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Competency level in radiotherapy across EU educational programmes: A cross-case study evaluating stakeholders' perceptions

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ABSTRACT

Introduction: The education of Therapeutic Radiographers (TRs) is regulated in some countries but is not standardised across the EU, leading to differences in competencies between and within member states. This study aimed to explore stakeholders' perceptions regarding underdeveloped competencies of TRs practising on the linear accelerator, identified in a previous study by the same research team.
Methods: Interviews with stakeholders from four countries (selected based on the characteristics of their degrees) were performed as part of this cross-case study. Stakeholders were asked to provide their perception regarding the least developed competencies identified in a previous study.
Results: The 27 stakeholders confirmed that Pharmacology, Quality Assurance (QA), Management and Leadership, Research (from the previous study) were underdeveloped and identified Image Verification and Critical Thinking as additional underdeveloped competencies. Suggested causes included: lack of regulation of required competencies at the national level, lack of training dedicated to radiotherapy (RT) (taught within generic modules) and lack of time within the degree programme. The ideal academic level to develop these competencies and whether they are essential varied between country and stakeholder.
Conclusion: It is essential to regulate learning outcomes at the national level to ensure a high level of care is provided to all RT patients and, ideally, standardise it across Europe. Education institutions should review their curricula to ensure that sufficient time is dedicated to RT and that the essential competencies are developed. Due to time constraints within some programmes, some competencies must be developed after graduation.
Implications for practice: Lack of regulation of learning outcomes (at European level and national level in many countries) and lack of RT-specific training lead to underdeveloped competencies that may compromise patient care.

Introduction

Radiography education is significantly different across the European Union (EU)[1–5] since neither the profession nor education is regulated at the European level (as opposed to other professions such as medicine or nursing).[6] Despite the EU's vision to promote mobility through standardisation of education across Europe,[6–8] the learning outcomes of the educational programmes that allow access to the profession are established at the national level,[9,10] resulting in education programmes with distinct characteristics. These differences resulted in graduates with different competencies, both in medical imaging (MI)[5] and radiotherapy (RT).[1]

This study focused on Therapeutic Radiographers' (TRs) education working on the linear accelerator. The most prominent role of these professionals is the delivery of ionising radiation to treat patients[11]; however, to perform this role, TRs must develop competencies in multiple areas, including immobilisation of the patient, imaging, decision-making, education, communication, and research, among many others.[12] There are also differences in the

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nomenclature due to a lack of harmonisation of the professional title, a range of national titles such as Therapeutic Radiographer (TR), Radiation Therapist (RTT), Radiotherapist, Radiation Therapy Technologist may also be found in the literature[9,13–15] and mentioned by the study participants in this study.

International guidelines,[16–18] as well as published literature,[12] are available regarding TRs' competencies. The use of international guidelines increase the competency level of graduates; however, not all education institutions implement them[1] as they are non-binding documents. Consequently, the levels of the competencies developed vary across the EU.[1]

Various studies addressed the development of individual competencies of utmost importance for the profession and the patient. For example, research competencies are well-established competencies of the TR,[16–18] but evidence shows that there is still room for improvement in skill level.[19–21] Patient safety seems to be developed across Europe. However, variation in the level exists between education institutions,[22] showing that variation in the most crucial competencies still exists. Previous studies have shown that some of these competencies are underdeveloped, and often the employer must complete the training to ensure safe practice.[23,24]

Technological evolution and new therapeutic modalities and techniques also influence the competencies required by graduates. As such, research into the essential competencies to practice gets outdated quickly, and the curricula must be frequently revised and updated. One prominent example is the introduction of artificial intelligence into RT practice,[25] which may require graduates to develop new skills.

In this study, "competency" means the ability to apply knowledge and skills to perform tasks autonomously and take responsibility for it.[26] Additionally, "graduate" means a person who completed a course of studies, irrespective of the academic level. The European Qualification Framework academic level (EQF)[26] was used given the European context of this research. This framework describes the academic levels from EQF1 (primary school) to EQF8 (doctorate), intending to facilitate the comparison of degrees between member states. Even though most European radiography programmes are at EQF6[1,4] as recommended by international benchmarking documents,[16–18] the minimum level required to practise therapeutic radiography varies from EQF4 to EQF7.[9] The EQF levels relevant for radiography are summarised in Table 1.

Many studies addressing the training in specific tasks of the TRs working on the linear accelerator have been published. However, most focus on roles that may not be fully established as being the responsibility of TRs (such as image verification analysis[24] or equipment quality assurance[27]). In contrast, well-established roles (such as immobilisation) are less studied. A survey conducted in 2019 by the SAFE EUROPE project provided an overall picture and identified which linear accelerator competencies were least developed across EU education institutions.[1] This survey asked academic staff to rate graduates' level of competency across 63 competencies identified from published literature. It was identified that Pharmacology, Equipment Quality Assurance (QA), Research and Education, and Management and Leadership competencies are significantly less developed across Europe at the end of their initial degree.

Table 1
EQF levels relevant for radiography.

EQF level	Description
EQF4	Secondary education
EQF5	Short higher education programme
EQF6	Bachelor's degree
EQF7	Master's degree
EQF8	Doctorate

The SAFE EUROPE project is a multi-national consortium funded by the ERASMUS + Programme. It comprises three national and one European professional organisation, two universities, and an oncology hospital. This project seeks to identify RT education gaps across Europe in light of the current international workforce mobility.

Due to the quantitative methodology used in the SAFE EUROPE survey, the education gaps could not be explained. As such, this current study aimed to explore European stakeholders' perceptions of RT education to i) explore the reason for these underdeveloped competencies, ii) determine the importance of developing these competencies in the degree that gives access to the profession and iii) identify at what stage of the continuous professional development process these competencies should be developed. A secondary aim was to assess if the stakeholders identified additional underdeveloped competencies not identified in the quantitative survey.

Methods

This cross-case study[28] is part of an explanatory sequential multiphase mix-method design. In a previous phase, a survey was distributed to educational institutions to identify the course characteristics and least developed competencies of TRs working on the linear accelerator across the EU.[1] The survey data was used to identify four EU countries with very different education models (maximum variation sampling[29]), as shown in Table 2. Stakeholders from these countries were interviewed to understand further the relationship between the underdeveloped competencies and the course programmes. Even though the United Kingdom (UK) was leaving the EU, it was the only country with an EQF6 RT-only programme that answered the SAFE EUROPE survey. Since this study used a maximum variation sampling to obtain varied perspectives from different education models, it was very relevant to include the UK model in this research. The data was collected at the beginning of the transition period; therefore, UK stakeholders' answers still reflect their status as a member-state.

Participants were invited by professional organisations associated with the SAFE EUROPE consortium and through social media, allowing stakeholders who are not members of these associations to participate. From the volunteers, the researcher selected six to nine stakeholders with different backgrounds and roles from each country: local and migrant TRs, clinical managers, educators, students, and professional association representatives. The individuals were selected based on their ability to provide the richest information (critical case sampling[29]) and a mix of experiences that would allow different points of view to be gathered.

The first semi-structured interview (Portugal, November 2019) was performed face-to-face. However, the remaining interviews (Poland, Finland and UK) were done online between April and August 2020 due to COVID-19 restrictions. Both group and individual interviews were used.

These interviews collected stakeholders' perceptions about the four least-developed linear accelerator competencies across Europe as identified in the previous study[1]: Pharmacology, Quality Assurance (QA), Management and Leadership, and Research and Education. All participants were asked about the competency level in their countries and across Europe; the factors affecting the level; the importance of these competencies for RT practice; and the recommended academic level to develop them. They were also invited to explore any additional competencies they believed to be underdeveloped.

Table 2
Education programmes characteristics in the countries included in the interviews.[1]

Country	Academic level	Programme Duration	Specialisms included in the programme	Proportion of the programme dedicated to RT
Finland	EQF6	3.5 years	RT + MI	10%
Poland	from EQF5 to EQF7	from 2 to 5 years	RT + MI + EP	from 20% to 47%
Portugal	EQF6	4 years	RT + MI (after 2014) RT-only (before 2014)	27% (after 2014)
UK	EQF6	3 years (4 years in Scotland)	RT-only	84%

EP = Electrophisiology; EQF = European Qualifications Framework academic level; MI = Medical Imaging; RT = Radiotherapy; UK = United Kingdom

NVivo (v12) was used for the thematic analysis. Line-by-line coding, triangulation of sources, negative case analysis, member checking, and researcher reflexivity were used to reduce research and participant bias, improving rigour.[30–33] Peer debriefing was also performed by interviewing three RT education experts across Europe from a European professional association.

Ethical permission to perform this research was granted by the Institute of Nursing and Health Research Ethics Filter Committee at Ulster University, UK (Ref 10/19/3.3a). Confidentiality was guaranteed. Participants had access to the participant information sheet at the time of invitation, and consent was obtained before the interview (written for the face-to-face and audio-recorded for the online interviews).

Results

A total of 27 stakeholders (Table 3) discussed the four competencies found to be developed at lower levels across Europe in a previous study by this research team[1]: Pharmacology, Quality Assurance (QA), Management and Leadership, and Research and Education. Additionally, the participants stated that image verification competencies were also underdeveloped, especially in new modalities, and critical thinking competencies were also at risk across Europe. The codes found in Table 3 were used to identify the origin of the quotes in the results.

Table 3
Participants' characteristics.

Country studied	Participants' characteristics
Finland (individual interviews)	FL1 – Local TR FL2 – Student FL3 – RT lecturer FL4 – Local TR FL5 – Local TR FL6 – Student
Poland (group interview)	PL1 – Clinical manager, professional body representative, RT lecturer PL2 – RT lecturer, local TR PL3 – Local TR PL4 – Student PL5 – Local TR PL6 – Local TR, professional body representative PL7 – Local TR, professional body representative
Portugal (group interview)	PT1 – Local TR, clinical educator PT2 – Local TR, clinical educator PT3 – Clinical manager PT4 – Emigrant TR PT5 – Emigrant TR PT6 – Emigrant TR PT7 – Emigrant TR PT8 – RT lecturer, ex-professional body representative
United Kingdom (individual interviews)	UK1 – Professional body representative UK2 – RT Lecturer UK3 – Local TR UK4 – Clinical manager, ex-RT lecturer UK5 – Immigrant TR, education and training leader UK6 – Local TR (newly qualified)

Tradition affects competency development, yet education has the power to change this tradition. To change tradition, "you have to change the education [first] because you've got to empower the people" (UK1) and equip TRs with the skills necessary to take new roles "because otherwise […] it takes a long time to change the profession" (UK1).

Stakeholders also agreed that the minimum academic level for the qualifying degree (i.e. the degree that gives access to the profession) should be EQF6. One stakeholder argued that EQF5 programmes allow TRs to practise safely. However, essential critical thinking and decision-making in unpredictable situations are not developed at this level.

Stakeholders emphasised that regulating the learning outcomes at the national level ensures that all the essential competencies are developed. Furthermore, if these underdeveloped competencies were regulated across Europe, an improvement in practice would be observed.

Pharmacology

Pharmacology subjects are often delivered to multiple healthcare professionals in generic study units but "not in radiotherapy" (FL3). Pharmaceuticals used for side-effect management, chemotherapies or other procedures related to oncology were poorly covered. Pharmaceuticals used to manage common side-effects are covered, but the pharmacological properties are very superficially discussed.

This learning is often undertaken during clinical placements in an unstructured fashion: "When they're in placement […] They'll be in the presence of people when conversations are being had about those drugs" (UK2). However, this results in students with different exposures and skills.

These competencies were also seen as "nurse stuff" (PL1) or other professionals in some countries and that "maybe, we are always going to be less involved in pharmacology"[a] (PT4). This contrasts with countries where "at an advanced practitioner level, […] you're in a position to […] move towards independent prescribing" (UK1).

RT-specific pharmacology was considered "important" (UK1). The main reason was that TRs have frequent contact with oncology patients with various therapies and side effects.

Some stakeholders believe that "you can learn [pharmacology] on the job" (FL6). However, the theory must be covered in the qualifying degree (EQF6) since patients' outcomes depend on the competency level of TRs to provide advice. Moreover, theoretical foundations are necessary for graduates to progress into advanced roles on patient review and prescription.

[a] "se calhar, nós vamos sempre estar sempre menos envolvidos em farmacologia" (PT4).

Management and leadership

Management and leadership skills were considered somehow intrinsic characteristics of the individual; yet they can be developed by specific training. Even though management skills applied to RT were considered "essential" (UK1) "at any level of the organisation" (UK5), this is considered "a very weak area" (UK2).

Similarly to pharmacology, these competencies are often covered in generic study units, and the specifics of RT management are often left out. RT management is complex and includes multiple dimensions: equipment and human resources management, cancer pathways, research management, among others.

Stakeholders agree that these competencies "should be developed by everybody" (UK2) in their qualifying degree (ideally EQF6). Further training at EQF7 may be beneficial if TRs take management roles. However, some stakeholders stated that TRs may also develop management and leadership skills without formal education. Since some stakeholders (including employers) do not consider management skills essential, these are often transferred to post-graduation programmes.

Equipment quality assurance (QA)

Competencies in QA of equipment used to treat patients are underdeveloped due to professional boundaries since "the QA for the machines is done by the physicists" (UK3); consequently, they have more training in these tasks. TRs are often limited to "very basic QA" (UK2). Multi-professional teamwork in equipment QA was deemed essential to ensure patient safety. Time restrictions in TRs' education programmes was also a reason for this underdeveloped competency.

In the UK, "students do have to get signed off as having assisted in those procedures" (UK2) and have "practical-type sessions" (UK6). While other countries do not specify QA as part of the practical learning: "the knowledge was acquired on the job"[b] (PT2) or that "it's something we have in the course. It's not so big" (FL3).

Equipment QA skills were deemed essential since "if we do not have knowledge of QA […] how can we be sure that […] we are doing the correct thing"[c] (PT5). Some stakeholders from multiple-specialism programmes believe that these competencies should be developed "after [graduation] because then it's unnecessary if you do diagnostic" (FL5).

Image verification

Image verification is the process of acquiring radiologic imaging to measure and correct differences between the patient's setup in the linear accelerator and the setup used for planning. Education institutions may not be up-to-date with these competencies since many modalities were introduced in the recent past, such as verification using Cone-Beam Computed Tomography (CBCT) or 4D imaging.

Curricula are not updated frequently, and there is a lack of equipment and academics with training in the new modalities. Also, universities may struggle to update their teaching methods due to issues in "information sharing. […] Even anonymised data is very difficult to share" (UK4).

In some countries, image verification tasks are considered part of advanced roles and students "weren't allowed to try matching […] for the real treatment" (FL2). This is even more pronounced for the new imaging modalities.

TRs' autonomy in performing and evaluating verification images varies across the countries interviewed. The general agreement was that these competencies must be developed in the undergraduate programme (EQF6) to allow TRs to perform these tasks autonomously and safely. Nevertheless, due to the limitations mentioned above, on-the-job training may be necessary.

Research and education

Research competencies are underdeveloped in the countries interviewed and across Europe. Educational institutions often do not develop this competency because of lack of resources (human and equipment), lengthy ethical procedures, and difficulties obtaining clinical data.

These barriers limit students' options, and often they "opt for the review article" (UK2) or "a research proposal" (UK4). As such, graduates may not be fully competent in performing research themselves, and consequently, they may be unable to create new knowledge to support their practice.

On the positive side, there is "a strong emphasis on evidence-based practice" (UK3), preparing graduates to apply research results into their practice. Also, most courses cover research methods theory during their programme.

Stakeholders agreed that research competencies are "very important" (PL1), but graduates require further education in research as part of their lifelong learning (EQF7 and EQF8). However, it may be "a personal decision"[d] (PT6) if TRs develop these competencies later on or not. Furthermore, their research experience in the undergraduate programme (EQF6) affects the decision since "without a basic set of skills with regards to research would make any future studies particularly difficult" (UK2).

Employers may not consider research as an essential competence for all TRs. Therefore, employers do not push universities to develop them. Furthermore, students also stated that they felt overwhelmed and "already had so much stuff to do that adding research to it would mean extra work" (FL2), compromising the overall learning experience. The significant students' workload emphasises that some competencies may need to be developed at a later stage.

Stakeholders did not sufficiently discuss education competencies. When discussing the research and education theme, participants often diverged to the research theme, even when prompted by the interviewer, indicating that the lack of research skills greatly impacted practice and overshadowed educational competencies.

Critical thinking

Stakeholders believe that multidisciplinary curricular units are substituting RT-specific content in education programmes to cut costs. As a consequence, if this trend continues, participants believe that "critical thinking [applied to RT] will reduce" (UK4). However, the development of all essential competencies is safeguarded if the learning outcomes are regulated.

Critical thinking is also an issue when the academic level is below EQF6: "Somebody who's trained to a level beneath the level six, potentially in a very narrow area, is only ever skilled to undertake a task" (UK1). Participants agreed that this competence must be developed in the qualifying degree because "being a professional is about that commitment to lifelong learning, the critical thinking, the ability to appraise" (UK4).

[b] "em termos de formação, eu não tive formação, […] o conhecimento foi adquirido on the job" (PT2).

[c] "se não temos noção dos "QA", […] como é que podemos ter certeza de que […] estamos a fazer algo que é benéfico" (PT5).

[d] "é uma opção pessoal" (PT6).

In some cases, “the last decision goes to the doctor” (PL2) and “some of the radiotherapists are content to do what they are told to do instead of questioning” (FL4) —indicating that autonomous decision-making and critical thinking may not be well-established across Europe because of professional traditions.

Participants agreed that due to the use of ionising radiation in humans, safety is well covered in most programmes, and TRs apply these concepts into practice. As such, TRs can identify common risks and take the necessary actions. Nevertheless, critical thinking was deemed essential to deal with new and unexpected situations, for which RT-specific knowledge is essential.

Discussion

It became clear that there is a gap between the competencies developed in European courses and those considered essential for practice. Therefore, there is potential to close this gap and improve patient care by continuously improving TRs education.

Course design is complex due to time restrictions within the programme. Therefore, choices must be made regarding which subjects are included in the curriculum.[34] Consequently, some competencies cannot be fully developed in the qualifying degree and should be further developed at post-graduate levels – for example, research competencies.

Nevertheless, a consensus is difficult due to differences in stakeholders' priorities depending on their country's tradition, background, and roles. For example, the employers' training priorities are not the same as educators' priorities.

Tradition also varied between countries, especially regarding TRs autonomy, showing that the competency needs may be country-specific. While Polish and Portuguese TRs are less involved in pharmacological patient care, these roles can be taken by TRs in the UK (at advanced levels but still requiring the underpinning knowledge). Another example is the limited decision making autonomy in certain countries, which leads to critical thinking skills being perceived as non-essential.

Tradition is a barrier for TRs to develop specific competencies, and since TRs are not trained in these competencies, the tradition is maintained in a vicious cycle. However, if the cycle is broken and TRs are equipped with the necessary skills to perform roles usually undertaken by other professions, there is potential to change practice.

Regulation of the essential learning outcomes to practise radiotherapy at the national level (and ideally at the European level) would ensure that the core competencies are developed to a minimum standard within the country (and across Europe). A European regulation could improve the standards of practice in countries where essential competencies are underdeveloped. It would also promote collaboration between universities. Nevertheless, national needs must be acknowledged, and a potential standardised curriculum must allow flexibility and time to develop other competencies beyond the core ones, as needed by the country.

There were multiple reasons for the lack of development of the competencies identified. A lack of RT-specific study units was a significant factor affecting Pharmacology, Management and Leadership, Image Verification and Critical Thinking competency level. Curiously, stakeholders believed that an excess of multidisciplinary training hinders the development of RT-specific competencies despite evidence that this type of training can be beneficial.[35] Not because multidisciplinary learning is harmful, but because of the reduction in RT-specific knowledge, which is essential to apply the competencies above to RT situations.[1] For example, graduates' must have enough RT lectures to learn about the different types of errors (random, systematic, intra-, inter-fraction) so they can critically evaluate verification images and take informed decisions.

Pharmacological management of side-effects may be developed in an unstructured fashion during placements; as such, students graduate with different competency levels, even within the same country or institution. This phenomenon of unstructured learning was previously observed in an earlier survey.[34]

Management and leadership skills are essential at all levels of RT practice. Participants also emphasised that these are crucial to achieve advanced practice, agreeing with the findings from Hilder et al.[36] It is also essential that these competencies are developed in the RT-specific context rather than in generic study units.

Regarding image verification, other authors also agree that these competencies are not fully developed at the end of the initial degrees, especially advanced modalities, and that graduates require on-the-job training after graduation.[23,24] However, it is acknowledged that TRs can safely take this role after training.[24] Technological advances such as the introduction of artificial intelligence in image verification and other tasks performed by TRs[25] requires the development of the necessary digital skills. Digital skills and advanced roles are being further researched in other SAFE EUROPE studies.

Traditional roles taken by TRs and other professions seem to be one of the causes of inadequate Equipment QA competencies. In 2014, in the UK, only 6% of the QA of advanced RT procedures were performed by TRs (while physicists performed 88%).[27] This tradition was identified as the main reason why TRs only develop basic QA competencies (such as daily QA).

Inter-professional issues also affect critical thinking when TRs do not have the autonomy to make decisions as mentioned by Finnish and Polish stakeholders. The lack of autonomy to take decision removes the justification to include these competencies in the education programmes. Autonomy is an essential characteristic that distinguishes a profession from an occupation.[37,38] In the interviews, it was clear that TRs are still under dominance from other professions, removing their autonomy and authority necessary to apply critical thinking.[39–41]

Lastly, lack of time, resources and access to clinical data seem to be the main reason for the underdeveloped Research competencies, even though research methods are well developed in theoretical study units. From all the competencies mentioned, research competencies are the best studied, and many publications confirm the need to invest in developing these skills among radiographers.[19–21] Despite being an underdeveloped competency, there is also evidence that these competencies can be developed after graduation, and an increase in TR-led research was observed in recent years.[42] TRs-led research is essential to develop the body of knowledge of the profession and improve patient outcomes.[43]

Safety subjects (including radiation safety and professional and ethical practice competencies[1]) are well developed across Europe may have led stakeholders to state that safety is well covered. In addition, the European Commission established guidelines on radiation protection training which may help harmonise this domain of education.[44] However, patient safety does not stop there, and stakeholders confirmed that the underdeveloped competencies discussed in this research directly impact patient safety. Furthermore, ensuring patient safety (meaning that no harm is caused[45]) is only the first step in achieving the highest level of care possible.

As such, developing these competencies have a great potential to improve safety and quality of care; some examples may include: QA competencies ensure that the equipment is safe to deliver ionising radiation to patients; critical thinking prepares them to evaluate patients' condition or setup before irradiation; pharmacology skills allows them to identify adequate medication to deal with symptoms of disease or RT side effects. Therefore, despite the differences in tradition across Europe, patients would benefit from increased competency levels.

Recommendations for practice and further studies

Education institutions should revise their programmes if they believe that these competencies are underdeveloped and that developing them benefits the professionals or the patient. Alternatively, post-graduate education or Continuing Professional Development (CPD) can be available to all European TRs, to ensure that these competencies can be developed after graduation. Research is recommended to identify possible methods to develop these competencies in initial and post-graduate degrees. Programmes must also be continuously revised and updated to keep up with the technological and clinical advances.

Education institutions should ensure that their curriculum does not develop these competencies (solely) as part of generic curricular units; application to RT is essential to prepare students for safe practice. This is important since the knowledge underpinning the application of these competencies to RT differs considerably from other specialisms and professions.

Students should be allowed longer time-frames and sufficient resources to perform their research projects by starting a research project earlier in their course. This may require an increase in academic staff able to support this research. Agreements between education and clinical institutions could be established to facilitate access to data.

Based on the results, it seems vital that all countries regulate the essential competencies to be developed in the degrees. Additionally, a pan-European standardisation of the curriculum for the education of TRs would be beneficial to avoid the discrepancies observed between counties. Additional research may be necessary to identify a curriculum that is consensual between parties while allowing flexibility and time to develop other competencies which are required in each country.

Since education and research competencies were discussed together, stakeholders preferred to focus on research. As such, it is recommended that further research is done focusing on stakeholders' perception of education competencies.

Limitations

Only four out of 28 EU countries were included in the study. Even though the countries were carefully selected for maximum variation, extrapolation is possible but carries some limitations if the country to which we aim to extrapolate markedly differs from the selected countries (Table 2). This qualitative study aimed for a deeper exploration of the results from the survey distributed across 19 EU countries; as such, the results complement each other.

Stakeholders' perception and opinion are subjective, and not all stakeholders addressed financial and organisational aspects of course design. As such, the implementation of the recommendations may not always be feasible.

The methodology aimed to identify the least developed competencies and possible causes, not establish a consensus. Further research is necessary to achieve this.

Conclusion

The current education of TRs does not fully develop all essential competencies identified in this study. There is great potential to improve patient care by improving TRs' competencies, especially those considered of concern across Europe: pharmacology, equipment QA, management and leadership, research, image verification and critical thinking.

Adequate RT-specific training in the programme is essential to develop essential RT competencies. Education institutions must also equip TRs with the skills necessary to perform roles beyond the traditional scope of practice in their country.

Research methods are well covered in theoretical lectures, but students should be able to put those methods into practice and run research projects during the course. This requires that students are offered enough time, resources, supervision and access to data. Collaboration between education and clinical institutions is essential. Research is essential to produce the evidence base necessary to inform professional practice.

Stakeholders also showed concern regarding the decrease in critical thinking related to RT. In some countries, TRs do not have the authority to take decisions, hindering the development of the critical analysis skills necessary to deal with unexpected situations. Research and critical thinking are essential competencies since they define a profession and distinguish it from a technical occupation.

Even though safety concepts are often covered and practised across Europe, given the use of ionising radiation by TRs, safety and quality of care can be further improved if TRs competencies are improved.

Not all competencies can be included in the qualifying degree due to time restrictions. Priorities vary according to the traditional tasks practised by TRs in each country and the stakeholders' perspective. International standardisation of education may contribute to improved standards; however, agreed core competencies must be complemented with the flexibility to develop additional competencies necessary in each country.

Conflict of interest statement

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