than 10% of staff that qualified within the last 10 years are now registered with the RCT – demonstrating a perceived lack of value or career relevance of PSA voluntary registration.

The immediacy and impact of risk related to the role of MECTs are significant due to the close relationship between their work and patient safety, medical device functionality, and clinical operations [1]. MECTs are responsible for the full-life cycle management of medical devices and systems that are often critical to life supporting and diagnostic functions. MECTs are employed in all hospital settings, in regulatory roles, in medical device design, in third-party service providers. [9] All these roles require a skillset that includes knowledge of engineering, clinical application and patient physiology.

The MECT workforce has an aging workforce and difficulties with recruitment means that staff are regularly appointed into Specialist roles with no medical equipment experience. Many Medical Engineering Technologists are employed within estates and facilities department and therefore don't have the surrounding Medical Physics and Clinical Engineering professional infrastructure. For those individuals, the assurance that would come from statutory registration e.g. mandatory programmes leading to minimum levels of competency and ongoing CPD is vital.

Risks are often immediate due to:

- Real-time patient reliance on medical devices (e.g., a calibration error in an infusion pump can cause under- or over-infusion instantly).
- Time-sensitive environments, like operating theatres and intensive care units, where equipment failure or misuse can cause immediate harm.
- Rapid response requirements in fault diagnosis and rectification where delays can critically impact patient outcomes.

The impact of any error, failure, or oversight by Clinical Technologists within Medical Engineering can be profound:

- Patient harm or death: Incorrect device setup or maintenance can directly lead to adverse clinical events.
- Legal and regulatory consequences: Incidents may trigger investigations under MHRA guidelines, CQC standards, or legal liability under health and safety laws.
- Operational disruption: Equipment downtime in theatres, wards, or diagnostic departments can halt clinical services.
- Reputational damage: Failures in device management can affect public and institutional trust.

- Equipment maintenance and calibration: Inaccuracies can lead to misdiagnosis or inappropriate therapy.
- Device user training and support: Inadequate support can result in misuse.
- Acceptance testing and commissioning: Missed faults in new equipment can propagate systemic risk.
- Innovation and custom design (e.g., bespoke patient interfaces or 3D printed aids): Poor design or testing introduces new risk vectors.

To assess the scale of the scale of the impact, there are approximately 100,000 infusion pumps, around 7,000 anaesthetic machines and 6,000 intensive care ventilators in the UK. Within a hospital environment there will be hundreds of different types of medical devices that these professionals will manage. The importance of this being down well is shown through Care Quality Commission audits in NHS England and similarly the Joint Commission in the United States of America requires similar reporting. [2] Originally the maintenance recommendations from manufacturers were always followed, but that no longer happens due to budgetary constraints. Instead, MECTs now routinely risk assess the maintenance requirements. This is mainly changes to testing frequency, but it could include changes to tests performed. When this happens, the risk moves from the manufacturer to the Trust / Health Board where the equipment is used. To do this well, it relies on the knowledge and experience of the MECT team.

MECT's go into patient's homes, to repair and service medical equipment. These may be for spinal injuries patients, long term-ventilation patients, etc. if this equipment fails there is a real risk of patient death or harm. [3] This is an expanding area of work with development of home-based equipment, e.g. the Hospital at Home.

With more medical devices being networked, this presents a new risk at scale. For example, the clinical configurations for infusion pumps. Originally, this was installed one pump at a time, but now all pumps can be updated with the touch of a button over the network. It will be a MECT that sets up the configuration and issues that to hundreds of pumps over the network. The configuration contains tens of patient safety critical decisions. A mistake in that configuration presents a real patient risk, e.g. the default pressure setting on the pump is changed. No longer is the risk associated with this one pump, but instead it could affect hundreds of pumps and therefore patients.

The role of MECTs includes the safe introduction of medical devices into the clinical environment. This means risk assessing the introduction and removal of medical devices. The professional makes sure the medical devices are fit for purpose, clinical staff are trained, they have the correct consumables available, H&S requirements are met and that the device is configured appropriately. At the end of a

device's life, they are responsible for ensuring that it is removed and disposed of safely and that any patient data is safely removed.

Medical Engineers are responsible for addressing patient safety issues, this includes investigating clinical incidents, producing reports on medical device failures, reporting failures to the MHRA, and raising these issues with the manufacturer including design flaws. [4, 5] Recent examples include a manufacturer changing their battery replacement frequency or changes to the design of wheels on a transport incubator following real world clinical issues raised by MECT's.

Health information technology has a great potential for improving patient safety but if managed poorly has a real risk of patient harm. Health information technology is often a medical device, their datasets need reviewed prior to introduction, they need to be commissioned safely, and maintained throughout their life, and their replacement managed, all this falls to the MECT. [6, 7]

There is the potential of harm from those employed in the private sector, there are many independent companies that offer medical device testing to: Trusts, GPs, dentists, etc. Trusts / Health Boards will review the training and competency of MECT staff employed in that role [8] but GPs, dentists, opticians, etc may not what to expect and create an unintended risk of poorly calibrated and unsafe devices being used. [9]

Physiological Measurement: invasive patient facing diagnostic practice

Physiological Measurement is a significant but under recognised area of Clinical Technologist practice. IPEM describes physiological measurement as the science of transforming physiological information into meaningful data to contribute to diagnosis or treatment, with Clinical Technologists performing clinical measurements on patients as part of multidisciplinary services involving Clinical Scientists, nurses, doctors, physiologists and engineers. [10,11] In practice this includes services such as urodynamics, upper gastrointestinal physiology, visual electrophysiology, microvascular and macrovascular assessment, intracranial pressure monitoring, pulse oximetry and spinal cord monitoring. [10] Some of these procedures are invasive or semi-invasive, including the use of urinary catheters, pressure sensors, pH sensors, specialist electrodes or intra-operative monitoring systems. [10] These activities may overlap procedurally with work undertaken in other pathways by nurses or medical staff, but the distinctive Clinical Technologist contribution is the integration of patient facing procedural skill with scientific measurement assurance: signal acquisition, calibration, artefact recognition, equipment performance, method limitations, quality assurance, reproducibility, interpretation of physiological data and technical reporting. Current NHS practice demonstrates that Clinical Technologists in Physiological Measurement services may undertake complex patient facing diagnostic investigations, perform and report urodynamic

tests to referring consultants, work autonomously, and make decisions and judgements that directly influence patient care. [12, 13] The regulatory issue is therefore not simply whether an individual can perform an invasive task, but whether the practitioner is consistently assured across the combined clinical, scientific, technical, interpretive and safety-critical dimensions of that task. Where such practice is undertaken by Clinical Technologists without a protected title or statutory registration, patients may be exposed to the same practical risks associated with invasive clinical procedures, compounded by risks from inaccurate measurement, poor signal quality, equipment miscalibration, inadequate infection control, misinterpretation, delayed diagnosis or inappropriate treatment decisions.

The need for mandatory statutory regulation is clear with voluntary registration among this group being very low and falling. Coupled to this is increasing complexity and networking of devices, many of which are migrating from the traditional NHS hospital environment to patient's homes, community settings and private care settings. Physiological Measurement illustrates a wider weakness in the current regulatory settlement: Clinical Technologists are not only supporting equipment used by registered professionals; in some services they are the autonomous patient-facing practitioner who performs, analyses and reports the investigation on which clinical management depends.

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Section 7: Rehabilitation Engineering Clinical Technologists

The term Rehabilitation Engineer (RE) can refer to Clinical Scientists, Clinical Technologists, Healthcare Scientists and/or Healthcare Science Practitioners. The individuals work within a wide range of multi-disciplinary services across the UK.

Rehabilitation Engineering Services [1] include:

- Posture and Mobility (P&M) e.g. Wheelchair Services, Custom Seating and Postural Management
- Electronic Assistive Technology (EAT) e.g. Specialist controls for powered mobility and alternative access to the computer and other technology
- Augmentative and Alternative Communication (AAC) and Environmental Controls (EC)
- Functional Electrical Stimulation (FES)
- Clinical Movement Analysis (CMA)
- Activities of Daily Living (ADL)
- Telehealth and Telecare

Approximately 52% of Rehabilitation Engineering activities occurs within Wheelchair and Posture Mobility Services within the UK. With 17% of the workforce working within EAT services including Augmentative and Alternative Communication (AAC) and Environmental Controls (EC) and 10% working within Gait Lab Analysis. The remaining percentage is made up with the other disciplines, including IT support. [2]

Currently Rehabilitation Engineers who are not Clinical Scientists are able to seek voluntary registration either through the RCT (Register of Clinical Technologists) or via the AHCS (Academy of Healthcare Scientists) as a Health Science Practitioner. Rehabilitation Engineers work in conjunction with other Allied Healthcare Professionals (AHP's) including Clinical Scientists, which are registered and legally protected by other healthcare governing bodies (i.e. HCPC). Working within these services typically as a multi-disciplinary team (MDT), many of the daily activities and core responsibilities to deliver a services provision, may overlap between the different AHP's and the Rehabilitation Engineers. However, due to the 'voluntary' nature of the RCT/AHCS registration, Rehabilitation Engineers are at potentially increased liability and risk, considering the role of the Rehabilitation Engineer requiring specific technical expertise and tailored training and knowledge to the same standard and discipline as their statutory registered colleagues.

Rehabilitation Engineers' responsibilities are outlined with competency requirements as provided by resources through IPEM and the Rehabilitation Engineering Services Management Group (RESMaG). [2]

These responsibilities mean Rehabilitation Engineers will be managing several risks within their profession, primarily related to the development and use of assistive technology and medical devices. These risks encompass patient safety, legal and ethical considerations, and potential for injury or harm. Therefore, ensuring that Rehabilitation Engineers are sufficiently trained to specific standards and have appropriate CPD management throughout their career is a critical for patient safety.

Summary of potential risks associated to Rehabilitation Engineering Services:

This section highlights some of the responsibilities of the Rehabilitation Engineers, with the associated risks and considerations required. [3,4,5] Many of the considerations are specific to Wheelchair Service and Postural Management services, however the risks highlighted can be related to the other disciplines of Rehabilitation Engineering. The impact of any error, failure, or oversight by Clinical Technologists within Rehabilitation Engineering can be profound to patients.

Rehabilitation Engineers are responsible for ensuring the safety and effectiveness of assistive technology, including wheelchairs, prosthetics, and other assistive technology devices i.e. voice output communication aids (VOCA) & VOCA mounting. These are typically conducted during a multi-disciplinary assessment/community domestically visit (patients' homes). Rehabilitation Engineers require the skills to work in collaboration with other healthcare professionals and relate technically complex information to other parties, including the patient. Inappropriate setup or incorrect misinformation of product use, malfunctions or improper design solutions can lead to patient injury or harm; this therefore means Rehabilitation engineers can face legal liability if the provision of assistive technology results in harm to a patient. To ensure that the design and development activities carried out by Rehabilitation Engineers comply with relevant regulations and quality standards - and to provide evidence of product conformity and safety when required by authorities - they compile technical files. These files include comprehensive documentation on product design, manufacturing processes, risk assessments, test reports, user information, and traceability records.

Rehabilitation engineers manage risks related to anatomy, physiology, and pathology of patients when designing and implementing assistive technologies. They require an in-depth-knowledge of the above to make sound clinical judgement when assessing, and issuing custom made Class 1 medical devices such as bespoke contoured seating to accommodate and/or correct postural abnormalities.

Without understanding the postural limitations and therefore implications to a patient correctly, postural seating may be ill-suited to a patient needs or even cause harm to both the short-term and long-term health. Incorrect seating or positioning within a prescribed seating system can lead to increased

pressure on the skin, potentially resulting in the occurrence of a pressure ulcer and further leading to more serious health conditions i.e. sepsis.

An incorrect set up of a mobility device (such as a Class 2 medical device - powered wheelchair) by a Rehabilitation Engineer can lead to various risks, including physical injury, decreased functionality, reduced quality of life or even death in extreme cases. These risks can arise from incorrect wheelchair stability setup, providing an inappropriate driving method to a patient and/or incorrectly programming a wheelchair driving system. The risk of misaligned programming can affect factors like wheelchair speed, acceleration, braking, and control responsiveness. Inappropriate wheelchair stability setup can increase the risk of dynamic instability when in motion, resulting in falls and potential significant injury, especially if the patient has not trained in their use.

Rehabilitation Engineers must ensure their work complies with relevant medical device regulations and safety standards. They generally work within a Quality Management System and, within requirements of standards such as ISO 9001, 13485, and 14971. Rehabilitation Engineers are expected to investigate and report any adverse incidents related to the medical devices they are involved with, including incidents where a device is suspected to have contributed to harm.

The Medicines and Healthcare Regulatory Agency (MHRA) receive reports of adverse incidents involving people seated in their wheelchairs in road vehicles. Many of these problems are caused by the incorrect use of the wheelchair and wheelchair tie-down in conjunction with the occupant restraint systems (WTORS).

As a result of this the MHRA provided guidance on the correct use of wheelchairs in a vehicle to prevent serious adverse incidents titled: Occupied wheelchairs in cars and private transport – reminders of safe use, which was published in March 2016. [6]

Rehabilitation Engineers, within wheelchair services particularly, are required to have an in-depth knowledge of wheelchair transportation guidance for manual and powered wheelchairs i.e. international standards ISO7176-19. Rehabilitation Engineers should also have a technical understanding of a custom-made medical device’s construction and their manufacturer’s guidance when used in transportation, understanding clinical implications to patients and be able to liaise with suppliers and/or transportation providers around the correct transportation of such devices. Referring to technical manuals where applicable or adhering to best practice guidance, as set out by the Posture Mobility Group. It is imperative that a Rehabilitation Engineer is able to identify when a medical device set-up or configuration is in breach of transportation guidelines and is capable of providing the necessary mitigating actions. This may involve collaboration with relevant stakeholders to reduce and mitigate

transportation risks as much as possible. The potential impact to a patient could lead to serious life changing injuries or death, in the case of a transportation collision.

With custom-made medical devices and 3rd party devices, Rehabilitation Engineers utilise risk evaluation documentation to support the systematic identification, assessment, and management of transportation-related risks.

Rehabilitation Engineers ensure that the most appropriate risk management solutions are implemented effectively. These solutions can take various forms, including providing advice to patients, creating specified user instructions, or assessing the setup and compatibility of equipment to ensure safe and effective use.

Rehabilitation Engineers actively participate in and contribute to national working groups focused on wheelchairs, specialised seating, and medical devices. Their involvement encompasses the development and review of national guidelines and standards, as well as oversight of safety, regulatory compliance, and device certification. This includes ensuring that equipment specifications, control standards, and safety requirements align with medical device regulations. Additionally, Rehabilitation Engineers play a key role in defining professional roles, competencies, and service functions within the specialty.

Rehabilitation Engineers may conduct operations within workshop settings, carrying out repairs, planned preventative maintenance checks or even manufacture of bespoke custom-made devices. This can include mechanical and electronic workshop practices depending on the discipline. Therefore, Rehabilitation Engineers require a robust understanding of workshop safety practices when working with tools and machinery, understanding and keeping updated with the latest Health and Safety Executive guidelines, in order to keep themselves, colleagues and patients safe within the working environment. This may also include the procurement of correct materials, ensuring patient safe materials, COSHH assessments and regulatory requirements to fire safety are being followed. These practises if not followed correctly could lead to an indirect influence on a patient's wellbeing and health.

Due to the nature of work conducted by Rehabilitation Engineers, staff would be working with vulnerable individuals, this requires staff to have adherence to ethical guidelines regarding dignity and respect (CQC, Regulation 10), confidentiality and patient privacy of vulnerable individuals.

The above scenarios and examples show the importance of correct and robust training of Clinical Technologists within Rehabilitation Engineering, with statutory registration a suitable way to ensure this is followed.

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Section 8: Sonographers / Sonography Clinical Technologists

Sonographers deliver ultrasound services across obstetrics, early pregnancy, gynaecology, general medical, vascular, cardiac, paediatric, musculoskeletal, breast, head and neck, emergency, community diagnostic and independent settings. Their practice is autonomous, operator dependent, interpretive and increasingly interventional. Unlike radiographers, nurses, midwives, podiatrists and physiotherapists, “sonographer” is not a protected professional title in UK law and there is no statutory register that assures sonographic education, competence, English language capability, continuing professional development or fitness to practice. [1-4]

The clinical risk arises because ultrasound is not simply image acquisition. It is a real time diagnostic act in which the practitioner acquires, analyses, interprets and frequently reports findings on which immediate clinical decisions are made. The European Society of Radiology describes ultrasound as highly operator dependent, and UK practice is unusual internationally in its expectation that many sonographers independently produce actionable reports. [5-8] The Royal College of Radiologists’ reporting standards require imaging reports to support safe, effective and efficient care; a sonographer’s report may therefore determine whether a patient is reassured, referred, discharged, rescanned, biopsied, treated or escalated. [9]

The consequences of error are immediate in early pregnancy. Health Services Safety Investigation Body (HSSIB) reported that national NHS incident data between April 2017 and August 2018 included 30 missed ectopic pregnancies causing serious harm and identified insufficient sonography capacity as a risk to safe seven-day early pregnancy services. [10] NICE guidance requires ultrasound and serial hCG assessment in early pregnancy complications, making competent ultrasound provision central to excluding ectopic pregnancy and avoiding delayed diagnosis. [11] A false positive diagnosis of non-viable pregnancy can also lead to intervention that damages a pregnancy that might otherwise have had a normal outcome; Doubilet et al. highlight this as the reason for stringent ultrasound criteria before diagnosing early pregnancy failure. [12]

The PSA’s 2019 right touch assurance report concluded that statutory regulation was not then required, but that conclusion depended substantially on assumptions that most sonographers were regulated through another profession and that risks were controlled through service regulation and clinical governance. [14] The same report recognised that statutory regulation should be reconsidered if entry routes changed or if patient vulnerability and procedural complexity increased. [15] Those conditions have now materialised: direct entry undergraduate and postgraduate sonography routes have expanded; internationally trained sonographers are increasingly recruited; and many sonographers are undertaking advanced reporting and interventional practice. [14-18]

The PSA has now recognised that the risk position has changed. In its 2024 public interest decision on the Register of Clinical Technologists, the PSA stated that sonography risks appear “sufficiently high” and the potential patient impact “sufficiently great” to recommend that UK Government consider whether accredited voluntary registration is likely to be adequate. The PSA also noted that better data are needed on the number of regulated and unregulated sonographers inside and outside the NHS. [19]

Workforce pressure compounds this risk. The SoR reported in 2026 that sonographer vacancy rates had increased dramatically since 2019, and HSSIB has already linked capacity constraints to risk in early pregnancy services. [10, 20] Shortage conditions increase reliance on agency, internationally recruited and independent sector sonographers, while reducing time for supervision, audit, preceptorship, peer review and CPD. In a profession where image acquisition, interpretation and reporting are tightly coupled, weak supervision and variable assurance create direct patient safety risk.

The education and registration landscape is structurally incoherent. CASE accreditation provides a recognised quality mechanism for ultrasound education, but CASE is not a statutory regulator and CASE accredited education does not confer statutory professional registration. [14] A direct entry sonographer may be clinically trained but ineligible for statutory registration; conversely, a radiographer, nurse or midwife may be statutorily registered without their regulator having assessed sonographic competence. [3, 14] Employers are therefore left to determine equivalence locally, creating variable standards and potentially excluding competent direct entry sonographers while admitting practitioners whose ultrasound education has not been independently benchmarked.

Documented harm supports this concern. A clinical harm review following concerns about ultrasound scans by two unregulated sonographers found that 876 scans required additional assessment, 64 patients had suffered physical and/or psychological harm, and 29 had experienced moderate to severe harm. [21] The review was also reported in the Health Service Journal, which described dozens of patients suffering moderate or severe harm after scans by an independent provider. [22] This is precisely the scenario statutory regulation is designed to prevent: where serious competence concerns arise, the system must be able to restrict or remove the practitioner, not merely review the provider.

Fitness-to-practise cases also demonstrate the vulnerability of the current model. The Health and Care Professions Tribunal Service (HCPTS) decisions have included sonography related concerns involving failure to identify anatomy, inaccurate reporting and voluntary removal from the HCPC register. [23] International complaint evidence similarly shows the potential gravity of sonographic error, including low lying placenta not identified at the mid pregnancy scan and misdiagnosis of non-viable pregnancy. [24, 25]

These cases do not show that sonographers are uniquely unsafe; they show that sonographic practice carries serious diagnostic and communication risk and therefore requires a regulatory mechanism that attaches to the sonographer role itself.

The independent baby scan sector exposes the inadequacy of relying on provider regulation alone. CQC guidance to the public advises expectant parents to ask what training the sonographer has had and whether they are on a register, while acknowledging that the RCT register is voluntary and that not all sonographers choose to join it. [26] This places an unrealistic burden on vulnerable patients and families to assess professional competence at the point of care. The DHSC Independent Pregnancy Loss Review stated that people seeking reassurance or souvenir scans from private clinics should be able to trust that their sonographers are qualified and regulated. [27] Provider regulation cannot provide that assurance where the practitioner title remains unprotected.

Communication risk is also material. UK consensus guidance on communicating unexpected news via ultrasound was developed because sonographers may be the first professionals to identify pregnancy loss, fetal anomaly or uncertain findings and must communicate those findings during the scan encounter. [28] This is not a purely technical role: it combines intimate examination, diagnostic uncertainty, emotional disclosure, safeguarding awareness and professional judgement. Without statutory regulation, patients may have no clear route for professional redress if the practitioner is not on a statutory or voluntary register.

Sonographer practice is increasingly interventional. British Medical Ultrasound Society (BMUS) evidence shows that many NHS sonographers practise at advanced or consultant level, and role development literature describes sonographer led advanced practice across reporting, intervention, education and governance. [16, 29] NICE supports contrast enhanced ultrasound using SonoVue for focal liver lesion characterisation, and ultrasound guided procedures are now embedded across cancer, vascular, breast, musculoskeletal, gynaecology and urology pathways. [30] These activities require consent, medicines governance, asepsis, local anaesthetic administration, recognition of complications and escalation. They cannot be safely reduced to technical scanning.

The lack of statutory registration creates direct pathway inefficiency. PGDs may only be used by specified registered health professionals. [31] Non statutorily registered sonographers therefore cannot use PGDs even where they have the competence to perform an ultrasound guided procedure. Services must rely on patient specific directions, ad hoc prescriptions or additional clinician support, introducing delay, duplication and legal ambiguity. This mirrors the wider IPEM argument for other scopes: inconsistent regulatory frameworks do not merely affect professional status; they create practical risk in clinical pathways.

Cancer pathway implications are now explicitly recognised nationally. The 2026 National Cancer Plan for England includes an action for NHS England and DHSC to examine the need for independent statutory regulation of sonographers by 2027. [32] Ultrasound is embedded in abdominal, pelvic, testicular, breast, head and neck, vascular, paediatric and gynaecological cancer pathways. If sonographers cannot be counted reliably as a regulated workforce, cannot consistently access advanced practice development, and cannot practise to full scope because of regulatory barriers, diagnostic expansion and early cancer diagnosis are weakened.

International evidence supports reassessment. A comparative study of New Zealand and Australia concluded that statutory regulation provides a reference point for minimum safe practice requirements in sonography. [33] European surveys demonstrate wide variation in sonographer education, reporting autonomy and role expansion, which is highly relevant to UK reliance on international recruitment. [15, 17, 18] In the UK, where sonographers often report independently and contemporaneously, international equivalence cannot safely be left entirely to variable local employer assessment.

There is also an occupational and service resilience risk. Systematic review evidence demonstrates a substantial burden of work-related musculoskeletal disorders among sonographers, and recent research links work related musculoskeletal disorders with occupational burnout. [34, 35] Burnout and injury affect retention, sickness absence, vigilance and service quality. Statutory regulation would not solve workforce shortage alone, but it would provide clearer workforce data, recognised education routes, mandatory CPD, protected title, professional identity and safer mobility between NHS and independent providers.

The current model therefore leaves patients exposed to a preventable combination of risks: an unprotected title; variable education and equivalence assessment; optional voluntary registration; incomplete workforce data; autonomous reporting; high risk early pregnancy and obstetric practice; emotionally complex communication; independent sector provision; interventional procedures requiring medicines governance; and documented harm. PSA accredited voluntary registration is valuable, but it cannot provide universal assurance while registration remains optional and the title remains unrestricted.

Statutory regulation is therefore proportionate. It would not replace CQC regulation, CASE accreditation, local governance, employer competence assessment or clinical audit. It would provide the missing national assurance mechanism: protected title, mandatory entry standards, recognition of UK and equivalent international education, English language requirements, mandatory CPD, fitness-to-practise powers, public register visibility and the ability to prevent individuals removed for incompetence or misconduct from continuing to practise as sonographers.

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Section 9: Consistency of approach across the Four Nations of the UK

Inconsistencies in regulation, governance and workforce requirements across the four UK nations create variation in how Clinical Technologists are trained, assessed, recognised and deployed. While patient need and the risks associated with practice remain the same, the absence of statutory regulation has resulted in differing local approaches to competence, scope of practice and professional assurance. The examples below illustrate how this variation leads to inconsistent standards, inequitable patient access and avoidable risks to patient safety.

Areas of inconsistency	England	Scotland	Wales	Northern Ireland	Public protection implications
National recognition of PSA accredited voluntary registers for healthcare science	NHS England guidance explicitly named AHCS, RCT and RCCP as PSA accredited registers for healthcare science and stated that Healthcare Science staff not currently registered were expected to join an Accredited Voluntary Register.[3]	The Scottish Government's baseline review recognises the voluntary accredited RCT as a route for Clinical Technologists through IPEM training or equivalence.[6]	The NHS Wales Healthcare Science Career Framework explicitly recognises RCT and RCCP as PSA accredited registers and describes AHCS's role in developing PSA-accredited registers.[9]	Northern Ireland's public-facing careers material describes HCPC regulation for Clinical Scientists and Biomedical Scientists but does not give equivalent prominence to PSA accredited voluntary registration for Clinical Technologists.[11]	The same category of practitioner may be subject to different levels of explicit national encouragement or expectation depending on geography.
Use in workforce or training standards	Skills England's Enhanced Clinical Practitioner apprenticeship standard requires	NES reporting states that Clinical Technologist trainees in nuclear medicine,	NHS Wales sets a strategic goal for registration policies to be in place in all health boards	Northern Ireland has a UK-wide Modernising Scientific Careers development plan and	Training to registration pathways are not equally embedded, risking variable assurance of

	registration with a statutory regulator, Social Work England or one of the accredited voluntary registers, including AHCS, RCT or RCCP.[4]	clinical engineering and radiation protection were expected to join the PSA accredited RCT.[7]	and trusts within three years.[9]	includes healthcare science in workforce disciplines, but visible national policy on PSA accredited Clinical Technologist registration appears less developed.[10] [12]	competence, CPD and conduct expectations.
National regulatory review activity	England has previously commissioned PSA Right touch Assurance work in relation to sonography, and the PSA later noted that sonography risks may need further review if routes into practice and risk profiles changed.[13]	Scotland has now commissioned a PSA Right-touch Assurance assessment for Healthcare Science, explicitly to consider risk of harm and future regulation.[8]	Wales has not commissioned an equivalent Scotland-style PSA Right touch Assurance assessment for all Healthcare Science, but its 2025 framework is more directive on registration policy development.[9]	No equivalent current Northern Ireland PSA Right touch Assurance assessment for Healthcare Science was identified in the reviewed sources.	A Scotland only assessment could lead to different conclusions for the same UK wide professional risk profile.
Employer discretion versus system expectation	England gives examples of stronger system expectation, but there remains evidence of low or variable uptake of	Scotland links training routes to RCT registration and is reviewing healthcare science regulation, but	Wales is moving towards registration policies in each health board and trust, but this remains policy	Northern Ireland evidence is more general: healthcare science is recognised, but PSA accredited registration does	Employer discretion allows uneven appointment standards, local variation and potentially unregistered

	AHCS/RCT registration among some healthcare science groups.[5]	the outcome is not yet known.[6] [8]	implementation rather than statutory compulsion.[9]	not appear as prominently in public-facing policy.[11] [12]	practice in materially similar roles.
Risk recognition for Clinical Technologist and sonographer practice	The PSA's 2024 RCT Standard One assessment found the RCT met the public interest test but stated that risks in sonography were sufficiently high that the four UK governments should consider whether accredited registration provides sufficient assurance or whether further regulatory oversight is needed.[13]	Scotland's 2026 Right-touch Assurance assessment is explicitly concerned with assessing risk in Healthcare Science and future regulatory options.[8]	Wales recognises healthcare science as critical to diagnostics, radiation safety, medical equipment and implementation of advanced technologies.[9]	Risk recognition for Clinical Technologist and sonographer practice	The PSA's 2024 RCT Standard One assessment found the RCT met the public interest test but stated that risks in sonography were sufficiently high that the four UK governments should consider whether accredited registration provides sufficient assurance or whether further regulatory oversight is needed.[13]

There is already demonstrable inconsistency across the UK in how PSA accredited voluntary registers are used, promoted and operationalised for Healthcare Science and Clinical Technologist practice. This matters because the underlying risks of Clinical Technologist practice - radiation exposure, nuclear medicine, radiotherapy technology, renal technology, medical engineering, rehabilitation engineering, medical device support, sonography and other technology-dependent patient pathways - do not stop at national borders.

The PSA itself recognises that Accredited Registers provide assurance for unregulated occupations, but also makes clear that voluntary registration is not a legal requirement to practise.[1] The UK Government's original policy model deliberately gave employers and commissioners discretion to use accredited registers, rather than requiring their use.[2] That discretionary model has now produced uneven four-nations implementation.

The key inconsistency is whether PSA accredited registration is treated as:

- a desirable professional option;
- a training outcome;
- an employer expectation;
- a requirement for enhanced or advanced practice;
- a health board or trust policy objective; or
- an insufficient safeguard requiring review against statutory regulation.

At present, the four nations appear to sit at different points on that spectrum.

In England, there are clear examples of PSA accredited registers being used in workforce guidance and education standards. NHS England COVID workforce guidance explicitly named AHCS, RCT and RCCP as PSA accredited registers for healthcare science and stated that Healthcare Science staff not currently registered were expected to join an Accredited Voluntary Register.[3] Skills England's Enhanced Clinical Practitioner apprenticeship standard also requires registration with a statutory regulator, Social Work England or one of the accredited voluntary registers, including AHCS, RCT or RCCP.[4] However, this remains programme- or employer-dependent, rather than a universal national registration requirement. NHS England's 2025/26 pay review evidence also points to continued inconsistency in registration uptake across parts of the healthcare science workforce.[5]

In Scotland, the Scottish Government's baseline review recognises the voluntary accredited RCT as a route for Clinical Technologists through the IPEM training scheme or equivalence route.[6] NES has also linked Clinical Technologist trainees in nuclear medicine, clinical engineering and radiation protection to expected RCT registration.[7] Scotland has now gone further by commissioning the PSA to undertake a Right-touch Assurance assessment for Healthcare Science, explicitly to explore risks and consider whether current controls need to be strengthened.[8] That is welcome, but because the commission is Scotland only, it raises the possibility of divergent conclusions for materially similar practice across the UK.

In Wales, the NHS Wales Healthcare Science Career Framework explicitly recognises the RCT and RCCP as PSA accredited registers and describes the role of AHCS in developing consistent regulation,

including PSA accredited registers.[9] The same framework sets a three year success measure for registration policies to be in place in all health boards and trusts.[9] This appears stronger than a purely optional employer led approach, but it remains policy implementation rather than statutory compulsion.

In Northern Ireland, the Department of Health describes Modernising Scientific Careers as a UK wide initiative intended to create a single, visible Healthcare Science workforce with structured education, training and career progression pathways.[10] However, Northern Ireland's public facing healthcare scientist careers material emphasises that Clinical Scientists and Biomedical Scientists are regulated by HCPC and must register before practising, but does not give equivalent prominence to PSA accredited voluntary registration for Clinical Technologists.[11] A 2024 Department of Health consultation on safe and effective staffing includes Healthcare Science disciplines and lists the PSA among relevant regulatory bodies, but does not set out an equivalent national expectation for PSA-accredited Clinical Technologist registration.[12]

This variation creates a public protection problem. The same category of practitioner may be subject to different levels of explicit national encouragement, training linkage, employer expectation or policy requirement depending on geography. The PSA's own RCT Standard One assessment identifies Clinical Technologists as working across nuclear medicine, radiotherapy physics, radiation physics, medical engineering, radiation engineering, rehabilitation engineering, renal technology and sonography.[13] It also describes risks including technical competence, autonomous decision-making, role expansion beyond expertise, advice on medical devices, home visits, radiation safety, nuclear medicine, sonography misdiagnosis, medication administration and obstetric ultrasound risk.[13]

That evidence strongly supports the argument that Clinical Technologist practice is not a low risk administrative category. It involves direct and indirect decisions affecting diagnosis, treatment, device safety, radiation exposure and patient management. Therefore, if registration expectations vary across the UK, the public protection controls also vary.

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Section 10: Conclusion

This document has set out the immediacy and impact of the risks associated with modern Clinical Technologist practice. Declining uptake in PSA voluntary registration, coupled with rapid evolution of technology across scopes of practice, which now include well established Advanced Clinical Practice diagnostic and therapeutic roles, has already transformed a workforce, whose current practice is increasingly moving out from traditional NHS hospital setting into patient's homes, or setting within the community and the private sector. These developments have rapidly outstripped a co-ordinated response in education, training and guidance and introduced increasing risks at an unprecedented scale in the UK. It has demonstrated quantifiable, role specific risks both from the literature, inspectorate reports, workforce intelligence, case studies from regions of the UK, as well as the statements of the Institute of Physics & Engineering in Medicine Special Interest Groups and the Education and Professional and Standards Council.

It is clear that there is an urgent need to protect patients through ensuring minimum, mandatory certified levels of education and assessment of competence, knowledge and skills and continuing professional development that can only be provided through statutory regulation.