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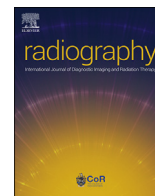
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Advanced practice roles amongst therapeutic radiographers/radiation therapists: A European survey



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ABSTRACT

Introduction: Advanced Practice (AP) roles in Radiotherapy (RT) over time are variable, often locally developed and not underpinned by professional standards which leads to conceptual and practical gaps. This study aimed to assess AP roles amongst Therapeutic Radiographers/Radiation Therapists (TR/RTTs) and identify educational gaps for this level across Europe.

Methods: An anonymous online survey was designed, validated, and distributed across Europe. Convenience sampling was used to recruit advanced TR/RTTs practitioners or TR/RTTs working in AP roles. Descriptive analysis from closed questions and thematic analyses from open questions are reported.

Results: A total of 272 responses were obtained, of which 189 eligible participations were from 21 European countries. 42% of respondents acknowledged additional education required to perform AP, and 25% reported a minimum of five years of RT practice to perform AP roles/tasks. There is a trend to work more on the clinical practice domain with a low percentage of working time allocated to research. Inconsistency was found in job titles, scopes of practice, and educational backgrounds across and even within countries. Education needs regarding knowledge about image-guided and adaptive RT, multi-modal imaging and technologies, and advanced treatment planning were found. Training needs on leadership and management skills and clinical site-specific expertise were identified.

Conclusion: This study clearly shows a gap in education support, a need for standardisation in job titles and scopes of practice across Europe.

Implications for practice: As the first large-scale assessment of current AP roles and educational support amongst TR/RTTs across Europe, this study recommends the establishment of governance structure and role regulation. It also informs the curricula for master programmes to align the education with current and future practice.

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Introduction

The scope of Therapeutic Radiographer/Radiation Therapist (TR/RTT)'s practice has evolved, driven by ever-changing demands due to

several factors: exponential cancer incidence and prevalence from the ageing population, growing cancer survivors with comorbid conditions, rising public expectations, technological advances, challenges in staff recruitment and retention, and cost containment in healthcare.^{1–3}

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New strategies in healthcare delivery have emerged such as task shifting^{4–6} or skill-mix^{7,8} where professionals expand or extend their scopes of practice to close care gaps. Implementation of specialist techniques requires more autonomy, responsibility, and accountability, leading to changing practice from operator level to referrer and practitioner level in Radiotherapy (RT) workflow. This advanced level enhances capacity and capability within the oncology workforce, streamlining patient pathways. New roles have developed under the umbrella of Advanced Practice (AP) and it is expected that these will continue to develop in the future to address bottlenecks in delivering high-quality and timely care to meet patient's needs.^{2,9–12}

Two decades of evidence shows that AP roles in RT improved outcomes with clinical significance (access to care, patient satisfaction), organisational significance (service capacity, cost-effectiveness), and professional significance (job satisfaction).²

The challenge of future-proofing RT relies on existing inter-professional workforce supported by new skills and expertise. However, many professionals were trained to work in a model of care that is discrepant from that required in the future. The change from being experienced in a previous role to novice in a new role is a period of adjustment and requires significant support.^{13,14} Furthermore, the nature and the evolution of AP roles in RT over time varies in terms of scope,¹⁵ often locally developed (not underpinned by professional standards) which leads to conceptual and practical gaps in terms of education and regulation. Cross-country research in this topic is scarce, particularly in Europe where professionals can practice in any other European free movement zone country.^{2,6,9,14}

This study was developed as part of the SAFE EUROPE project¹⁶ aiming to assess AP roles amongst TR/RTTs' practice and identify educational gaps for this level across Europe.

Methods

A cross-sectional study using an anonymous survey that was developed and distributed online between the 1st December 2021 and 31st March 2022 across Europe.^{17,18} The target population consisted of TR/RTTs working in European countries at AP (official or informal). Inclusion criteria were advanced TR/RTT practitioners or trainee advanced TR/RTT practitioners, or TR/RTTs who considered themselves working in AP roles/tasks (irrespective of recognition as “Advanced practitioners -APs” in their countries).

Survey design

No validated survey was available, therefore the survey (Appendix A) was designed based on previous research,² selected published reports^{19–22} and surveys^{23,24} about current practices in healthcare.

The survey consisted of three-sections (Table 1): I - socio-demographic characteristics; II - professional profile including current AP roles; IIA or IIB- two split sub-sections depending on the AP status (formal vs informal) to explore additional education, role evaluation and support; III - current and future education and training needs for AP.

Key concepts used in the survey were defined²⁵ and clarified with examples to remove any ambiguity since the concept of AP has different interpretations across countries and regions.^{26–28}

The survey comprised both closed and open questions. Most of the closed questions allowed multiple choice responses with an option of “other” to allow for expansion of responses. This survey was designed in English (Microsoft Forms¹⁸), and distributed online to allow effective access to TR/RTTs (working in European

Table 1
Quantitative and qualitative survey items.

Categories	Variables	Scale	Values or options nr	Multiple answers
I – Sociodemographic				
Social	Gender	nominal	3 ^a	
Professional experience	Working country	nominal	49 + other	
	If other previous working country: countries	open		
Educational background	TR/RTT work experience	ratio	years	
	RT working area(s)	nominal	11 + other	X
	Academic level /EQF) to practice as TR/RTT	ordinal	5 + other	
	Education country	open		
	Areas/specialisms included in education	nominal	4 + other	X
II- Professional profile				
Current AP roles	Advanced activities	nominal	27 + other	X
	Areas of clinical practice & site-specific roles	nominal	13 + other	X
Current level	Working practice	nominal	4 + other	
IIA – Advanced practitioner's profile or IIB – TR/RTTs' profile				
AP profile	IIA/B- Job title	open		
	IIA/VB- Job description	nominal	3 ^b	
	IIA- Job plan	nominal	3 ^b	
	IIA/B - Working time by AP pillar	ratio	%	
AP professional experience	IIA/B - AP work experience	ratio	years	
	IIA - Current post work experience	ratio	years	
	IIA/B - Length of AP post/role in department	ratio	years	
	IIA/B - If work experience requirements: minimum	ratio	years	
AP education & training	IIA/B - If education requirements (degree/qualification): country, name, academic level/credits/hours	open		
	IIA/B - If additional training/qualification for AP: providers	nominal	9 + other	X
	IIA/B - If financial support for education/training: sources	nominal	8 + other	X
	IIA/B - If no additional education/training: factors	nominal	nominal	X
	IIA/B - Accreditation/formal agreement	nominal	3 ^b	
	IIA/B - RT specific AP framework/protocol	nominal	3 ^b	
AP support	IIA - Multi-professional AP framework	nominal	3 ^b	
	IIA/B - If supervision/peer support: staff	nominal	4 + other	X
	IIA/B - AP post permanent funding/role remuneration	nominal	3 ^{b/2^c}	
	IIB - If temporary funding: sources	nominal	6 + other	X
	IIA/B - If participation in role/task implementation: drivers	nominal	7 + other	X
AP role/task	IIA/B - If role/task evaluation: tools	nominal	9 + other	X
	IIA/B - If role/task impact assessment: metrics	nominal	14 + other	X
	IIA/B - If role/task no evaluation: factors	nominal	19 + other	X
	IIA/B - Mandatory model	nominal	2 ^c	
	IIA/B - Access	nominal	3 ^b	
CPD	IIA/B - Activities type	nominal	21 + other	X
III – Education and training needs				
Current AP	Areas of knowledge	nominal	27 + other	X
	Capabilities or advanced skills	nominal	24 + other	X
	If gaps in education and training: explanation	open		

Table 1 (continued)

Categories	Variables	Scale	Values or options nr	Multiple answers
Future AP	If new emerging AP roles: potential clinical areas	nominal	13 + other	X
	If new emerging AP roles: role/task	open		
	If AP role/task inclusion in standard practice: role/task	open		
	Other comments	open		

^a yes/no/prefer not to state, ^b yes/no/not sure, ^c yes/no AP- Advanced Practice, CPD- Continuing Professional Development, EQF- European Qualification Framework, RT- Radiotherapy, TR/RTT- Therapeutic Radiographer/Radiation Therapist.

countries) with flexibility concerning the time or place of their participation.²⁹

Pilot testing

External experts validated the survey, and TR/RTTs verified the reliability in a pilot study through a test-retest.^{17,29} These two groups represented different European countries and areas of RT professional practice.

Five external RT experts performed content validity and tested the functionality of the online survey. Each survey item was rated on a four-point Likert scale regarding the relevance and appropriateness of content against the study aims. The experts answered questions regarding the administration (e.g., survey reply time, ease of use), organisation (e.g., sections structure, logical ordering), and content (e.g., language understanding, question clarity, question bias, response options). A Cronbach's alpha coefficient of 0.89 was achieved illustrating that the items were relevant to the study aims.³⁰ Minor suggestions were incorporated into the survey.

A pilot survey was performed with a small group (n = 5) of TR/RTTs (two APs and three TR/RTTs working in AP roles) to perform the reliability test with two weeks apart. One participant was excluded from the analysis because the practitioner had changed the professional role between the two survey tests. The Intraclass Correlation Coefficient (ICC) was conducted for continuous variables.³¹ ICCs greater than 0.962 (p < 0.001) in the four respondents were achieved. The Cohen's kappa coefficient was calculated for the qualitative (categorical) items.³² Coefficients greater than 0.639 (p < 0.001) were obtained for all respondents. Both tests reflected good reliability.^{31,33} Minor changes were performed in the survey to improve readability of one question.

Survey distribution

Convenience sampling was used to recruit the TR/RTTs to participate in the survey. Multiple strategies were used to disseminate the study with the collaboration of the SAFE EUROPE project partners¹⁶ including professional organisations from three countries and a European-wide professional organisation. Respondents were invited via email with weblink (and follow-up reminders), posts on social media (Twitter, LinkedIn), and weblink on the project website.

Anonymity was ensured and consent was implied by the respondents completing the survey. Email reminders were sent to countries with no respondents and regular posts were published on social media to increase the response rate and countries' representativity. Ethical approval was granted by the Institute of Nursing and Health Research Ethics Committee at Ulster University, Belfast (Project Number: FCNUR-21-080).

Data analysis

Data was analysed using Microsoft Excel (v16.60) and IBM SPSS statistics (v27) for descriptive statistics and the qualitative data was exported to NVivo (v1.5.2) for thematic analysis.^{34,35} Data from pilot study was not included. Not all respondents answered every question (two tailored versions). Quantitative data and qualitative data were analysed separately, triangulated, and interpreted. Non-English text from open questions, mainly related to job titles and academic courses and qualifications, was translated using DeepL Translator software (DeepL GmbH, Cologne, Germany).³⁶

Results

Demographics and survey engagement

A total of 272 responses were obtained; 189 were eligible respondents (72% female, n = 137/189). Invalid respondents (n = 83) were excluded from data analysis and illustrated in Table 2. The largest group of respondents (57%, n = 107) self-reported as TR/RTTs working in AP roles/tasks, followed by APs' group (31%, n = 59). Other respondents self-reported as "undecided" about their own working practice level (9%, n = 17) or as "other" (3%, n = 6). Respondents of this last group were trainee APs, consultant practitioners, senior TR/RTTs, nurses with postgraduation in RT, etc.

Respondents came from 21 European countries (Fig. 1). United Kingdom (UK) (n = 41), Portugal (n = 34), and Ireland (n = 23) were the most represented countries. The top ten responding countries were categorised by self-reported working practice level (Table 3). Only the respondents who identified as "APs" responded sub-section IIA, and the others answered sub-section IIB (Table 1).

Some respondents (16%, n = 31) are emigrant TR/RTTs from UK (n = 8) and Portugal (n = 6). More than one third of these had worked in three or four different countries (n = 9) and the non-European country most represented in these migrant TR/RTTs was Australia (n = 5).

Education and professional background

The respondents had a median of 13 years professional experience (1–37 years), most had worked in treatment units (94%), planning image (54%) or education and training (52%) before moving to AP level (Fig. 2).

The median educational level to TR/RTTs registration was EQF6 (Bachelor's degree), with a range from EQF4 (High school) to EQF8 (Doctorate degree). Some respondents selected other academic levels (e.g., nursing with one year of RT postgraduation). Undergraduate RT-only programme was the most common (48%, n = 90/189), followed by the qualification programme with three specialisms: RT, Medical Imaging, and Nuclear Medicine (29% n = 54/189).

Table 2
Excluded survey responses.

Exclusion criteria	n
Non-practicing TR/RTTs	36
Working in non-European countries	11
Not self-defined as "Advanced Practitioner"/"TR/RTT working in AP role/tasks"/"undecided"/"other"	33
Not considered as TR/RTTs working in AP role/tasks after survey data analysis	3
Total	83

AP- Advanced Practice, TR/RTTs- Therapeutic Radiographers/Radiation Therapists.

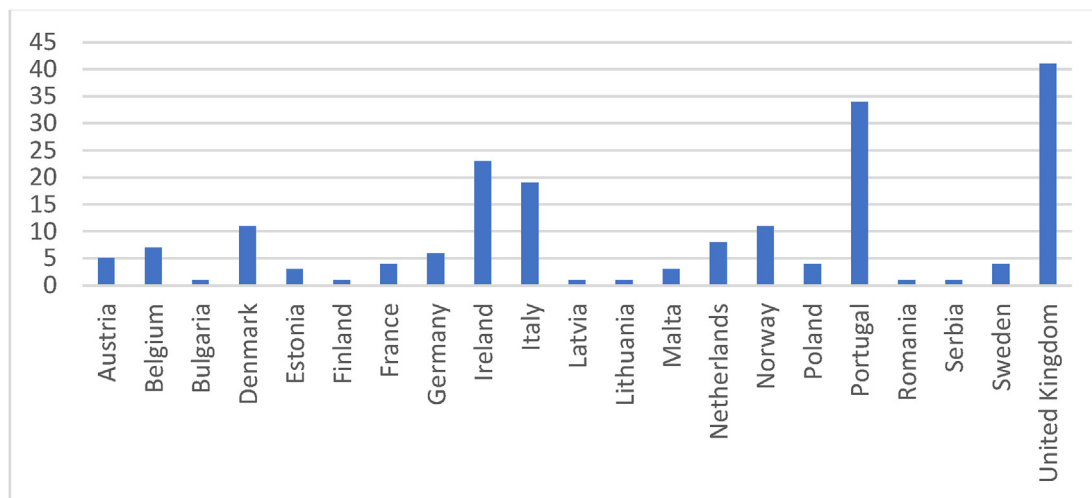


Figure 1. Respondents by country.

Table 3 Respondents' characteristics by working practice level with the top ten responding countries.

	TR/RTT in AP roles n (%)	Advanced Practitioner n (%)	Undecided n (%)	Other n (%)	Total n (%)
Total	107 (57)	59 (31)	17 (9)	6 (3)	189 (100)
Gender					
Female	75 (70)	43 (73)	14 (82)	5 (83)	137 (72)
Male	32 (30)	15 (25)	3 (18)	1 (17)	51 (27)
Prefer not to state	0 (0)	1 (2)	0 (0)	0 (0)	1 (1)
TR/RTT experience					
Years: median (range)	12 (1–36)	16 (3–37)	10 (2–34)	20 (6–34)	13 (1–37)
TR/RTT education					
EQF level: median (range)	6 (4–8)	6 (5–8)	6 (4–7)	6 (5–7)	6 (4–8)
With additional training to AP	61 (57)	29 (49)	5 (29)	5 (83)	100 (53)
AP experience					
Years: median (range)	5 (0–30)	8 (0–23)	6 (0–23)	7 (1–22)	6 (0–30)
Country					
Austria	2 (2)	1 (2)	2 (12)	0 (0)	5 (3)
Belgium	5 (5)	0 (0)	1 (6)	1 (17)	7 (4)
Denmark	5 (5)	5 (8)	1 (6)	0 (0)	11 (6)
Germany	2 (2)	2 (3)	2 (12)	0 (0)	6 (3)
Ireland	23 (22)	0 (0)	0 (0)	0 (0)	23 (12)
Italy	11 (10)	7 (12)	1 (6)	0 (0)	19 (10)
Netherlands	6 (6)	1 (2)	1 (6)	0 (0)	8 (4)
Norway	4 (4)	5 (8)	1 (6)	1 (17)	11 (6)
Portugal	17 (16)	12 (20)	4 (26)	1 (17)	34 (18)
United Kingdom	16 (15)	21 (36)	1 (6)	3 (50)	41 (22)
Others	16 (15)	5 (8)	3 (18)	0 (0)	24 (13)

AP- Advanced Practice, EQF- European Qualification Framework, TR/RTT- Therapeutic Radiographer/Radiation Therapist.

Over half of those surveyed had undertaken postgraduate education or training courses (53%, n = 100/189) to support AP level (Table 3). Some respondents had undertaken RT-specific masters' programmes, such as "RT and Oncology" (n = 15/189), and others in multi-professional healthcare programmes such as "Advanced Practice" (n = 10/189). Other respondents had specific postgraduate modules, with some respondents undertaking several modules. The most mentioned training courses were from the European Society for Radiotherapy and Oncology-ESTRO (Table 4).

During education/training, 54% (n = 67/189) of respondents reported clinical supervision or peer support mostly performed by medical doctors, advanced TR/RTT practitioners and medical physicists. A substantial number of TR/RTTs (67% n = 84/189) had obtained funding for education/training supported mainly by the employer. Professionals without additional training for AP justified this mainly with the course's cost, role/task without the requirement of it, and lack of funding.

13% of respondents (n = 24/189) work in a country different from where they graduated, and 6% of respondents (n = 11/189) have undertaken postgraduate education in another country from their working country and from where they had undertaken previous education for TR/RTT registration.

AP professional profile

The median (range) of professional experience in AP roles/tasks was 6 years (0–30 years), while the self-reported "APs" group had more experience: 8 years (0–23 years). The AP roles were performed more in site-specific role dependent, such as prostate (n = 104/189), breast (n = 98/189) and head and neck cancers (n = 97/189), than in clinical areas, such as palliative care (n = 65/189) and practice development (n = 61/189) (Fig. 3). Of the 27 suggested advanced activities (Fig. 4), the most common were advanced Image-Guided Radiation Therapy (IGRT) or Adaptive Radiation Therapy (ART – e.g., anatomical changes detection, decision making and approval), patient information (e.g., specialist information for pre-/during/post-treatment), and patient assessment (e.g., patient examination, treatment toxicity management). The least reported advanced activity was the participation on national guidance and communication (e.g., report writing, RT working group). Other identified activities were associated with brachytherapy (e.g., service planning and delivery, ultrasound guidance), and site-specific roles on lymphoma, sarcoma, oesophagus and chordoma.

Governance and sustainability

Job titles varied and were inconsistent both within and across countries. Many respondents answered the job titles in the language of working country. The APs' group also presented inconsistent job titles (Table 5), with some presenting multiple role titles

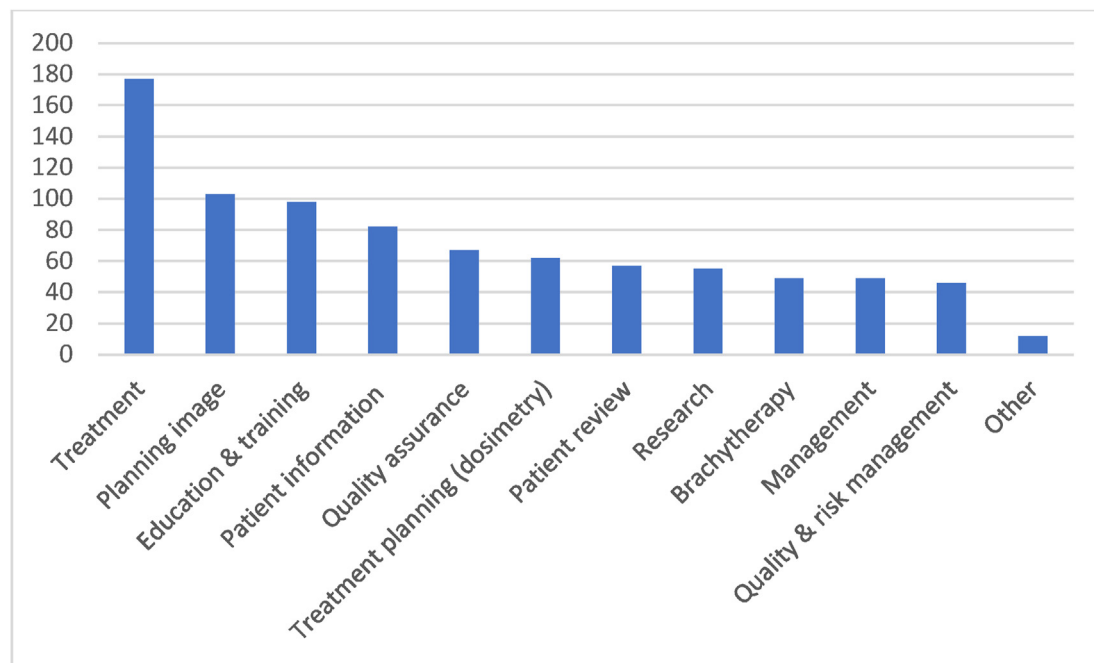


Figure 2. Self-reported working areas that respondents have worked as a TR/RTT.

($n = 8/59$). The most common title amongst APs was TR/RTT, with or without “senior” title (25%, $n = 15/59$).

Overall, most survey respondents (75%, $n = 141/189$) had a job description for their post, while 11% ($n = 21/189$) did not know if they had. A job plan was available in 32% ($n = 19/59$) of APs, while 19% ($n = 11/59$) did not know if they had.

The percentage of working time for each AP pillar shows a large focus on clinical practice (Table 6). The total sum of the respective times for the four pillars per respondent differed from 100% in 26% of the cases (12% responded less than 100%, and 14% reported a total higher than 100%).

42% of respondents ($n = 80/189$) acknowledged the existence of minimum requirements of additional education to undertake AP roles/tasks; “master’s degree” or “master module” were the most cited. One in four respondents (25%, $n = 48/189$) recognised a minimum number of working years as a requirement to perform AP roles/tasks in their departments; “five years” was the most reported.

Only 32% ($n = 60/189$) of practitioners responded that their AP are regulated by a national society/regulatory body or by formal agreement in the RT department. Nearly half of the respondents (49%, $n = 93/189$) indicated that their country had a RT-specific framework for AP or that the department had protocols for AP roles/tasks performance. Also, 66% ($n = 39/59$) of APs indicated that their country had a multi-professional AP framework for healthcare.

78% ($n = 46/59$) of APs stated that their AP posts had permanent funding, 12% ($n = 7/59$) reported temporary funding provided by the employer or government, 10% ($n = 6/59$) had no current knowledge about post funding. Regarding TR/RTTs working in AP role/tasks, only 14% ($n = 26/130$) had financial compensation for this extra responsibility.

47% of respondents ($n = 88/189$) declared they were involved in implementing the AP role/tasks in the department, being the main drivers: implementation of new technologies/techniques,

emerging role/task, service/care pathway redesign, and quality improvement programme.

24% of respondents ($n = 46/189$) indicated their advanced post/role/task was evaluated. Evaluations were performed mainly through process evaluation, competency/capability assessment, annual report. 47% of TR/RTTs ($n = 88/189$) reported that their AP roles/tasks had demonstrated impact namely in quality initiatives, patient, and professional satisfactions (Fig. 5). Respondents who answered that there is no AP role/task evaluation of impact assessment in their departments (7%, $n = 14/189$), justified it by organisational and professional issues, such as: limited staff resources, lack of dedicated time, and departmental culture (Fig. 6).

60% ($n = 114/189$) of practitioners confirmed that CPD was mandatory to the practice of AP roles/tasks, and they have regular access to CPD opportunities in their workplace (51% $n = 97/189$). Usually, the practitioners engage in CPD activities such as conferences, professional meetings, courses, in-house training among others (Fig. 7).

Education needs

The top three areas of knowledge required to improve current AP were: IGRT/ART, multimodal imaging & technologies, and advanced treatment planning. Leadership and management skills, and clinical site-specific expertise were the top three training needs identified to further develop the AP (Table 7).

63% of respondents ($n = 119/189$) think that new AP roles will emerge to meet service needs in their countries. The top three identified potential areas were practice development, lung cancer, and breast cancer. Emerging roles that were specified by some respondents were single areas of expertise or specific roles based on treatment site or technique/technologies. Also, some appointed roles were associated with research, education, and management (Table 8).

Table 4
Self-reported additional education and training undertaken to support AP roles.

Education (n)	Training (n)
<i>Masters</i> (48 ^{a,b})	<i>ESTRO Courses/Workshops</i> (19 ^{a,b})
(Enhanced/Advanced) RT & Oncology (Clinical Practice) (15)	Advanced skills in modern RT (5)
Advanced (Clinical) Practice (10)	IGRT & ART (2)
Medical Imaging and Radiation Oncology (2)	Modern brachytherapy (2)
Healthcare Management (2)	GEC-ESTRO (2)
Management (2)	Advanced Treatment Planning (1)
Research and Innovation in Healthcare (1)	Physics (1)
Public Health (1)	IMRT (1)
RT Treatment Planning (1)	SBRT (1)
System Administrator (1)	SGRT (1)
Radiography (1)	Positioning and immobilisation for RT (1)
Biophysics: Medical Physics and Biomedical Engineering (1)	Train the trainers (1)
<i>Postgraduate certificate/diploma/specialization</i> (17 ^{a,b})	Research for RTTs (1)
RT/RT & CT (4)	<i>In house training</i> (10 ^{a,b})
Healthcare Management (2)	Advanced clinical roles (2)
Practice Educator/Education/Trainer Practitioner (2)	MRI in RT (1)
Advanced Practice (1)	MRI-LINAC (1)
Health Protection (1)	Online ART (1)
Management Leadership in Health and Social Care (1)	SBRT (2)
Quality (1)	Brachytherapy (2)
<i>Master/Postgraduate modules</i> (23 ^{a,b})	<i>Vendor training</i> (4 ^b)
Clinical skills (3)	Fiducial marker insertion (1)
IGRT (3)	SpaceOAR™ insertion (1)
Patient review (2)	IGRT (1)
Brachytherapy (2)	IGRT & motion management (1)
Informed consent (2)	<i>Other certifications</i> (1)
Advanced communications (1)	Certified Associate in Project Management (1)
Prescribing (1)	
Research in clinical practice (1)	
IMRT (1)	
Symptom management (1)	
Expert practice (1)	
Good clinical practice (1)	
Biological basis of disease (1)	
Radiation safety (1)	
Bachelor's degree (1)	
Interprofessional Healthcare (1)	

ART- Adaptive Radiation Therapy, CT- Computed Tomography, ESTRO- European Society for Radiotherapy and Oncology, GEC- *Groupe Européen de Curiethérapie*, IGRT- Image-Guided Radiation Therapy, IMRT- Intensity Modulated Radiation Therapy, LINAC- Linear accelerator, MRI- Magnetic Resonance Imaging, RT-Radiation Therapy, RTTs- Radiation Therapists, SBRT- Stereotactic Body Radiation Therapy, SGRT- Surface Guided Radiation Therapy ^a Some respondents only reported the level/type of the qualification without programme's title identification ^b Some respondents reported more than one additional education programme.

Only 24% of respondents (n = 45/189) believed that inclusion of any current AP roles/tasks in the standard scope of practice, would happen and specified roles based on specific techniques/technologies (Table 9).

The majority of TR/RTTs (52% n = 99/189) consider that there are gaps in education/training for AP in their regions or countries, and 30% (n = 60) had no opinion. Explanations were varied, analysed thematically, and grouped into three levels: European, national, and organisational (Table 10). At national level factors were divided into direct and indirect. The direct were specific factors related to AP support and governance, while indirect were factors related with educational background to TR/RTT registration or professional status that somehow conditions the role development and subsequent AP implementation.

Findings by country

The top three participating countries (UK, Ireland, and Portugal) were compared. In UK, almost all TR/RTTs stated that CPD is mandatory for AP; TR/RTTs working in Ireland showed clear knowledge about their level of practice definition (no participant answered “not sure” contrary to the trend of 1 in 10 respondents and no participant self-defined as advanced practitioner); all respondents working in Portugal that self-reported as APs stated they do not have job plans.

Discussion

Demographics & survey engagement

To engage the maximum number of European countries, the survey was designed to include both formal and informal AP amongst TR/RTTs. The interest in TR/RTTs' role development was demonstrated by the substantial number of attempted participations.

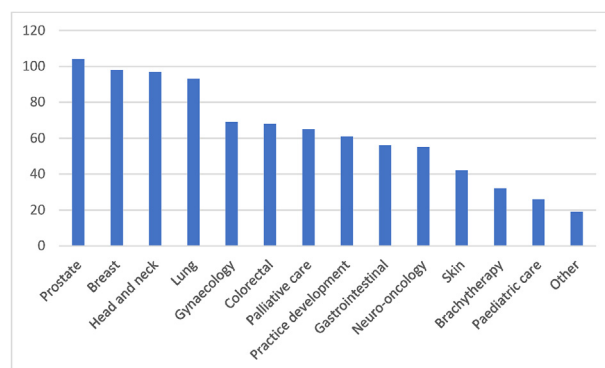


Figure 3. Self-reported current AP roles of the respondents.

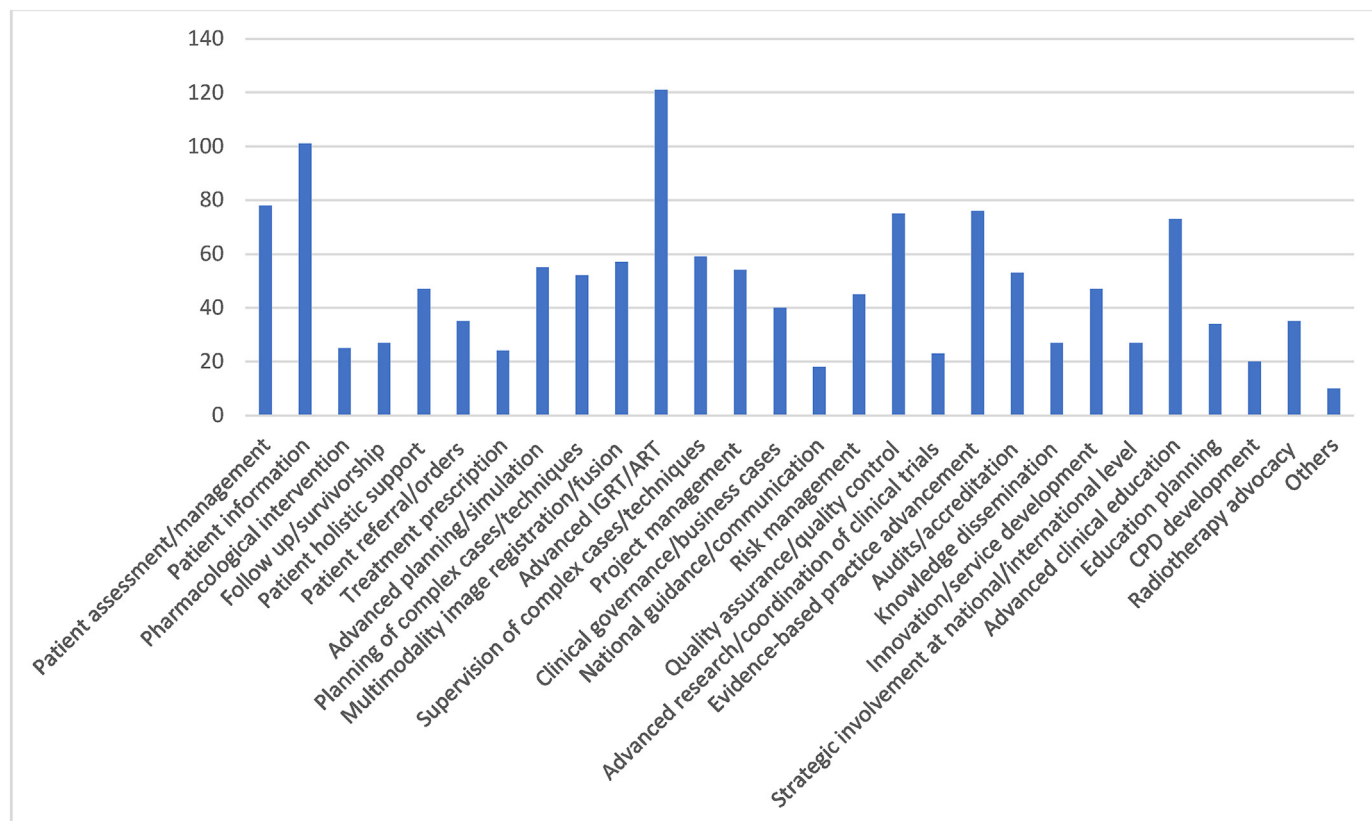


Figure 4. Self-reported advanced activities from current AP.

Table 5 Job titles of advanced TR/RTT practitioners (n = 59) classified by AP pillar.

Job title	Clinical area or site-specific role	n*
Clinical Practice		
(Senior) TR/RTT		15
(Senior) Dosimetrist		7
Advanced TR/RTT practitioner	Brachytherapy, urology, lung & upper gastrointestinal, gynae oncology	6
(Clinical) Specialist TR/RTT	Treatment planning, IGRT, ART	6
Consultant TR/RTT	Colorectal, head and neck cancer	3
Clinical nurse specialist in RT/Nursing specialist RTT		2
Advanced practitioner dosimetrist		2
Technical lead/Clinical technical specialist	IGRT	2
Treatment review TR/RTT		1
Medical physicist assistant		1
Trainee consultant TR/RTT	Breast	1
Management and Leadership		
Head or chief TR/RTTs	Brachytherapy, dosimetry	7
Lead or manager	Quality assurance, brachytherapy	3
Team leader or operational manager	Brachytherapy	2
Systems administrator		2
Coordinator RT department		1
Supervisor	Computed Tomography	1

Table 5 (continued)

Job title	Clinical area or site-specific role	n*
Education		
Education supervisor/head		3
Practice educator TR/RTT		1
Training and development superintendent		1
Training coordinator		1
Research		
Research coordinator		1
Researcher		1

ART- Adaptive Radiation Therapy, IGRT- Image-Guided Radiation Therapy, TR/RTT- Therapeutic Radiographer/Radiation Therapist. *8 respondents from this group have job titles composed by multiple role titles.

Respondents were from 54% of EFRS countries (n = 19/35) plus two non-EFRS members (Romania and Bulgaria). The most represented country was UK aligning with the literature review² where the UK formed 35% of the published evidence about TR/RTT AP roles whilst all European countries formed 46% of the total. The second most represented country was Portugal, contrary to the absence in

Table 6 Survey respondents' distribution of working time by AP pillars.

AP pillar	Median (%)	Range (%)
Clinical practice	60%	0–100%
Leadership and management	15%	0–100%
Education	10%	0–100%
Research	5%	0–75%

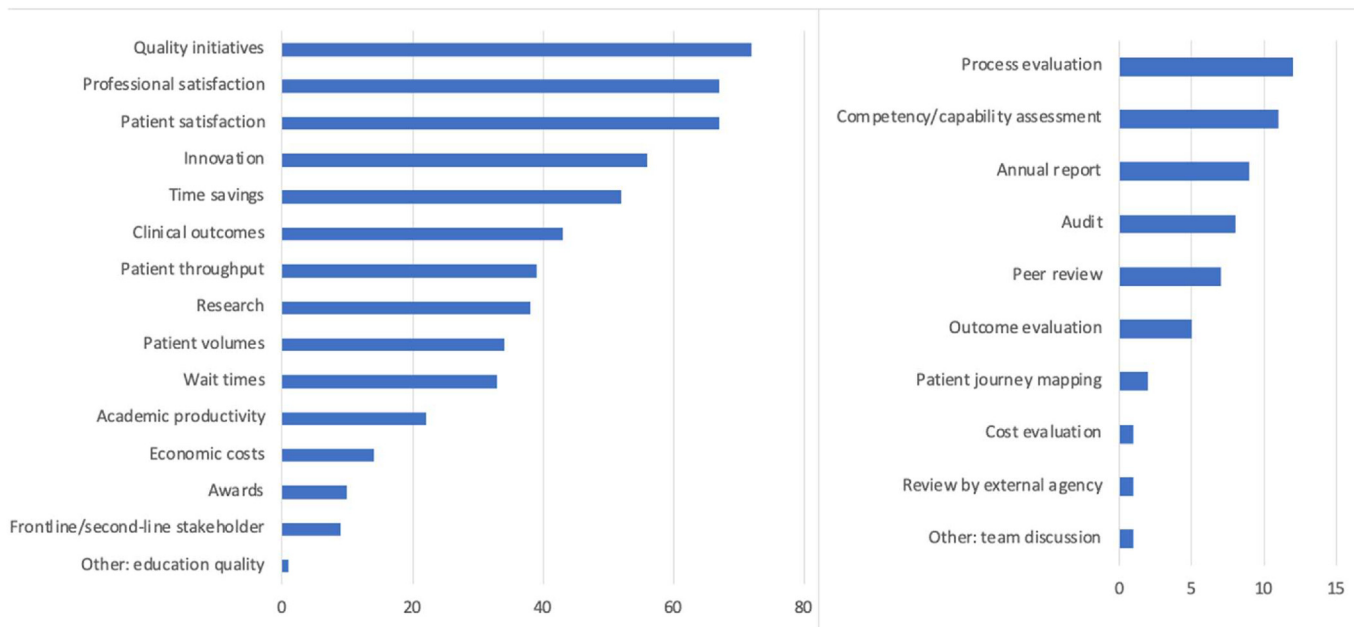


Figure 5. Reported metrics and tools used in evaluation and impact assessment of AP roles/tasks.

publications about AP in RT. The assistance of four national professional bodies of Malta, Poland, Portugal, and UK with survey dissemination in addition to the European distribution via the EFRS member may have contributed to this finding.

The respondents who were “undecided” regarding their own working practice level (9%, n = 17/189) denotes a lack of knowledge regarding AP with Portugal being the country more representative in this group (24%, n = 4/17). The “other level” (3%, n = 6/189) responses, included one consultant practitioner from UK. This non-medical consultant role working in four core domains of practice³⁷: has more responsibility with a strategic perspective compared to advanced practitioner, but was also included in our sample since it met our umbrella definition of AP.^{25,38} Also, the same group included one nurse with postgraduate qualification in RT because in some European countries the responsibilities of this profession are performed by nurses.³⁹

Education and professional background

Education and training that support AP in RT varied considerably (Masters in AP or RT-specific, postgraduate modules, external courses, in-house training, etc.) which was consistent with the

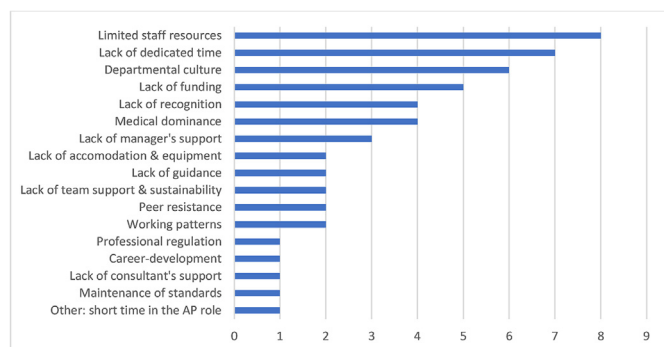


Figure 6. Reported factors that hindered evaluation and impact assessment of the AP roles/tasks.

literature in this profession² and with evidence from various healthcare professions.^{6,10} From the thematic analysis interpretation, when a country does not have a minimum requirement of EQF6 for TR/RTT registration, it has a low level of professional recognition hindering the role development and further education to underpin the AP.⁴⁰

AP professional profile

Our findings show a broad scope of AP roles across Europe. Informal AP was reported by 66% of respondents (n = 124/189, sum of group of TR/RTTs working in AP roles plus group self-reported as “undecided” about their working practice level). Informal AP was reported cross-country in other healthcare professions (e.g., nursing)^{6,41} and this study confirms the existence of informal AP amongst TR/RTTs in most participant countries, with the evidence of professionals undertaking several roles and activities at advanced level in RT departments. A mismatch between restrictive regulation, higher skill level of practitioners and growing healthcare needs in oncology leads to questions regarding patient safety and liability for the TR/RTTs.

The most common activities performed in AP roles are activities associated with direct care (patient information and support, patient assessment and management) in line with the literature.² Surprisingly, activities of project management (e.g., engagement of team members, identification of partnerships & funding), clinical governance and business case (e.g., setting and monitoring service standards, performance management) were reported more often in the current practice when compared literature.² Through analysis of the job titles, we found that TR/RTTs also work in certain AP site-specific roles such as gynaecology, colorectal and gastrointestinal, which are seldom discussed in the literature.²

Governance and sustainability

Advanced TR/RTT practitioners work under a “mixed bag” of job titles that create confusion for healthcare professionals, employers, and patients at national and European levels. The inconsistency of the job titles in this level of practice is associated with lack of role recognition that affects acceptance in the clinical setting and may

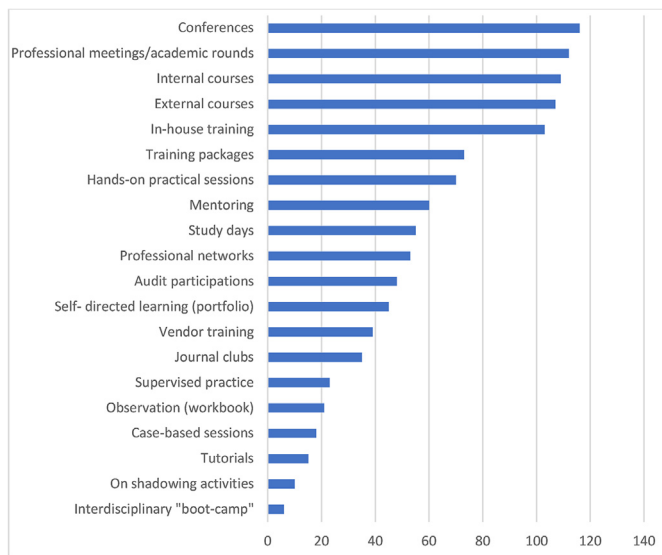


Figure 7. Reported CPD activities usually undertaken by the professionals.

even lock practitioners into their workplaces, hindering movement between healthcare organizations.^{11,42,43}

Regarding AP's group, only about one-third had a job plan for their working time with specific times allocation by AP pillar. (This question was not addressed in the other subsection). Mapping the percentage of working time of all respondents by AP pillar revealed that the clinical practice pillar had priority over the remaining three pillars. It should be noted there may be some margin of error in this data analysis because 26% (n = 49/189) of respondents answered with a total time different from 100%. Of these, 23 responded a total time higher than 100%, which could mean extra time allocated from regular working hours (overtime) or other job contracts. Whilst 26 responded a total time lower than 100%, which could mean a part-time job contract. The neglect of the other three pillars is described

with a negative impact on professional development and practice according to several authors in other healthcare professions^{10,14}

According to our findings and literature, a Master's degree is crucial for undertaking AP roles to work across the four pillars,^{25,44} preferably RT-specific programme and some years of professional experience are mandatory to advance the role, but the number of years is not consensual.⁴⁵

Education needs

The importance of TR/RTTs in identifying AP clinical and education needs based on their population and health economy has been previously identified.^{44,46} There is evidence that some respondents undertake postgraduate education for AP in a different country to where they undertook the bachelor's degree, suggesting a lack of education opportunities in several European countries. This finding is aligned with the described deficit of postgraduate education opportunities for radiographers across Europe.⁴⁷

Limitations

Convenience sampling can negatively impact the study in terms of selection bias, but the research team considered it an appropriate method of identifying respondents in circumstances where the target population is not clearly defined. There was no complete register of advanced TR/RTTs practitioners working in Europe. Also, there is considerable variability in perception about what constitutes AP roles in RT across countries. The survey was emailed to all EFRS members and picked up by social media. Therefore, the exact response rate is difficult to determine. There may be some bias in approaching EFRS members as it does not cover all European countries, but since we use social media that allowed non-members to participate, this bias was minimised.

The survey was only available in English; therefore, the language bias may have excluded some respondents from non-English speaking countries. Several respondents answered some open

Table 7 Self-reported education and training needs to improve current AP roles/tasks.

Areas of knowledge	n	Capabilities or Advanced skills	n
IGRT/ART	74	Leadership skills (negotiating, influencing)	61
Advanced treatment planning	73	Management skills (people, time, financial, project)	54
Multimodal imaging & technologies	60	Clinical site-specific expertise	54
Imaging (diagnostic, molecular, functional)	56	Specialty expertise	52
Accelerator technology & dosimetry	56	Technical site-specific expertise	46
Radiation biology & oncology	53	Complex cases supervision	45
Risk management & audit	53	Complex decision-making & professional judgement	44
Quality assurance & tools	50	Critical thinking (analysis, evaluation, synthesis)	40
Brachytherapy & intraoperative RT	49	Professional networking	40
Proton & carbon ion therapy	48	Education and CPD planning	40
Patient education & counselling	43	Communication skills (oral, written, active listening)	38
Psychology of cancer care	43	Digital skills (information technology)	38
Practice development & innovation	43	Collaborative working skills (multi/inter/transdisciplinary)	37
Cancer nutrition	36	Technological expertise	36
Advanced care planning & treatment	35	Technique-related expertise	33
Research & bioethics	35	Complex problem solving (creative thinking, adaptability)	32
Management & clinical governance	34	Emotional intelligence	32
Radiation & nuclear physics	34	Academic involvement	30
Communication in supportive care	32	Coordination of clinical trials	27
Cancer survivorship & patient advocacy	32	Knowledge dissemination	25
Social & holistic care	31	Reflective skills (self-reflection, observation)	24
Pharmacology & radiopharmacology	29	Ethical reasoning	17
Biostatistics	27	Green skills (environment)	9
Medical physics instrumentation	22		
Complementary & alternative medicine	21		
Informatics in healthcare & telemedicine	19		

AP- Advanced Practice, ART- Adaptive Radiation Therapy, IGRT- Image-Guided Radiation Therapy, CPD- Continuing Professional Development.

Table 8
Reported areas of clinical practice with more potential for new AP roles development and emerging AP roles.

Areas of clinical practice	n	Emerging roles (e.g., activities)	n
Practice development	66	Area/site-specific (e.g., new patient clinic acceptance, HDR application, follow up, pathway management)	14
Lung	56	Technique/technology-based (e.g., SBRT, online MRI-LINAC)	11
Breast	54	Image guidance (e.g., IGRT/ART, real time monitoring & dose optimisation)	7
Palliative care	49	Pre-treatment (e.g., personalized dose & fractionation)	7
Prostate	49	Research, development & innovation (e.g., clinical trials, service development)	6
Head & Neck	46	Information & support (e.g., psychology of cancer care, patient adherence)	4
Brachytherapy	43	On-treatment care (e.g., drug prescribing, cannulation)	3
Gynaecology	42	Education & training (e.g., supervisor, staff engagement)	3
Neuro-oncology	42	Management & problem solving (e.g., RT data, AI, technological flaws, FMEA, FMECA)	3
Colorectal	31	Radiation protection	2
Gastrointestinal	28		
Paediatric care	25		
Skin	24		
Other: hyperthermia	1		

AI- Artificial Intelligence, AP- Advanced Practice, ART- Adaptive Radiation Therapy, FMEA- Failure Mode and Effects Analysis, FMECA- Failure Mode, Effects, and Criticality Analysis, HDR- High Dose Rate, IGRT- Image-Guided Radiation Therapy, LINAC- Linear accelerator, MRI-Magnetic Resonance Imaging, SBRT- Stereotactic Body Radiation Therapy.

questions in the language of the working country, leading to additional challenges in analysing the qualitative data.

Recommendations

The scope of AP level, job titles, education programmes, training support and regulation varied substantially across Europe. Neither the profession nor education of TR/RTTs is harmonised across Europe,^{48–54} and this has been highly reflected in advanced level practice. There is potential to close the gap between education and current practice and ultimately improve patient care. Developing minimum educational and practice standards may facilitate the comparability and recognition of this level across countries.

To address inconsistency, to guide effective planning and development of advanced TR/RTTs practitioners, we recommend the following:

Governance structures and regulation

- Involve key stakeholders to develop an AP framework to establish minimum requirements in education (Master's degree) and in practice (years of RT professional experience).^{3,55–59}
- Raise awareness of key stakeholders (e.g., employers, managers, regulatory bodies, policy-makers) of the importance of a job plan with a rebalanced allocation of working time for all AP pillars.²⁵

Table 9
Reported AP roles with trend to be included in the future scope of TR/RTTs' practice.

AP roles (e.g., activities)	n
Technique/technology-based (e.g., SBRT, SGRT, proton therapy, IGRT, ART, radiosurgery, AI)	9
Complex treatment planning (e.g., contouring consultation)	6
Area/site-specific (e.g., cerebral AVM, brachytherapy)	5
Education & training (e.g., liaison with academic education & work-based learning, supervision, clinical education, education planning)	4
Management & leadership (e.g., case manager, new technique implementation and impact assessment,	4
Clinical lead on-treatment (e.g., decision making on target delineation, reflective practice)	3
Research	3
Follow up	1

AI-Artificial Intelligence, AP- Advanced Practice, ART- Adaptive Radiation Therapy, AVM- Arteriovenous Malformation, IGRT- Image-Guided Radiation Therapy, RT- Radiation Therapy, SBRT- Stereotactic Body Radiation Therapy, SGRT- Surface Guided Radiation Therapy.

- Establish AP framework for TR/RTTs, including healthcare core capabilities and RT-specific advanced competencies and skills by AP role.^{25,60}

Table 10
Factors perceived by TR/RTTs that contributed for gaps in education and training of AP roles.

Level & factors	n*
European	
Limited access to courses (cost, language barrier)	3
National	
Direct	
No formal training for specific AP roles	7
Lack of regulation and guidance on AP governance	6
No education requirements for AP level: master's degree and regular CPD activities	4
Inexistence of master's degree specific for RT or AP	3
Unclear educational routes to AP	2
Outdated educational curricula and training programmes for AP	2
Inexistence AP framework based on roles & capabilities	2
Inexistent training programmes based on 4 pillars of AP	1
Lack of site-specific modules for AP in RT	1
Indirect	
Dual qualification for TR/RTTs practice: low proportion of RT curricula/clinical placements	11
Lack of professional recognition and career development	6
Academic degree lower than EQF6 level for TR/RTT registration	5
Lack of strategy for higher education and CPD	4
Outdated job title and job description	1
Lack of support from professional body	1
Organisational	
Work-based learning with low support from universities	8
Existence of <i>ad hoc</i> AP roles at local level	5
Lack of protected time or study leave	5
No funding for AP roles remuneration/reward	4
Lack of access to clinical mentorship and supervision	2
Limited staff resources	2
Lack of team support	2
Limited funding for AP education or training	2
Low medical doctors' support in supervision	2
Low management support	2
No AP roles sustainability: without succession planning	1
Gap between department and universities	1
Difficulties in AP roles compliance with the four pillars: demands of the clinical role	1

AP- Advanced Practice, CPD- Continuing Professional Development, EQF- European Qualification Framework, RT- Radiotherapy, TR/RTTs- Therapeutic Radiographers/ Radiation Therapists *Some respondents have provided more than one factor.

Evaluation and impact assessment

- Standardise this level of practice with harmonisation of job titles and descriptions for advanced posts to ensure public safety, role recognition, enabling the mobility of practitioners across Europe.^{11,61}
- Evaluate AP posts and assess the impact of AP roles in terms of clinical, organisational, and professional outcomes for AP sustainability and continuous improvement of RT service.⁶²
- Regular review of scope of AP should be undertaken to facilitate comparison across countries.⁴³

Education and training

- In countries without AP Masters qualification:
 - Creation of accredited Master's programmes dedicated to AP in RT.⁵⁹
 - In case of economic unfeasibility,⁶³ consider possible collaborations with other healthcare multi-professional master programmes with elective modules (generalist) for the core capabilities and optional modules (specialist) for the RT-specific competencies and advanced skills (e.g., clinical placements with supervision, mentorship).^{10,64} Another suggestion is to get possible collaborations with universities from neighbouring countries or assist professionals in undertaking distance learning programmes.⁶⁵
- In countries with AP Masters qualification:
 - Clear pathways for TR/RTTs with more support from universities and employers (e.g., supervision, clinical placements, funding, protected time/study leave).¹⁰
 - Constant revised and updated curricula to keep up with emerging AP roles and RT technologies evolution.⁶⁶
- CPD should be mandatory for AP and activities should be focused on healthcare (core capabilities enhancement) and role-specific (RT-specific education updating). The activities should be offered locally or be supported by the employer (e.g., funding, protected time).^{10,67–70}

Conclusion

As the first large-scale assessment of current AP and education support amongst TR/RTTs across Europe, this study highlights the need to establish a governance structure and role regulation to support this level. Creation of dedicated programmes for AP in RT should be prioritised since this survey shows educational gaps. The continuous update of educational programmes aligned with current and future practice is crucial, and findings from this study can guide the curricula of advanced TR/RTT practitioners.

APs in oncology will continue to be valuable within the healthcare workforce hence there is a need to consider the profession of TR/RTT in a more systematic approach from standard practice to advanced level to harmonise radiotherapy care across Europe.

Further research could use this survey in national contexts after validation and adaptation of the language-translation and even for worldwide study. Studies focused on key stakeholders of AP in RT should be performed to obtain in-depth perspectives to understand the challenges that hinder the standardisation of this level in national and European contexts.

Conflict of interest statement

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.radi.2022.12.003>.

References

1. IAEA. *Radiotherapy in cancer care: Facing the global challenge*. International Atomic Energy Agency; 2017.
2. Oliveira C, Barbosa B, Couto JG, Bravo I, Khine R, McNair H. Advanced practice roles of therapeutic radiographers/radiation therapists: a systematic literature review. *Radiography* 2022;**28**(3):605–19. <https://doi.org/10.1016/j.radi.2022.04.009>.
3. Duffton A, Devlin L, Tsang Y, Mast M, Leech M. Advanced practice: an ESTRO RTTC position paper. *Tech Innov Patient Support Radiat Oncol* 2019;**10**:16–9. <https://doi.org/10.1016/j.tipsro.2019.06.001>.
4. WHO. Task shifting: Rational redistribution of tasks among health workforce teams. In: *Global recommendations and guidelines*. World Health Organization; 2008. <https://www.who.int/healthsystems/TTR-TaskShifting.pdf>.
5. de Maeseneer J, Bourek A, McKee M, Barry M, Brouwer W, Kringos D, et al. *Task shifting and health system design: report of the expert panel on effective ways of investing in health (EXPH)*. European Union; 2019.
6. Maier CB, Aiken LH. Task shifting from physicians to nurses in primary care in 39 countries: a cross-country comparative study. *Eur J Publ Health* 2016;**26**(6): 927–34. <https://doi.org/10.1093/eurpub/ckw098>.
7. Sibbald B, Shen J, McBride A. Changing the skill-mix of the health care workforce. *J Health Serv Res Pol* 2004;**9**(Suppl 1):28–38. <https://doi.org/10.1258/135581904322724112>.
8. Tsang Y, Roberts N, Wickers S, Nisbet H. Embracing skill mix in the clinical oncology workforce - capturing impacts of consultant therapeutic radiographers in the UK. *Clin Oncol* 2021;**33**(5):e239–42. <https://doi.org/10.1016/j.clon.2021.02.001>.
9. Jones A, Powell T, Watkins D, Kelly D. Realising their potential? Exploring interprofessional perceptions and potential of the advanced practitioner role: a qualitative analysis. *BMJ Open* 2015;**5**(12):e009740. <https://doi.org/10.1136/bmjopen-2015-009740>.
10. Fothergill IJ, Al-Oraibi A, Houdmont J, Conway J, Evans C, Timmons S, et al. Nationwide evaluation of the advanced clinical practitioner role in England: a

- cross-sectional survey. *BMJ Open* 2022;12(1):e055475. <https://doi.org/10.1136/bmjopen-2021-055475>.
11. Hooks C, Walker S. An exploration of the role of advanced clinical practitioners in the East of England. *Br J Nurs Mark Allen Publ* 2020;29(15):864–9. <https://doi.org/10.12968/bjon.2020.29.15.864>.
 12. Khine RNM, Stewart-Lord A. An examination of Advanced Clinical Practice: qualitative insights from therapeutic radiography advanced and consultant practitioners based in England. *Tech Innov Patient Support Radiat Oncol* 2021;17:97–101. <https://doi.org/10.1016/j.tipsro.2020.12.003>.
 13. Twine N. The first year as a nurse practitioner: an integrative literature review of the transition experience. *J Nurs Educ Pract* 2017;8(5):54. <https://doi.org/10.5430/jnep.v8n5p54>.
 14. Lawler J, MacLaine K, Leary A. Workforce experience of the implementation of an advanced clinical practice framework in England: a mixed methods evaluation. *Hum Resour Health* 2020;18(1):96. <https://doi.org/10.1186/s12960-020-00539-y>.
 15. Tsang YM, Routsis DS. Adapting for adaptive radiotherapy (ART): the need to evolve our roles as therapeutic radiographers. *Radiography* 2021;27:S39–42. <https://doi.org/10.1016/j.radi.2021.08.004>.
 16. SAFE EUROPE project. *Safe Europe | safe & free exchange of EU radiography professionals across Europe*. <https://www.safeeurope.eu/>. [Accessed 2 February 2022]. Accessed.
 17. Creswell JW, Creswell JD. *Research design: qualitative, quantitative, and mixed methods approaches*. 2018.
 18. Microsoft Forms. <https://forms.office.com>.
 19. Jones M, Collins K, McDonnell A, Jones R, Doyal L, Cameron A, et al. *Exploring new Roles in practice (ENRiP)*. School of health and related research (SCHARR). University of Sheffield; 2001.
 20. ACT Allied Health. *Radiation Therapy extended scope of practice: phase 1*. Office of the Allied Health Adviser; 2009.
 21. Price R, Miller L. *An evaluation of the impact of implementation of consultant practitioners in clinical imaging*. Society and College of Radiographers; 2010. <http://uhra.herts.ac.uk/handle/2299/10083>. [Accessed 30 January 2022]. Accessed.
 22. *Advanced practice working group (APWG) to the board of directors of the Australian Institute of radiography (AIR). Discussion paper: a Model of advanced Practice in diagnostic Imaging and radiation Therapy in Australia*. 2009.
 23. EFRS, Results of the EFRS 2020 annual survey. Educational wing members, 2020, European Federation of Radiographer Societies. www.ehrs.eu.
 24. Society and College of Radiographers (Scor). *Trainee consultant and consultant radiographer survey 2018*. 1st ed. 2018. <https://www.sor.org/learning-advice/professional-body-guidance-and-publications/documents-and-publications/policy-guidance-document-library/trainee-consultant-and-consultant-radiographer-sur>. [Accessed 2 February 2022]. Accessed.
 25. Health Education England. *Multi-professional framework for advanced clinical practice in England*. 2017. Published online.
 26. Cowling C. A global overview of the changing roles of radiographers. *Radiography* 2008;14:e28–32. <https://doi.org/10.1016/j.radi.2008.06.001>.
 27. Hardy M, Legg J, Smith T, Ween B, Williams I, Motto J. The concept of advanced radiographic practice: an international perspective. *Adv Consult Pract Radiogr* 2008;14:e15–9. <https://doi.org/10.1016/j.radi.2008.10.001>.
 28. Eddy A. Advanced practice for therapy radiographers – a discussion paper. *Radiography* 2008;14(1):24–31. <https://doi.org/10.1016/j.radi.2006.07.001>.
 29. Bowling A. *Research methods in health: investigating health and health services*. UK: McGraw-Hill Education; 2014.
 30. Bonett DG, Wright TA. Cronbach's alpha reliability: interval estimation, hypothesis testing, and sample size planning. *J Organ Behav* 2015;36(1):3–15. <https://doi.org/10.1002/job.1960>.
 31. Koo TK, Li MY. A guideline of selecting and reporting intraclass correlation coefficients for reliability research. *J Chiropr Med* 2016;15(2):155–63. <https://doi.org/10.1016/j.jcm.2016.02.012>.
 32. McHugh ML. Interrater reliability: the kappa statistic. *Biochem Med* 2012;22(3):276–82. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3900052/>. [Accessed 25 July 2022]. Accessed.
 33. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics* 1977;33(1):159–74. <https://doi.org/10.2307/2529310>.
 34. Guest G, MacQueen K, Namey E. *Applied thematic analysis*. SAGE Publications, Inc.; 2012. <https://doi.org/10.4135/9781483384436>.
 35. Braun V, Clarke V. *Successful qualitative research: a practical guide for beginners*. SAGE; 2013.
 36. Takakusagi Y, Oike T, Shirai K, Sato H, Kano K, Shima S, et al. Validation of the reliability of machine translation for a medical article from Japanese to English using DeepL translator. *Cureus* 2021;13(9). <https://doi.org/10.7759/cureus.17778>.
 37. College of Radiographers. *Consultant radiographer – guidance for the support of new and established roles*. 2019.
 38. Booth L, Henwood S, Miller P. Reflections on the role of consultant radiographers in the UK: what is a consultant radiographer? *Radiography* 2016;22(1):38–43. <https://doi.org/10.1016/j.radi.2015.05.005>.
 39. Sousa F, Somoano M, Jourani Y, Van Gestel D. Qualitative evaluation of the role of RTTs IGRT specialists and their influence on treatment delivery. *Tech Innov Patient Support Radiat Oncol* 2022;22:9–15. <https://doi.org/10.1016/j.tipsro.2022.03.002>.
 40. Couto JG, McFadden S, McClure P, Bezzina P, Beardmore C, Hughes C. Competency level in radiotherapy across EU educational programmes: a cross-case study evaluating stakeholders' perceptions. *Radiogr Lond Engl* 2022;28(1):180–6. <https://doi.org/10.1016/j.radi.2021.10.015>. 1995.
 41. Evans C, Pearce R, Greaves S, Blake H. Advanced clinical practitioners in primary care in the UK: a qualitative study of workforce transformation. *Int J Environ Res Publ Health* 2020;17(12):4500. <https://doi.org/10.3390/ijerph17124500>.
 42. Thompson J, Tiplady S, Hodgson P, Proud C. Scoping the application of primary care advanced clinical practice roles in England. *Int J Health Gov* 2020;25(3):245–58. <https://doi.org/10.1108/IJHG-03-2020-0015>.
 43. de Bont A, van Exel J, Coretti S, Ökem Z, Janssen M, Ludwicki T, et al. Reconfiguring health workforce: a case-based comparative study explaining the increasingly diverse professional roles in Europe. *BMC Health Serv Res* 2016;16(1):637. <https://doi.org/10.1186/s12913-016-1898-0>.
 44. Coleman K, Jasperse M, Herst P, Yelder J. Establishing radiation therapy advanced practice in New Zealand. *J Med Radiat Sci* 2014;61(1):38–44. <https://doi.org/10.1002/jmrs.33>.
 45. Martens B, Veldman L, Singleton M, Fawcett S, Ali S. Radiation therapists' perceptions of advanced practice in Alberta. *J Med Imag Radiat Sci* 2018;49(1):62–9. <https://doi.org/10.1016/j.jmir.2017.12.002>.
 46. Field LJ, Snaith BA. Developing radiographer roles in the context of advanced and consultant practice. *J Med Radiat Sci* 2013;60(1):11–5. <https://doi.org/10.1002/jmrs.2>.
 47. McNulty JP, Rainford L, Bezzina P, Henner A, Kukkes T, Pronk-Larive D, et al. A picture of radiography education across Europe. *Radiography* 2016;22(1):5–11. <https://doi.org/10.1016/j.radi.2015.09.007>.
 48. Couto JG, McFadden S, Bezzina P, McClure P, Hughes C. An evaluation of the educational requirements to practise radiography in the European Union. *Radiography* 2018;24(1):64–71. <https://doi.org/10.1016/j.radi.2017.07.009>.
 49. Couto JG, McFadden S, McClure P, Bezzina P, Camilleri L, Hughes C. Evaluation of radiotherapy education across the EU and the impact on graduates' competencies working on the linear accelerator. *Radiography* 2021;27(2):289–303. <https://doi.org/10.1016/j.radi.2020.08.010>.
 50. Sá dos Reis C, Pires-Jorge JA, York H, Flaction L, Johansen S, Maehle S. Curricula, attributes and clinical experiences of radiography programs in four European educational institutions. *Radiography* 2018;24(3):e61–8. <https://doi.org/10.1016/j.radi.2018.03.002>.
 51. Bibault JE, Franco P, Borst GR, Van Elmpot W, Thorwhart D, Schmid M, et al. Learning radiation oncology in Europe: results of the ESTRO multidisciplinary survey. *Clin Transl Radiat Oncol* 2018;9:61–7. <https://doi.org/10.1016/j.ctro.2018.02.001>.
 52. England A, Geers-van Gemeren S, Henner A, Kukkes T, Pronk-Larive D, Rainford L, et al. Clinical radiography education across Europe. *Radiography* 2017;23:S7–15. <https://doi.org/10.1016/j.radi.2017.05.011>.
 53. McNulty JP, England A, Shanahan MC. International perspectives on radiography practice education. *Radiography* 2021;27(4):1044–51. <https://doi.org/10.1016/j.radi.2021.04.004>.
 54. Eriksen JG, Beavis AW, Coffey MA, Leer JW, Magrini S, Benstead K, et al. The updated ESTRO core curricula 2011 for clinicians, medical physicists and RTTs in radiotherapy/radiation oncology. *Radiother Oncol J Eur Soc Ther Radiat Oncol* 2012;103(1):103–8. <https://doi.org/10.1016/j.radonc.2012.02.007>.
 55. Coffey M, Leech M. Introduction to the ESTRO European qualifications framework (EQF) 7 and 8: benchmarking radiation therapist (RTT) advanced education. *Tech Innov Patient Support Radiat Oncol* 2018;8:19–21. <https://doi.org/10.1016/j.tipsro.2018.09.008>.
 56. EFRS, European Qualifications Framework (EQF) level 7 benchmarking document: radiographers, Published online January 2017. <https://api.ehrs.eu/api/assets/posts/208>.
 57. Australian society of medical imaging and radiation therapy. *Pathway to advanced practice: advanced practice for the Australian medical radiation professions*. Published online February, https://www.asmirt.org/asmirt_core/wp-content/uploads/129.pdf, 2017. [Accessed 4 January 2022]. Accessed.
 58. Canadian Association of Medical Radiation Technologists. *Advanced practice in medical radiation technology: a Canadian framework*. Published online, <https://www.camrt.ca/wp-content/uploads/2015/02/Advanced-Practice-in-Medical-Radiation-Technology-A-Canadian-Framework.pdf>; 2015.
 59. Motshweneng OS, Mdletshe S. Preparing for advanced practice radiation therapy in South Africa: conceptual and curricular considerations. *Health SA SA Gesondheid* 2021;26:1587. <https://doi.org/10.4102/hsag.v26i0.1587>.
 60. Ryley N, Middleton C. Framework for advanced nursing, midwifery and allied health professional practice in Wales: the implementation process. *J Nurs Manag* 2016;24(1):E70–6. <https://doi.org/10.1111/jonm.12291>.
 61. Harris MA, Snaith B, Adamson HK, Foster B, Woznitza N. An analysis of advanced and specialist posts in diagnostic radiography: do job descriptions describe advanced practice? *Radiography* 2021;27(2):437–42. <https://doi.org/10.1016/j.radi.2020.10.008>.
 62. Duffton A, Moore K, Williamson A. Diversity in radiation therapist/therapeutic radiographer (RTT) advanced practice (AP) roles delivering on the four domains. *Tech Innov Patient Support Radiat Oncol* 2021;17:102–7. <https://doi.org/10.1016/j.tipsro.2021.02.003>.
 63. Coffey M, Rosenblatt E. Guest short communication: is education of RTTs really unnecessary? *Tech Innov Patient Support Radiat Oncol* 2018;8:1–2. <https://doi.org/10.1016/j.tipsro.2018.09.001>.
 64. Bell CA, Collieran V. Empowering nurses, midwives and allied health professionals to gain an academic, research and quality improvement experience

- within clinical practice. *Int J Pract-Based Learn Health Soc Care* 2019;**7**(2): 69–79. <https://doi.org/10.18552/ijpblhsc.v7i2.641>.
65. Matthews K, Wright C, Osborne C. Blending work-integrated learning with distance education in an Australian radiation therapy advanced practice curriculum. *Radiography* 2014;**20**(3):277–82. <https://doi.org/10.1016/j.radi.2014.03.008>.
66. Barbosa B, Bravo I, Oliveira C, Antunes L, Couto JG, McFadden S, et al. Digital skills of therapeutic radiographers/radiation therapists – document analysis for a European educational curriculum. *Radiography* 2022;**28**(4):955–63. <https://doi.org/10.1016/j.radi.2022.06.017>.
67. EFRS. *CPD recommendations and guidance notes*. 2018. Published online January.
68. Giles E. How do medical radiation science educators keep up with the [clinical] joneses? *J Med Radiat Sci* 2014;**61**(2):102–11. <https://doi.org/10.1002/jmrs.53>.
69. Mohamed Afif A, Goh MZH, Lin YJ, Ho GD, Anwar T, Chong CM, et al. An analysis of the continuing professional development needs of radiographers and radiation therapists in Singapore. *Radiogr Lond Engl* 2021;**27**(3):927–34. <https://doi.org/10.1016/j.radi.2021.03.002>. 1995.
70. Manship S. The perceptions of ontario radiation therapists and their managers regarding continuing professional development. *J Med Imag Radiat Sci* 2014;**45**(2):85–91. <https://doi.org/10.1016/j.jmir.2014.01.005>.