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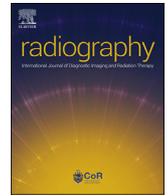
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## Systematic Review

## Advanced practice roles of therapeutic radiographers/radiation therapists: A systematic literature review

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## ABSTRACT

**Introduction:** Advances in Radiotherapy (RT) technology and increase of complexity in cancer care have enabled the implementation of new treatment techniques. Subsequently, a greater level of autonomy, responsibility, and accountability in the practice of Therapeutic Radiographers/Radiation Therapists (TR/RTTs) has led to Advanced Practice (AP) roles. The published evidence of this role is scattered with confusing terminology and divergence regarding the perception of whether a specific role represents AP internationally. This study aims to establish an international baseline of evidence on AP roles in RT to identify roles and activities performed by TR/RTTs at advanced level practice and to summarise the impact.

**Methods:** A systematic PRISMA review of the literature was undertaken. Thematic analysis was used to synthesise the roles and associated activities. Six RT external experts validated the list. The impact was scrutinised in terms of clinical, organisational, and professional outcomes.

**Results:** Studies (n = 87) were included and categorised into four groups. AP roles were listed by clinical area, site-specific, and scope of practice, and advanced activities were organised into seven dimensions and 27 sub-dimensions. Three most-reported outcomes were: enhanced service capacity, higher patient satisfaction, and safety maintenance.

**Conclusion:** Evidence-based AP amongst TR/RTTs show how AP roles were conceptualised, implemented, and evaluated. Congruence studies have shown that TR/RTTs are at par with the gold-standard across the various AP roles.

**Implications for practice:** This is the first systematic literature review synthesising AP roles and activities of TR/RTTs. This study also identified the main areas of AP that can be used to develop professional frameworks and education guiding policy by professional bodies, educators and other stakeholders.

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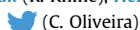
## Introduction

Radiotherapy (RT), also known as therapeutic radiography, is a major component of cancer treatment with about half of cancer

patients receiving RT.<sup>1–6</sup> Therapeutic Radiographers/Radiation Therapists (TR/RTTs) are health care professionals whose role includes administering radiation to the tumour whilst minimising radiation to organs at risk (OAR) and providing patient care throughout treatment planning and delivery.<sup>7–10</sup> The advancements in RT technology have enabled the implementation of new treatment techniques<sup>11</sup> and subsequently increased patient care demands. Thus, TR/RTT's clinical practice has evolved in many countries with specialisation of existing roles and emerging new roles, such as the Advanced Practice (AP) and consultant practice roles.<sup>12</sup> The titles TR/RTT were used in this work, however, it is acknowledged that there is no European harmonisation in the title of these professionals. The EFRS uses the title of

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“Radiographer” (using “Therapeutic Radiographer” to specify those practising RT), ESTRO refers to these professionals as “Radiation Therapists”, but each country regulates the title and the profession differently.<sup>13</sup>

AP roles are not performed at time of graduation (entry-level) but rather when the TR/RTTs have several years of professional experience underpinned by postgraduate education.<sup>12,14</sup> New flexible workforce models have been created from the resulting skills-mix (or task shifting) innovations which maximises efficiency and effectiveness to meet service demands.<sup>15–18</sup> This is important in RT, where a considerable gap exists between actual and optimal utilisation of RT across European countries. The goal of AP is to ensure the highest patient care with appropriate skills-mix and roles. However, conceptual and practical gaps are present because of the nature and evolution of these roles.<sup>3,5,15,19</sup>

The definition of AP roles is confusing due to the unclear and inconsistent terms used such as “role extension”, “role expansion”, and “specialised practice”.<sup>20,21</sup> Furthermore, the perception of whether a specific role represents AP varies internationally.<sup>22–27</sup> Moreover, AP roles can be embedded into standard practice over time.<sup>11,20</sup>

Currently, RT departments seek patient safety with better clinical outcomes and cost-effective service.<sup>28</sup> Advanced practitioners in RT have clinical expertise within areas such as pre-treatment planning, dosimetry, site-specific treatment, and technical innovation. TR/RTTs practising at an AP level have a pivotal role in the patient journey, from the referral, treatment coordination, follow-up, and liaison with the multidisciplinary oncology team.<sup>12</sup>

Two European benchmarking documents guide AP in RT for educational institutions and professional bodies.<sup>29,30</sup> Other literature from national policies includes frameworks and resources to support the implementation of AP roles.<sup>31–36</sup> These frameworks define advanced knowledge, skills, and competencies required for TR/RTTs to develop the scope of practice.

This literature review has adopted the definition from the multi-professional framework for advanced clinical practice in England.<sup>14</sup> The framework defines that AP roles are delivered by experienced practitioners with a high degree of autonomy and complex decision-making, supported by further education (masters degree or equivalent). Moreover, it embraces the core capabilities (knowledge, skills, behaviour) that convey the extent to which practitioners can adapt to change and solve problems with high complexity and in uncertain contexts. The framework establishes 48 capabilities that allow the developing of new roles across the four pillars of AP – clinical practice, leadership and management, education, and research.

However, no AP framework based on roles and activities (with associated core capabilities and specialist competencies) exists for the profession of TR/RTTs. As a result, quality standards vary across countries, and several countries do not have professional bodies in RT, hindering the TR/RTT role development. It is crucial to have organisational governance to guarantee patient safety when professionals take on new roles through legal guidelines, regulatory and professional frameworks.<sup>20</sup> There is an urgent need to gather evidence from the implemented AP roles worldwide for future research with global and local significance.

This review aims to synthesise the evidence in AP roles amongst TR/RTTs' practice. Firstly, to identify AP roles and their dimensions in clinical practice areas with associated activities and tasks. Secondly, to summarise the impact of AP roles.

## Methods

A Systematic Literature Review (SLR) was performed following the Centre for Reviews and Dissemination (CRD) guidance<sup>37</sup> for

undertaking reviews in health care and following the Preferred Reporting Items for Systematic and Meta-Analyses (PRISMA) protocol.<sup>38</sup> A systematic search was conducted between January 2020 and March 2021.

### Search strategy

A three-part search strategy (Table 1) was used based on the PICO framework omitting the definition of comparison (in this case, the standard practice) according to the methods used in previous allied health professional (AHP) SLRs.<sup>39,40</sup> Population was defined as TR/RTT (including common titles for the profession)<sup>41</sup> intervention was defined as AP (including a breadth and inclusive terminology); and outcomes was the level of practice. The final query (P AND I AND O) used on the bibliographic databases search used Boolean techniques to ensure no relevant literature was missed in the search strategy. The PRESS evidence-based checklist<sup>42</sup> was used to guide the electronic search strategy development, and refinements were performed through discussion and peer-reviewed by the research team consisting of international TR/RTTs and RT lecturers with different academic backgrounds and professional roles. To check the evolution and quality of published evidence on AP roles, no restrictions were applied regarding the publication year, format and study design. Also, a hand search of key RT peer-reviewed journals was conducted (including articles in press) and a literature review snowballing was performed.

### Screening and study selection

A comprehensive search was performed following criteria listed on Table 2. Two independent reviewers performed the systematic search in electronic databases independently for identification. Citations were then screened for eligibility (Zotero 5.0) by reviewer one. Duplicate records were removed and where titles did not provide enough information about the study, abstracts were pre-screened against the inclusion criteria. The full text of potentially relevant papers was retrieved and examined. To ensure reliability and minimise selection bias, all selected and in-doubt papers were checked independently by two other reviewers. If divergences between researchers persisted, the final decision was reached through consensus. Multiple reports of the same study were aggregated.

### Quality screening

The Critical Appraisal Skills Programme<sup>43</sup> (CASP) tools was applied for Randomized Controlled Trials (RCT), cohorts, qualitative studies, SLR; the reporting standards from CRD at the University of York was used for studies about health service changes<sup>44</sup> and organisational case studies<sup>45</sup>; the Sirriyeh et al.<sup>46</sup> tool was used for the remaining studies with diverse designs. The scores obtained were converted into three grades: good, moderate, and low.

### Data extraction and synthesis

The data extraction and synthesis of the included studies consisted of two distinct phases:

- 1 charting study characteristics and findings using Excel (V16.60).
- 2 summarising AP roles evidence. The papers were thematically analysed<sup>47</sup> using NVIVO (V.1.5.2). All data related to AP roles was organised into themes (dimensions) and sub-themes (such as activities or tasks, and education requirements). The outcomes related to the impact of AP roles, including associated

**Table 1**  
Search strategy based on the PICO framework.

Inclusion criteria	Search terms	Query phrases
<b>Population</b>		
Therapeutic radiographer/ Radiation therapist	Radiotherapist, radiation therapist, RTT, radiographer, therapeutic radiographer, radiation therapy technologist, radiation therapy technician, radiological technologist, radiology technologist, radiology technician, electroradiology technician, medical X-ray technician	A = radiotherapist OR RTT OR radiographer OR ((radiation OR therap* OR radiolog* OR electroradiology OR medical X-ray) AND (therapist OR radiographer OR technician OR technologist))
Radiotherapy	Radiotherapy, radiation therapy, therapeutic radiography, radiation oncology, brachytherapy	B = radiotherapy OR (radiation AND (therapy OR oncology)) OR (therapeutic radiography) or brachytherapy
<b>Intervention</b>		
Advanced practice	Advanced practice, advanced scope, role extension, role expansion, role development, role advancement, expert practice	C = advance* OR extension OR expansion OR development OR enhanced OR expert OR speciali* OR consultant OR radiographer-led OR therapist-led
Advanced practitioner	Advanced practitioner, consultant, specialized (-ised), specialist, enhanced, radiographer-led, therapist-led	
<b>Outcomes</b>		
Level of practice	Scope of practice (-ise), roles, skills, tasks, capabilities, responsibility, autonomy, accountability = (population) AND (intervention) AND (outcomes) = A AND B AND C AND D	D = scope OR practi* OR role OR skill OR task OR capabilit* OR responsibility OR autonomy OR accountability
<b>Final query<sup>a</sup></b>		
<b>Databases</b>		
Health-specific	MEDLINE complete, PubMed Central, Cochrane Reviews	
Education-specific	ERIC	
Multidisciplinary	Scopus <sup>b</sup> , Web of Science <sup>b</sup>	

<sup>a</sup> Without further adaptations (at syntax level and subject headings) on the advanced search platforms. Differences between the platforms were the search options, modes, and expanders.

<sup>b</sup> To avoid unnecessary duplication of effort a filter was used to exclude MEDLINE from the search.

**Table 2**  
Inclusion and exclusion criteria.

Inclusion criteria
Focus on AP of TR/RTTs (referred to in title/keywords/text or if the reviewers considered the subject related)
Peer-reviewed journal articles (original/research/regular articles)
Systematic literature reviews
Exclusion criteria
Focus on standard practice of TR/RTTs (traditional scope of practice)
Focus on disciplines from Radiation Sciences (radiography, radiology, nuclear medicine) but not in RT
Focus on other RT professionals (e.g.: MDs, nurses, MPs) but not on TR/RTTs
Focus on AP of other AHPs (e.g.: physical therapists, occupational therapists)
Non-English publications
Editorials, letters, commentaries, position and discussion papers, benchmarking guidelines, abstracts from conference proceedings (unless full-text article available)

AHPs-allied health professionals, AP-advanced practice, MDs-medical doctors (clinical or radiation oncologist), MPs-medical physicists, TR/RTTs-therapeutic radiographers/radiation therapists, RT-radiotherapy.

indicators and metrics, were coded using a toolkit developed by Gerrish et al.<sup>48</sup> and adapted for the radiography profession by Snaith et al.<sup>49</sup>

The resulting list of AP roles and activities was validated and reorganised by six external experts representing different European countries and areas of RT (professional practice, education and training, management, research, patient advocacy).

**Results**

From the systematic search, 91 articles<sup>27,50–139</sup> published between 1999 and 2021 were deemed eligible for the review (see Fig. 1 with the PRISMA flow diagram). In the final review were included 87 studies (see supplementary File 1 for full tabular summaries of included studies). The first paper with an AP role description in RT was published more than 20 years ago in the UK.<sup>65</sup> The studies were conducted in 10 different countries (Table 3), the

majority from the UK (35%), Canada (31%) and Australia (18%). Only five studies resulted from international collaborations.<sup>56,73,99,126,129</sup>

Of the studies included, 41% used mixed-methodology, 30% used quantitative designs, and 29% used qualitative approaches. Most of the studies are non-experimental descriptive research designs, with only one RCT<sup>80</sup> and two clinical studies.<sup>78,87</sup> Some studies resulted from audits (11%) and service evaluations (9%). Four studies<sup>51,66,72,82</sup> are SLR (narrative and scoping reviews were excluded).

Forty-four per cent of the studies involved TR/RTTs acknowledged as “advanced practitioners”, and the job titles were diverse between and within countries (Table 4). The remaining studies involved TR/RTTs that performed activities or tasks autonomously or adopted a new role beyond their scope of practice, described as TR/RTT (39%), senior (10%), specialist (6%), and research TR/RTT (1%).

The majority of studies (72%) reported exclusively on the clinical practice pillar of AP, 18% included research, 18% included education, and 13% included leadership. Only 11% comprehended all four pillars of AP (Table 5).

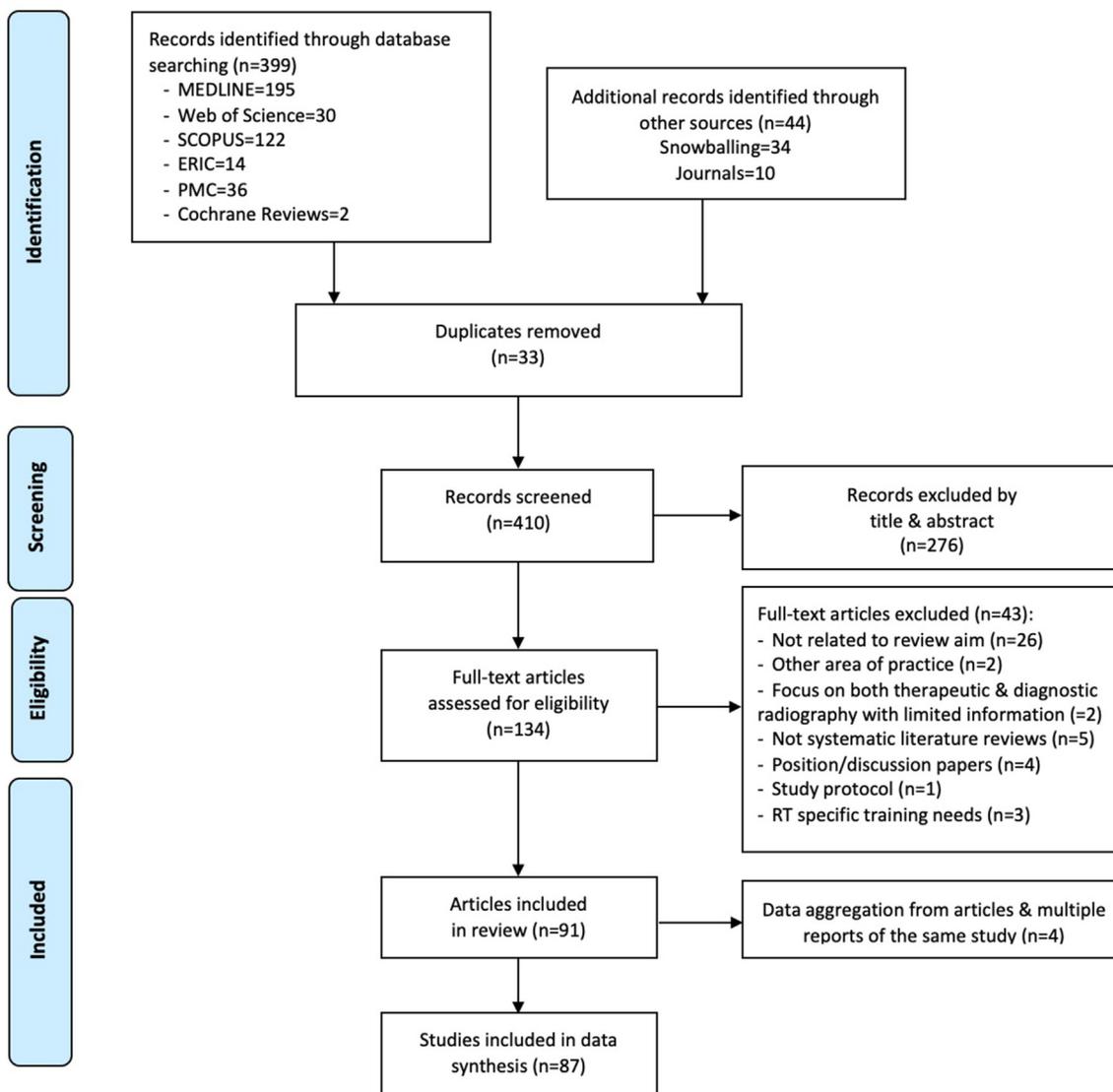


Figure 1. PRISMA flow diagram.

Table 3  
Included studies per country.

Country	Studies (n)	References
United Kingdom	30	54,58,60,61,64,65,69–71,73,75–77,82,87, 90,96,100,106,110,111,116,117,120,121,130,131,133,135,139
Canada	27	55–57,68,74,83–86,88,89,97,102–105,107,108, 113,114,122–126,132,136
Australia	16	50,51,53,63,66,67,72,78,80,95,109,115,118,119,127,127
Italy	4	52,92,93,101
New Zealand	3	27,62,91
Netherlands	2	59,134
Singapore	2	129,138
Ireland	1	112
Ghana	1	99
Hong Kong	1	137

The studies were clustered into four groups (Table 6) according to the key themes and summarised in terms of research focus, methods, and findings (see supplementary File 2 for full tabular summaries of each group). Some studies were included in more than one group.

Role evaluation and development

In this largest group, most of the studies (86%) were single-role research, 19% were clinical audits, and 13% were service evaluations. The most common were single-centre studies in single-area of clinical practice, like palliative care or in one site-specific role such as breast cancer.

Task congruence

Studies investigating task congruence assessed TR/RTTs' competencies compared to other professionals (e.g., Medical Doctors - MDs: radiation or clinical oncologists) in the performance of a specific activity. The majority were single-centre studies reporting good agreement rates. 53% checked the performance of TR/RTT in specific tasks involving treatment planning (such as target delineation and autonomous simulation) and imaging of pre-treatment delivery. Other studies investigated activities related to patient care, such as treatment toxicity assessment or patient follow-up. The site-specific role more studied was breast cancer, mainly activities performed

**Table 4**  
Job titles amongst TR/RTTs working in AP roles.

Job titles	Countries
Advanced Practice Radiation Therapist (APRT)	Canada, Australia, Singapore
Advanced Clinical Practitioner Advanced Therapeutic Radiographer Consultant Therapeutic Radiographer	United Kingdom
Clinical Specialist Radiation Therapist (CSRT)	Canada, Italy
Radiation Therapy Advanced Practitioner (RTAP)	Australia

during breast planning, such as contouring, and treatment field definition on computed tomography-simulation.

*Role implementation and stakeholders' insights*

The majority in this group were feasibility studies on AP (47%) with an exploratory approach using surveys, interviews or focus groups to investigate the perceptions of RT stakeholders: TR/RTTs, MDs, nurses, and medical physicists (MPs). There were also studies per scope of practice such as patient review, image review, treatment planning, and information and support.

In addition to the primary studies there were four SLR. Two reviews focused on non-specific scope of practice: one investigated the international current AP for national adaptation<sup>51</sup> and the other reported evidence about the impact of AP on patient outcomes and health service quality.<sup>82</sup> The remaining two reviews focused on specific scope of practice: image review<sup>66</sup> and psychosocial support.<sup>72</sup>

*Educational programmes*

Education and training to support the development, implementation, and sustainability of AP roles formed the smallest group. Competency packages, frameworks, orientation and in-house programmes (or postgraduation courses) dedicated to AP for TR/RTTs were described in these papers.

*Evidence related to AP roles*

This review provided insight into all the TR/RTTs' AP roles and activities, as identified across the literature. Since the AP definition

**Table 5**  
Reporting of AP "four pillars".

Advanced Practice pillar	Studies (n)	References
Clinical	63	51–54,57,58,60,61,63,64,66–68,71,72,74–78,80,82,85–93,95,99–105,108,110,112–115, 117–120,122–124,126–131,133–137
All pillars	10	55,56,27,65,69,73,83,84,96,125
Clinical, education and research	1	121
Clinical and research	5	50,59,106,107,116
Clinical and education	3	111,138,139
Clinical and leadership	1	62
Education	2	70,132
Unspecified	2	97,109

**Table 6**  
Included studies per group.

Cluster	Studies (n)	Papers (n)	References
Role evaluation and development	37	40	54,57,58,60,61,63,68,69,71,73–81,83–86,94,98,99,103,106, 110,112,113,115–117,125, 126,130,133,135,136,139
Task congruence	30	30	50,52–54,57,59,74,87–90,92,93,95,100–102,104,105,111,114,118–120,122,123,128,131,134, 138
Role implementation and stakeholders' insights	19	19	27,51,55,56,62,64–67,72,82,96,97,108,109,123,127,129,137
Educational programmes	7	7	70,91,107,111,121,132,138

is an evolving concept, some activities considered AP at the time of publication of the studies became routine practice due to the continuous change of scope of practice of TR/RTTs over time. These activities were excluded from the list of advanced activities: such as 2D imaging assessment and decision making, mould room tasks.<sup>88,89,93,114,127,131</sup>

The thematic analysis reported activities and tasks from AP roles into seven dimensions, and 27 sub-dimensions (Table 7). Also, the advanced practitioner specialise by clinical area of practice, disease site-specific role, and scope of practice (Table 8).

The most studied AP site-specific role was breast cancer (n = 30), reporting advanced activities such as target delineation and comprehensive care interventions. The most investigated clinical area of AP was palliative care (n = 24), describing activities such as referral, patient assessment, treatment prescription (Fig. 2).

The most-reported scopes of AP amongst TR/RTTs were information and support (n = 24) and on-treatment review (n = 15) (Fig. 3). The first includes activities such as specialised information and holistic patient support, including diverse interventions. The second includes treatment assessment and management, patient referral and orders, and pharmacological intervention.

*Evidence related to the impact of AP roles*

The outcomes were structured in three domains of significance: clinical, organisational, and professional. Each of these domains was divided into several sub-domains. Each sub-domain identified impact indicators (measurable and perceived) and described the outcomes with some metrics (Table 9). The three most-reported outcomes from AP roles were: enhanced service capacity, higher patient satisfaction, and safety maintenance.<sup>101,128</sup> Only two studies reported negative outcomes.

*Education and training of AP roles*

In this review, education and training for AP in RT varied considerably (e.g., Masters in AP, Masters modules, in-house training) and often were not described. Therefore, there is no robust evidence about standardised AP programmes. This lack of strategic educational pathways at national levels directly affects

**Table 7**  
List of activities from TR/RTTs' AP roles according to included studies.

Dimensions & subdimensions	Examples of activities	Sources
<b>Patient Care &amp; Support</b>		
Patient assessment & management	Physical, psychosocial, cognitive, sexual, and spiritual condition examination. Patient history taking, treatment toxicity assessment/management, documentation of clinical response to treatment, etc.	50,51,58,60,61,64,65,68,69,71,73,83,84,99,106,106,108,110,115,116,123,125,129,133,139
Patient information	Evidence based information for disease, prognosis, interventions, and treatment. Telephone help line counselling, informed consent for procedures, post-treatment information, etc.	51,56,61–63,65,68,69,71–73,78,81,99,112,113,115,117,125,129,133,137–139
Pharmacological intervention	Independent or supplementary drugs prescribing/administering/dispense, medications review, etc.	56,61,62,69,71,73,83,97,106,108,116,125
Follow-up & survivorship	Physical/remote consultation, chronic side effects support/intervention, etc.	62,68,68,87,112,117,125,126,135,138,139
Patient holistic support	Intervention in anxiety/distress/diet/exercise/relaxation/quality of life, liaison with support groups, etc.	27,61,63,65,69,72,73,78,80,112,115,117,129,138
Patient referral & orders	Referral to other disciplines, order for dressings/tests/imaging investigations. New patient clinic acceptance, review referral packages, requests authorizations, etc.	55,56,61,61,64,65,68,69,71,73,83,99,106,110,112,115,117,125,133
<b>Treatment Planning</b>		
Treatment prescription	Dose prescription/fractionation/dose supplementation areas/dose constrains for OAR, etc.	55,56,62,69,73,75,83,115,125
Advanced planning & simulation	Physical/virtual simulation, target delineation, OAR contouring, clinical mark up. Plan/simulation evaluation & approval, contrast administration (IV/oral/rectal/cannulation), etc.	51–57,62,69,73,83,84,95,100–104,118–120,122,125,128,130,134,136–138
Planning of complex cases & techniques	Peer review of IMRT/VMAT/brachytherapy/SRS/total CNS/high risk target volumes. Technical and dosimetry consultation, re-planning of complex cases, etc.	55,56,62,67,69,73,75,77,83,84,120,125,138
Multimodality image registration & fusion	Quality evaluation and approval, manual adjustments, etc.	62,77,83,84
<b>Treatment Imaging &amp; Delivery</b>		
Advanced IGRT/ART	(3D/4D/markers) imaging assessment, anatomical changes detection, plan of the day selection, adapt to position, decision making, and image approval, etc.	59,69,77,85,90,92,96,111,120,124,138
Supervision of complex cases & techniques	Online checking, plan acceptance, re-plan decision. Expert advice at problem solving, technical consultation, etc.	69,77,85,90,111,120,125,138
<b>Management &amp; Consultancy</b>		
Project management	Engagement of team members, identification of partnerships and funding/ grants, progress reports, etc.	55,69,138
Clinical governance & business cases	Setting and monitoring service standards, performance/resources management. Recruitment and retention, managerial and MDT meetings, policies development, etc.	55,56,62,65,69,138
National guidance & communication	Writing management reports, patient's advocacy, RT working groups (profiles, protocols, etc).	65,69,107
<b>Quality &amp; Risk Management</b>		
Risk management	Establishment of a radiation safety culture, risk improvement project (safe working practices), etc.	55,62,98,138
Quality assurance & quality control	Site-based QA rounds, online plan checking, quality improvement project, QA meetings, QA groups, etc.	27,56,62,67,75,77,84,98,103
<b>Research &amp; Innovation</b>		
Advanced research & coordination of clinical trials	Management of task groups, coordination of multicentre/international clinical trials, etc.	55,56,69,73,116,125,138
Evidence-based practice advancement	Development of standards/protocols, establishment of site-specific expertise for professional leadership, MDT/site group meetings, tumour board activities, expert role model in RT with best professional practices, etc	56,59,62,65,69,73,75,77,83,84,96,125,138
Audits & accreditation	Development of audits programmes for new model of care/pathway/changing of practices/new RT techniques, involvement in programmes accreditation, etc.	55,62,65,69,73,74,125,138
Knowledge dissemination	Peer-review presentations and publications, reviewer for peer review journals, books and chapter author/co-author, awards, and honours, etc.	55,65,69,84,116,125,132,138
Innovation & service development	Service redesign for comprehensive care, innovative integration of new technologies/techniques/procedures. Planning of new facilities, development of multi-professional research agenda/ new principles/concepts, etc.	65,69,73,83,84,138
Strategic involvement at national & international level	Participation in advisory committees/special interest groups/expert panels/ communities of practice, etc.	69,84
<b>Education &amp; Training</b>		
Advanced clinical education	Coordination/supervision/evaluation of students from different academic degrees and inter-professional education	55,56,62,69,96,97,121,125,132,138,139
Education planning	Lead role in development and assessment of educational inter-professional programmes. Recommendation of national & international curriculum, implementation of education programmes, etc.	51,65,69,121,125,138

**Table 7** (continued)

Dimensions & subdimensions	Examples of activities	Sources
CPD development	External consultancy, assessor of international courses, development of training programmes for complex techniques, set in-house teaching courses with competence and training packages, etc.	69,107,125,138
RT advocacy	Development of RT education resources for healthcare/community, awareness projects, etc.	65,73,107,138

CNS-central nervous system, CPD-continuing professional development, IGRT/ART-image-guided radiation therapy/adaptive radiotherapy, IMRT-intensity-modulated radiation therapy, IV- intravenous, MDT-multidisciplinary team, OAR- organs at risk, QA-quality assurance, RT-radiation therapy, SRS-stereotactic radiosurgery, VMAT-volumetric modulated arc therapy.

**Table 8**

List of activities from TR/RTTs' AP roles by clinical area or disease site-specific or scope of practice according to included studies.

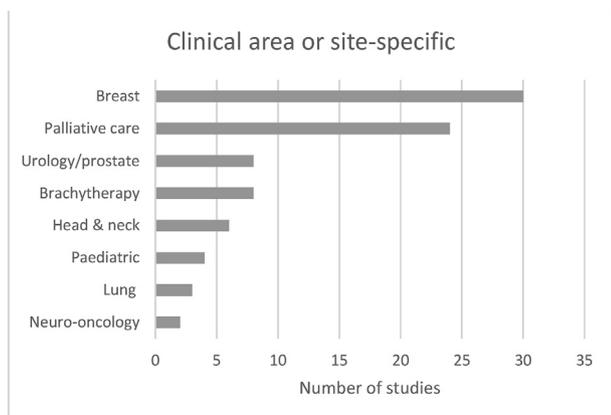
Advanced Practice Roles	Examples of activities	Sources
<b>Clinical area or site-specific</b>		
Brachytherapy	Patient initial assessment, patient information & counselling, patient education (pre-brachytherapy information) OARs contouring for HDR, effective planning, process coordination Treatment application	27,59,62,75,96,113 62,85,96,138 59
Breast	Comprehensive care, review clinics for radical patients, consultation with new patients, referrals (physiotherapy, psychologist & medical), dietary & exercise interventions, psychosocial interventions, seroma evaluation & management Clinical breast mark up, simulation RTT-led, breast boost localisation, OARs contouring, target delineation (tumour bed, cavity, seroma), breast & boost planning	27,60,61,72,78,80,82,83,85,96,105,110,121 132,138 51–53,57,60,62,70,83,101–104,118,119, 130,134,136
Head & Neck	Target localisation with multi-modality imaging, planning image, target definition & delineation (e.g., tomotherapy/adaptive RT), image assessment & approval	27,83–85,96,138
Lung	RT patient pathway management, MDT presentation of patient clinic data, responsible for the SBRT pathway, compile patient information leaflets (radical & palliative & SBRT)	69,96 138
Neuro-oncology	Patients' selection, breath-hold coaching, support in simulation & treatment New patient pre-treatment assessment clinic, presentation of patient's clinic data in peer review session, post SRS follow-up, SRS clinic	69,96 27,63,139
Paediatric	Patient & parents counselling (telephone "follow-on"), specialized support & comfort (diversionary DVD, long-term tools for parents, education sessions in schools) Treatment coordination (patient's advocacy, guidance & support for parents' decision making, liaising with paediatric oncology MDT (e.g., psychosocial, hospital play specialist, RT & oncology staff))	138,139
Palliative care	Patient assessment (before, during & after treatment) & screening (diagnostic imaging, histology review, toxicity assessment, prescribing/administering medication), remote follow up, patient information & counselling (informed consent), supportive care, liaison with palliative care teams, referral & triage Treatment prescription, simulation (mark up, fields localisation/ordering simulation), treatment planning (approval), shared treatment decision making Supportive care: continuity of care (point of contact), treatment delivery team, pain control, scheduling future appointments, pre-treatment image approval Program planning & delivery (admission & discharge, triage referrals, treatment booking, transportation, documentation, liaison with other specialties, MDT meetings with case summary presentation & recommendations)	54–56,68,70,73,75,82–85,95,107,122, 125,126,138 54,62,69,70,73,75,76,95,96,100,108,122, 138 54,75,97,125,126,138 54,55,73,75,83,95,107,126
Urology/prostate	On-treatment review (including patients from clinical trials), acute toxicity assessment, follow-up	27,87,96,116,117,123,133,135
Other sites	Gynaecology, colorectal, skin, mycosis fungoides	27,55,70,83–85,96,106,138
<b>Scope of practice</b>		
Follow-up	Remote or physical follow-up clinic, survivorship support	55,68,87,112,117,135
Image review	IGRT/ART: image assessment & decision making (with approval)	27,55,56,59,62,66,70,85,88,96,127,138
Information & support	Patient specialised information, counselling, and holistic support	27,51,56,61–63,65,68,69,71–73,78,80,99, 106,112,113,110,115,117,125,129,139
On-treatment review	Treatment assessment & management, pharmacological intervention, patient referral & orders	50,51,56,60,61,64,62,70,71,106,110,115, 117,129,133
Pre-treatment	Simulation/CT-simulation RTT-led, site-specific tasks: CTV delineation, OARs contouring, advanced planning	51–53,56,57,62,67,83,122,134,136,138
Practice development	Leadership & supervision of RT staff, quality improvements initiatives & reports	27,51,55,69,96,97
Clinical research	Research & development, clinical analysis, clinical trials research, clinical research with co-joining role of patient review	27,51,55,69,116
Other roles	Management site-specific advanced practitioner, education & training advanced practitioner, molecular RT, radiation safety/QA RTT, information technology, new technology education, SBRT/SRS/tomotherapy advanced practitioner	27,55,56,62,85,96,103,132

CT-computed tomography, CTV-clinical target volume, HDR-high dose rate, IGRT/ART-image-guided radiation therapy/adaptive radiation therapy, MDT-multidisciplinary team, OARs- organs at risk, QA-quality assurance, RT-radiotherapy, RTT-radiation therapist, SBRT-stereotactic body radiation therapy, SRS- stereotactic radiosurgery, tt-treatment.

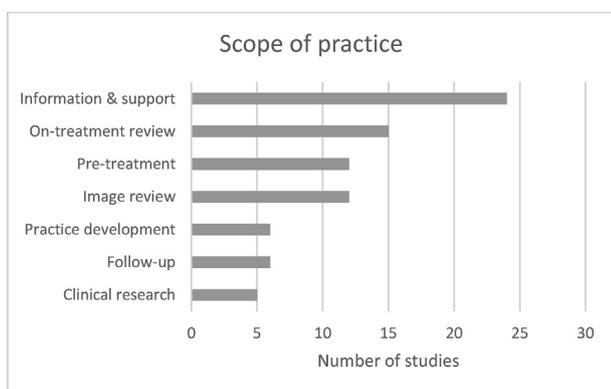
standardisation of AP roles, regulation, and protection for advanced practitioners and patients. Despite this, many studies highlight the key role of education to AP development and validation of advanced skills, specialist competencies and core capabilities.

**Discussion**

This SLR shows that TR/RTTs are able to develop their skills to perform AP roles with a positive impact on patient care and satisfaction. The most common roles were site-specific in breast cancer,



**Figure 2.** Number of studies per clinical area of practice or disease site-specific role of AP amongst TR/RTTs.



**Figure 3.** Number of studies per scope of AP amongst TR/RTTs.

clinical area in palliative care, and also roles which involved a broader scope of practice such as information and support, and on-treatment review. These were evaluated in post-role implementation studies, mostly single-role at single-centre. Multi-centre, larger cohort studies focusing on various roles, with design of pre- vs post-implementation would be more informative to the community regarding the impact.

Congruence studies have shown that TR/RTTs are at par with the gold-standard. Several feasibility studies investigating key stakeholders' perceptions at different settings (national, regional, or local level) support the view that role development of TR/RTT positively impact patient care.<sup>27,55,56,62,64,65,97,108,124,129,137</sup> Further research should focus on other stakeholders (inter-professional teams, professional bodies, regulators, employers, government agencies, etc) to gain a broader perspective.

We have used AP as an umbrella term, and the study selection was based on the research team's interpretation of AP roles from multiple perspectives and realities. The studies were analysed according to the adopted definition from the multi-framework applicable across various AHPs.<sup>14</sup> Advanced practitioners in RT were referred by a multitude of different titles. A considerable number of included studies did not fulfil all the requirements of the adopted definition with the description of the four pillars of AP, possibly because the roles predated the definition.

Most of the findings came from non-experimental research, especially descriptive studies or exploratory case studies with real-world data and outcomes giving information on the implementation strategies.

To date, there are reviews focused on AP for AHPs, but very few on TR/RTTs.<sup>39,40,140</sup> Inconsistent national implementation of AP was reported in Australia,<sup>109,141</sup> and in the case of diagnostic radiography, the AP roles were not successfully implemented.<sup>142</sup> Nursing, the pioneers of AP in healthcare, reported drivers, challenges and outcomes of this level of practice.<sup>143–147</sup> Also, AHPs<sup>39,40,148</sup> (including physiotherapists<sup>149–151</sup> and radiographers)<sup>152,153</sup> did the same. Barriers included multi-faceted challenges at various levels: organizational (lack of role clarity, management, and recognition), resources (lack of administrative assistance, cost containment issues), interactional (lack of professional support structures, medical dominance, protectionism), and role *per se* (complex nature of the role, working in isolation, mismatch between professional influence and authority). Besides the AP, the consultant practice (the next level beyond AP) evidenced by the role of the non-medical consultant practitioner was also explored and evaluated by nursing,<sup>48,154–156</sup> AHPs,<sup>157–159</sup> and radiographers.<sup>160–165</sup> Similar contexts are described across the various professions, such as lack of consistency in job description and role titles, different education preparation and supervision, ambiguity between consultant and AP levels and core profession roles that leads to different interpretations by educators and employers presenting risks that can affect the quality of patient care.

#### Evidence related to AP roles

Many of the advanced activities, resulted from task delegation (e.g. on-treatment review, drugs prescription), or from innovation due to technology evolution and new service models (e.g. stereotactic body RT, radiosurgery clinic) or from enhancement to improve patient experience (e.g. holistic care, survivorship support). AP roles in health care can also arise from changing the interface between services, including transfer, relocation, and liaison.<sup>18</sup>

The review findings are consistent with grey literature.<sup>31,33–36,166–172</sup> However, two AP roles were not well evidenced, such as a *clinical specialist in integrated cancer care* (one of the proposed areas on the Australian pathway to AP)<sup>31</sup> and *community liaison expert practitioner* (one model of AP roles on the UK for provision of continuity of care between the primary, secondary and tertiary sectors undertaken within the community).<sup>35</sup> USA is an exception, having one publication<sup>32</sup> from 2007 with no studies included in this review. This suggests that AP roles are not implemented in TR/RTTs' practice in the USA<sup>173,174</sup> due to lack of regulation, education and structural framework.

The only AP role cross-compared between countries in the included studies was palliative care<sup>73</sup> with role description and educational support in cancer centres across Australia, Canada, the UK and Denmark. These findings are corroborated by an overview of "Rapid access palliative RT programmes"<sup>175</sup> across several countries that confirmed positive outcomes of having TR/RTTs undertaking AP roles in palliative care.<sup>83,84,94,95,107,126</sup> An 11-year-long clinical perspective of this AP role supports the development of holistic care for patients with advanced cancer.<sup>176</sup>

Some papers reported new roles and opportunities<sup>177–188</sup> for role development in RT, and many authors believe that this is a "season of change" for TR/RTTs due to the image-guided RT developments and adaptive RT implementation. That is, traditional roles of TR/RTTs are impractical to keep pace with these technological advancements.

#### Evidence related to the impact of AP roles

There is evidence that TR/RTT practice is improved or maintained compared to the gold-standard, with two exceptions in this

**Table 9**  
Impact of AP roles according to outcomes reported on the included studies.

Domains & sub-domains	Outcomes & examples of metrics	Sources
<b>Clinical significance</b>		
<b>Patient care</b>		
Enhanced patient-focused care	Continuity of care (e.g., #patient handoffs, #disruptions, #emergency visits & hospitalizations) and comprehensive & holistic care (e.g., #liaison with support groups, and #complementary & supplementary support activities)	50,61,62,65,80,83,87,91,95,98,110,116,117,126,138
Enhanced paediatric-focused care	Compliance & cooperation with treatment using distracting techniques (e.g., #tt disruptions and delays)	63,139
Streamlined palliative care	Expedited care between referral & tt delivery (e.g., gatekeeping role, "fast-track" programmes, #first consultation with consent), efficient patient visit (e.g., #hospital visits, #sim&treat on the same day, #remote follow-up #inappropriate appointments #in-patient transfers)	54,68,73,75,76,83,84,95,100,122,138
<b>Clinical outcomes</b>		
Improved treatment outcomes	High local control rates (time of first recurrence), minimal treatment toxicity (toxicity grading scales)	58
Improved quality of life	Effective symptoms/side-effects management through timely and effective tt & interventions (e.g., #on-treatment reviews, level of patient anxiety, documentation on side-effects tracking)	50,73,75,87,99,110,116,138
<b>Access to care</b>		
Expedited care	Effective referral triage/pathway (e.g., #new patients, #clinic waiting times, #days from referral), improved workflow (e.g., #sim/tt/consultation times)	27,54,55,61,62,73,75,76,83–85,94,103,116,131,136,138
<b>Patient satisfaction</b>		
Higher patient satisfaction	Comprehensive consultation (e.g., appointment length, holistic interventions) and enhanced patient comfort (e.g., waiting times: appointments, tt table)	54,55,60,61,64,71,73,83–85,87,90,91,94,99,110,112,116,117,122,126,131,133,135,138
Enhanced patient experience	Patient empowerment (e.g., appointments' flexibility, level of knowledge about tt), and reassurance (e.g., patient stress & anxiety levels, confidence in staff, patient disclosure, #recommendations)	54,60,61,65,68,75,80,84,87,91,99,110,112,116,117,126,129,131,139
<b>Organizational significance</b>		
<b>Service efficiency</b>		
Enhanced service capacity	Enhanced patient throughput (e.g., time between care path activities, care path total time) and efficient workflow (e.g., time audits in activity time, elimination of redundancies, time delays between activities),	52,54,55,57,59,62,69,73,75–77,83–85,90,91,93,102,104,114,116,120,122,124–126,130,131,134,136,138
Improved resource utilization	Human resources optimization (e.g., time savings of unscheduled activities for MDs, etc) and technology utilisation (e.g., #efficient bookings #inappropriate referrals, time savings for tt unit)	54,59,73,77,83–85,91,102–104,126,131,138
<b>Quality &amp; safety of care</b>		
Improved quality	Evidence-based best practice (e.g., development & compliance of guidelines/policies, increased contouring consistency), development of quality projects (e.g., adoption of new QA tools, #QA "case rounds", reports & assessments on clinical trials)	55,69,73,77,83–85,93,94,114,116,130,134,135
Maintenance of safety	Consistency in practice* (e.g., error data #patient data handoffs #trends analysis, documentation for performance & process analysis), high agreement between RIT & MD tasks' performance (e.g., comparison of toxicity assessment, volumes contouring, image review), compliance rate for standards in clinical audits (e.g., patient outcomes tracking) * Minimal consistency between RTTs & MDs tasks' performance: tumour bed contouring (breast without clips) and OAR delineation (prostate, bladder, and rectum)	50,52–54,57–59,73,74,85,87–90,92,93,95,100,102,104,105,111,115,118–120,122,123,131,133,134,138  101,128
<b>Service effectiveness</b>		
Increased cost-effectiveness	Increased service capacity (e.g., #patient volumes, #appointments/activities, #in-patient assessments) with cost savings (e.g., resources and workflow optimization, time savings)	78,84,103,104,125,130
<b>Technical Innovation</b>		
Enhanced service development	Establishment of new technology/techniques (e.g., participation on dedicated working groups, new workflow implementation, service redesign)	55,68,69,73,77,83,85,114,130
<b>Research</b>		
Increased knowledge dissemination	Increased research & audit dissemination (e.g., presentations, peer-reviewed publications, books/chapters of books), clinical trials compliance, patient involvement)	55,69,73,84,85,107,121

(continued on next page)

Table 9 (continued)

Domains & sub-domains	Outcomes & examples of metrics	Sources
<b>Professional significance</b>		
<b>Quality of working life</b>		
Increased job satisfaction	Role development, career progression, job opportunities, higher remuneration, motivation, team working in MDT	27,50,55,61,62,64,68,70,75,85,91,97,98,108,116,120,124,129–131
Raised professional autonomy	Professional profile: identity & recognition, capabilities & competencies (skills & knowledge), confidence & support (e.g., improved staff moral due to team acceptance, self-awareness, respect from colleagues)	50,61,64,73,85,91,97,98,100,108,116,120,124
<b>Staff satisfaction</b>		
Increased MDT satisfaction	Improved recruitment & retention, inter-disciplinary/professional collaborative practice (e.g., skills mix adoption, team cohesiveness, effective communication), workload optimization (flexibility, distribution), reduced work-related stress	54,55,58,59,62,71,75,83–85,91,93,97,108,116,131,138
Improved time efficiency	Time savings in MDT, reduction in workload of medical & nursing staff	50,60,62,71,75,83,84,91,98,102,103,114,116,129
<b>Academic recognition</b>		
Higher productivity	Reviewer for peer reviewed journals, author/co-author of peer reviewed publications (#published manuscripts, #abstracts, #guidelines, #posters), editor/author of books, speaker/expert panellist/members (conferences, courses, communities of practice, working groups), awards, honours	55,69,84,125,138

MDs-medical doctors, MDT-multi-disciplinary team, QA-quality assurance, RTTs-radiation therapists, sim&treat-simulation and treatment, tt-treatment.

review. In La Rocca et al. study,<sup>101</sup> the extreme random interobserver variability in breast cancer tumour bed contouring was linked to the use of scar-based planning and tissue remodelling after surgery in the group without clips (variability found between TR/RTTs and MDs but also between MDs). In Schick et al. study,<sup>128</sup> the OAR delineation (bladder, prostate, rectum) was inconsistent with the gold-standard despite an education intervention. Both studies recommended continuous education and appropriate training allied to evidence-based practice to improve TR/RTT's performance for future task transfer. This review evidences that with appropriate education TR/RTTs can safely perform tasks that improve care.

One of the omissions of the research was the clinical evidence regarding the impact on treatment outcomes, with only one study<sup>58</sup> reporting local control rates and treatment toxicity. This finding agrees with other authors<sup>12,148</sup> who identified a lack of robust data on patient outcomes. Few studies investigated paediatric-focused care, academic recognition, and cost-effectiveness. This last output should also be analysed on organisational innovation with a rigorous methodology to evaluate AP roles before the implementation in daily routine.<sup>28</sup>

#### Education and training of AP roles

Concerns regarding the lack of adequate postgraduation education throughout Europe for AP roles in RT has been raised,<sup>20,189,190</sup> besides the existing problem of lack of consistency in educational backgrounds of TR/RTTs across Europe.<sup>3,8,13,191</sup>

According to EFRS 2020 survey<sup>192</sup> there are less postgraduate training opportunities on advanced treatment planning, advanced RT, and stereotactic RT than on imaging modalities in European countries. Additionally, in countries where TR/RTTs undertake postgraduation in non-RT related areas, their education did not necessarily improve the RT practice.<sup>193</sup> Therefore, it is necessary to implement strategic educational pathways for this level directed towards the evolving needs of RT.

#### Limitations

Only English papers were included therefore there is the potential that AP roles implemented in non-English speaking countries have been excluded.<sup>194</sup> Dissemination bias should be considered due to the lower probability of studies with non-significant or negative results to be published.<sup>195</sup>

The terms used for the population “TR/RTTs” were based on the most common titles for the profession at the European level,<sup>13,41</sup> although the review aimed for a worldwide scope. However, the search query identified a significant portion of studies (57%) from non-European countries.

Although only one researcher performed the coding process, six external experts with different professional perspectives reviewed each list item to enhance the validity of the coded activities.

#### Additional studies since the SLR

Since the review presented here, an additional seven articles exploring AP roles amongst TR/RTTs have been identified.<sup>187,188,196–200</sup> These include: an innovative AP role (sexual care after RT)<sup>197</sup> and a pathway for credentialing online adaptive RT role<sup>188</sup> in collaboration with different countries.

#### Conclusion

The AP roles and associated activities performed by TR/RTTs identified in this study, illustrate the main areas that could be used to develop professional frameworks and educational programmes. More than two decades of peer-reviewed evidence regarding role development and implementation of AP in RT departments can support Higher Education Institutions (HEI), or organisations aligned with an HEI or professional body, conceptualising and implementing AP roles.

A succession of positive findings over time is known, and there is a trend to demonstrate and quantify AP impact on three

variables: clinical, organisational, and professional outcomes. Experienced and trained TR/RTTs with core capabilities and competencies beyond the scope of practice are flexible practitioners with capacity to improve patients' quality of care.

### 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.2022.04.009>.

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