# Who leads, who treats, what dose? European paediatric DTC practice –an EXPeRT survey

**Michaela Kuhlen, Jelena Roganivic, Samuele Naviglio, Fredrik Baecklund, Rachel Bello, Tal Ben-Ami, Luca Bergamaschi, Ernest Bilic, Ewa Bien, Manuel João Brito, Alicia Castañeda, Maja Cesen Mazic, Nuno Jorge dos Reis Farinha, Aleksandra Jovanovska, Ronald de Krijger, Maria Debora de Pasquale, Rossella Elisei, Gema Grau Bolado, Gabriela Guillén, Magalie Haissaguerre, Dana Hartl, Jorge Huerta-Aragonés, Malgorzata A. Krawczyk, Livia Lamartina, Filipa Leite, Valeriano Leite, Ricardo López Almaraz, Nevena Manevska, Ludovic Mansuy, Evelina Miele, Elin Hallan Naderi, Thilde Nordmann Winther, Isabelle Oliver Petit, Zeynep Alev Özön, Marta Giorgia Podda, Apostolos Pourtsidis, Yves Reguerre, Maria Sandström, Dominik T. Schneider, Saniye Ekinci, Jasna Suput Omladic, Beata Sztangierska, Cecile Verite, Nicolas Waespe, Kee Howe Wong, Bilgehan Yalcin, Michael Abele, Gianni Bisogno, Daniel Orbach, Ines B. Brecht, Calogero Virgone, Antje Redlich**

**Angaben zur Veröffentlichung / Publication details:**

Kuhlen, Michaela, Jelena Roganivic, Samuele Naviglio, Fredrik Baecklund, Rachel Bello, Tal Ben-Ami, Luca Bergamaschi, et al. 2026. “Who leads, who treats, what dose? European paediatric DTC practice –an EXPeRT survey.” *European Journal of Endocrinology*. https://doi.org/10.1093/ejendo/lvag091.

Research Article

# Who Leads, Who Treats, What Dose? European Paediatric DTC Practice – an EXPeRT survey

Michaela Kuhlen[1,2,3], Jelena Roganivic[4], Samuele Naviglio[5], Fredrik Baecklund[6], Rachel Bello[7,8], Tal Ben-Ami[9], Luca Bergamaschi[10], Ernest Bilic[11], Ewa Bien[12], Manuel João Brito[13], Alicia Castañeda[14], Maja Cesen Mazic[15], Nuno Jorge dos Reis Farinha[16], Aleksandra Jovanovska[17], Ronald de Krijger[18], Maria Debora de Pasquale[19], Rossella Elisei[20], Gema Grau Bolado[21], Gabriela Guillén[22], Magalie Haissaguerre[23], Dana Hartl[24], Jorge Huerta-Aragonés[25], Malgorzata A. Krawczyk[12,26], Livia Lamartina[27], Filipa Leite[28], Valeriano Leite[29], Ricardo López Almaraz[30], Nevena Manevska[31], Ludovic Mansuy[32], Evelina Miele[19], Elin Hallan Naderi[33], Thilde Nordmann Winther[34], Isabelle Oliver Petit[35], Zeynep Alev Özön[36], Marta Giorgia Podda[10], Apostolos Pourtsidis[37], Yves Reguerre[38], Maria Sandström[39], Dominik T. Schneider[40], Saniye Ekinci[41], Jasna Suput Omladic[42], Beata Sztangierska[43], Cecile Verite [44], Nicolas Waespe[45,46], Kee Howe Wong[47], Bilgehan Yalcin[48], Michael Abele[27], Gianni Bisogno[49,50], Daniel Orbach[51], Ines B. Brecht[27], Calogero Virgone[49,52], Antje Redlich[1]

[1] Department of Paediatrics, Paediatric Haematology/Oncology, Otto-von-Guericke-University, Leipziger Str. 44, Magdeburg-D 39120, Germany; antje.redlich@med.ovgu.de

ORCID 0000-0002-1732-1869

[2] Paediatrics and Adolescent Medicine, Faculty of Medicine, University of Augsburg, Augsburg, Germany; michaela.kuhlen@uk-augsburg.de ORCID 0000-0003-4577-0503

[3] Bavarian Cancer Research Centre (BZKF), Stenglinstr. 2, Augsburg-D 86156, Germany

[4] Children's Hospital Zagreb, Department of Pediatric Oncology and Haematology, Klaiceva 16, Zagreb 10000, Croatia; jelena.roganovic02@gmail.com; ORCID 0000-0002-7960-6069

[5] Institute for Maternal and Child Health IRCCS "Burlo Garofolo," Trieste, Italy, samuele.naviglio@burlo.trieste.it

[6] Pediatric Oncology Unit, Karolinska University Hospital, 171 64 Stockholm, Sweden; fredrik.baecklund@regionstockholm.se ORCID 0000-0003-1333-2912

[7] The Jesse Z and Sara Lea Shafer Institute for Endocrinology and Diabetes, National Center for Childhood Diabetes, Schneider Children's Medical Center of Israel, Petach Tikva, Israel

[8] Gray Faculty for Medical and Health Sciences, Tel Aviv University, Tel Aviv, Israel; Rachelb2@clalit.org.il

[9] Paediatric Haematology/Oncology Unit, Kaplan Medical Centre, 7661041 Rehovot, Israel, affiliated with Hadassah-Hebrew University Medical School, Jerusalem, Israel, tal.ben.ami11@gmail.com ORCID 0000-0003-0017-6332

[10] Pediatric Oncology Unit, Fondazione IRCCS Istituto Nazionale dei Tumori, Milan 20133, Italy; luca.bergamaschi@istitutotumori.mi.it ORCID 0000-0003-2149-329X; marta.podda@istitutotumori.mi.it ORCID 0000-0002-0855-2526

[11] University of Zagreb, School of Medicine, Division of Pediatric Hematology and Oncology, UHC Zagreb, Kispaticeva 12, 10000 Zagreb, Croatia; ernestbilic@gmail.com ORCID 0000-0002-1909-118X

[12] Department of Paediatrics, Haematology, and Oncology, Medical University of Gdansk, Gdansk, 80-211, Poland; ebien@gumed.edu.pl ORCID 0000-0002-2091-2686; mkrawczyk@gumed.edu.pl ORCID 0000-0001-7093-8975

[13] Pediatric Oncology, Centro Hospitalar e Universitario de Coimbra EPE, Hospital Pediátrico, Coimbra, Portugal; mjbrito@ulscoimbra.min-saude.pt

[14] Pediatric Cancer Center Barcelona, Hospital Sant Joan de Déu. Barcelona, 08014, Spain; alicia.castanedah@sjd.es

[15] University Children´s Hospital Ljubljana, 1000 Ljubljana, Slovenia; maja.cesenmazic@kclj.si ORCID 0000-0003-2434-8960

[16] Hospital Center of São João (CHSJ), 4200-319 Porto, Portugal; nuno.reis.farinha@gmail.com

[17] Department of Hematology and Oncology, University Children`s Hospital, Faculty of Medicine, Ss Cyril and Methodius University in Skopje, 1000 Skopje, North Macedonia; jovanovska.a@gmail.co ORCID 0000-0003-2851-5228

[18] Princess Máxima Center for Paediatric Oncology, and Department of Pathology, University Medical Center Utrecht, Utrecht 3584 CS, The Netherlands; r.r.dekrijger-2@prinsesmaximacentrum.nl ORCID 0000-0001-6871-1296

[19] Oncohematology, Hemopoietic Transplantation, Cellular Therapies and Clinical Trials, Bambino Gesù Children's Hospital, IRCCS, 00165 Rome, Italy; mdebora.depasquale@opbg.net ORCID 0000-0003-1082-6810; evelina.miele@opbg.net ORCID 0000-0002-4747-1032

[20] Endocrine Unit 2, Department of Clinical and Experimental Medicine, University Hospital of Pisa, Pisa 56124, Italy; rossella.elisei@unipi.it ORCID 0000-0002-5333-9257

[21] Pediatric Endocrinology, Cruces Hospital, Barakaldo, 48093 Bizkaia, Spain; mariagema.graubolado@osakidetza.eus

[22] Department of Pediatric Surgery, Hospital Universitari Vall d´Hebron, Barcelona 08035, Spain; gabriela.guillen@vallhebron.cat ORCID 0000-0001-5632-2672

[23] Department of Endocrinology and Endocrine Oncology, Haut-Lévêque Hospital, University Hospital of Bordeaux, Pessac, France; magalie.haissaguerre@chu-bordeaux.fr ORCID 0000-0001-5007-7602

[24] Thyroid Surgery Unit, Department of Surgery and Anesthesiology, Gustave Roussy, 114 rue Edouard Vaillant, 94805 Villejuif, France; dana.hartl@gustaveroussy.fr ORCID 0000-0003-1161-5628

[25] Sección de Oncología y Hematología Pediátricas y del Adolescente, Servicio de Pediatría, Hospital General Universitario Gregorio Marañón, Madrid, Spain; jorge.huerta@salud.madrid.org

[26] Paediatric Haematology/Oncology, Department of Paediatrics, University Hospital Tuebingen, Tuebingen, Germany; michael.abele@med.uni-tuebingen.de ORCID 0000-0002-9780-603X; ines.brecht@med.uni-tuebingen.de ORCID 0000-0001-7973-3300

[27] Gustave Roussy, Département d'Imagerie Médicale, Service de Cancérologie Endocrinienne, F-94805, VILLEJUIF, France; livia.lamartina@gustaveroussy.fr

[28] Department of Pediatrics, Portuguese Oncology Institute of Porto, Porto, Portugal; filipa.leite@ipoporto.min-saude.pt

[29] Serviço de Endocrinologia, Instituto Português de Oncologia de Lisboa Francisco Gentil, Rua Professor Lima Basto, 1099-023 Lisboa, Portugal; vleite@ipolisboa.min-saude.pt ORCID 0000-0001-5479-7332

[30] Paediatric Haematology and Oncology Unit, Hospital Universitario de Cruces, 48903 Barakaldo-Bizkaia, Spain; ricardo.lopezalmaraz@osakidetza.eus ORCID 0000-0001-5521-9892

[31] Institute of Pathophysiology and Nuclear Medicine, Faculty of Medicine, University of Ss Cyril and Methodius, 1000 Skopje, North Macedonia; dr.nmanevska@gmail.com ORCID 0000-0001-7168-3775

[32] Department of Pediatric Hematology and Oncology, Children's University Hospital, Nancy, France; lu.mansuy@chru-nancy.fr

[33] Department of Head and Neck Oncology, Division of Cancer Medicine, Oslo University Hospital/The Norwegian Radium Hospital; 0379 Oslo, Norway; elinad@ous-hf.no ORCID 0000-0002-0715-2272

[34] Department of Paediatrics and Adolescent Medicine, Rigshospitalet, Copenhagen University Hospital, Copenhagen, Denmark; thilde.nordmann.winther.02@regionh.dk

[35] Endocrine Unit, Children Hospital, TSA 70034, 31059 Toulouse cedex, France; oliver.i@chu-toulouse.fr

[36] Pediatric Endocrinology, Faculty of Medicine, Hacettepe University, 06100-Ankara, Turkey

[37] Pediatric and Adolescent Oncology Clinic, Children's Hospital MITERA, 6, Erythrou Stavrou Str., 151 23, Marousi, Athens, Greece; ped.adol.onc@mitera.gr apourtsidis@hygeia.gr ORCID 0000-0003-4031-6619

[38] Paediatric Oncology and Haematology Unit, CHU Saint Denis de La Réunion, Bellepierre 97400, France; yves.reguerre@chu-reunion.fr

[39] Department of Diagnostics and Interventions, Oncology, Umeå University, 901 85 Umeå, Sweden; maria.sandstrom@umu.se ORCID 0009-0002-4328-8561

[40] Clinic of Paediatrics, Klinikum Dortmund, University Witten/Herdecke, Dortmund, Germany; dominik.schneider@klinikumdo.de ORCID 0000-0001-8153-1601

[41] Pediatric Surgery, Faculty of Medicine, Hacettepe University, 06100-Ankara, Turkey; sekinci@hacettepe.edu.tr

[42] Clinical Department for Endocrinology, Diabetes and Metabolic Disease, University Children's Hospital Ljubljana, 1000 Ljubljana, Slovenia; Jasna.suputomladic@kclj.si

[43] Department of Pediatrics, Diabetology and Endocrinology, Medical University of Gdansk, Gdansk, 80-211, Poland; bsztangierska@uck.gda.pl

[44] Paediatric Oncology and Haematology Unit, CHU Bordeaux, 33076 Bordeaux, France; cecile.verite@chu-bordeaux.fr

[45] Division of Pediatric Hematology/Oncology, Department of Pediatrics, Inselspital, Bern University Hospital, University of Bern, 3010 Bern, Switzerland; nicolas.waespe@unibe.ch; ORCID 0000-0002-2271-8959

[46] CANSEARCH research platform in pediatric oncology and hematology, Department of Pediatrics, Gynecology and Obstetrics, University of Geneva, 1206 Geneva, Switzerland

[47] Head & neck and thyroid oncology unit, Royal Marsden Hospital, London SW3 6JJ, United Kingdom; Keehowe.wong@rmh.nhs.uk

[48] Department of Pediatric Oncology, Faculty of Medicine, Hacettepe University, 06100-Ankara, Turkey; bilgehanyalcin@yahoo.com ORCID 0000-0003-2840-0308

[49] Department of Woman and Child's Health, University Padua, Padua, Italy

[50] Pediatric Hematology Oncology Division, University Hospital of Padua, Padua, Italy; gianni.bisogno@unipd.it ORCID 0000-0003-4462-5523

[51] SIREDO (Care, Innovation & Research in Childhood, Adolescent & Young-Adult Oncology) Oncology Center, Institut Curie, 75005, Paris Sciences et Lettres University, Paris, France; daniel.orbach@curie.fr ORCID 0000-0002-2520-139X

[52] Paediatric Surgery, University Hospital of Padua, Padua, Italy; calogero.virgone@unipd.it ORCID 0000-0002-3651-9416

**Correspondence:** Michaela Kuhlen, Department of Paediatrics, Paediatric Haematology/Oncology, Otto-von-Guericke-University, Leipziger Str. 44, Magdeburg-D

39120, Germany. Email: michaela.kuhlen@med.ovgu.de and Paediatrics and Adolescent Medicine, University Medical Centre Augsburg, Stenglinstr. 2, 86156 Augsburg, Germany. Phone: +49 821 400169307, Fax: +49 821 400179307. Email: michaela.kuhlen@uk-augsburg.de

**Running head**: European survey on paediatric DTC

**Keywords:** paediatric, differentiated thyroid carcinoma, survey, European practice, EXPeRT

**Word counts**

| | |
|---|---|
| Abstract | 241/250 |
| Number of tables / figures | 1+2/7 |
| Main text | 3,080/3,500 |
| References | 32 |

## Abstract

***Objective:*** To map real-world management of paediatric differentiated thyroid carcinoma (DTC) across Europe and identify targets for harmonisation.

***Design:*** Cross-sectional, web-based survey of centres providing paediatric DTC care.

***Methods:*** One consolidated response per centre was requested from a clinician overseeing paediatric DTC. The instrument covered centre profile/multidisciplinary tumour board organisation; staging and guideline use; risk stratification and dynamic response; diagnostics; surgery/lymph node management; radioiodine therapy (RAIT) policy and activity selection; Thyroid-Stimulating Hormone targets, follow-up, shared-care/transition. Analyses were descriptive at centre level.

***Results:*** Forty-two centres from 18 countries participated. Among centres answering each item, university/academic hospitals ≈75%; paediatric age cut-off ≤18 y ≈70%; dedicated multidisciplinary tumour board (MDT) ≈60%. Staging systems varied and the primary guidance was mixed (~30%), American Thyroid Association (ATA) 2015 (~25–30%), national (~20–25%), or European Thyroid Association (ETA) 2022 (~10–15%). Dynamic response-to-therapy categories were commonly used. For unilateral presumed low-risk disease, hemithyroidectomy was the usual initial surgery in about two-thirds to three-quarters of centres, total thyroidectomy was less frequent. For low-risk patients, RAIT policy split between de-escalation (≈55%) and risk-adapted use (≈45%). When given, activity was determined by weight, dosimetry, or fixed empiric approaches. Country-level patterns were evident (ETA- vs ATA-leaning/national environments).

***Conclusions:*** Across Europe, centres broadly endorse risk-adapted care but diverge at key decision nodes—extent of surgery, formal risk framework, and RAIT in low-risk disease—reflecting guidance plurality and organisational context. Leveraging existing infrastructures

offers pragmatic avenues to reduce unwarranted variation while generating paediatric-specific evidence to refine recommendations.

## Significance statement

We report the first pan-European view of real-world management of paediatric differentiated thyroid carcinoma across 42 centres in 18 countries. Practice varies systematically in three domains central to outcomes and late effects: surgical extent, use of formal risk frameworks (ATA vs ETA vs national), and radioiodine therapy (RAIT) policy in low-risk disease. Hemithyroidectomy is commonly preferred for unilateral presumed low risk, while RAIT use splits between de-escalation and selective application. We provide a concise ATA–ETA comparison and an illustrative MDT-anchored care pathway to help teams situate their practice. These data identify targets for harmonisation and show how existing European infrastructures (EXPeRT, CPMS, and PARTNER) can support reference-board decision-making and prospective outcome capture.

## Introduction

Differentiated thyroid carcinoma (DTC) in children and adolescents is rare, yet its incidence appears to be increasing, and patients require specialized, multidisciplinary care across surgery, endocrinology, nuclear medicine, and paediatric oncology. (1-5) While survival is excellent in most cases, optimizing long-term quality of life and minimizing late effects—

particularly those potentially related to radioactive iodine therapy (RAIT)—remain central goals of contemporary management. (6-13) Within Europe, practice patterns for paediatric DTC are perceived to vary substantially, including which specialties lead initial care, the application of formal risk stratification, the extent of surgery including lymph-node dissection, and indications and dosing strategies for RAIT. (14-16) These observations have been echoed within the European Cooperative Study Group for Paediatric Rare Tumours (EXPeRT) network and motivated the present survey.

Over the past decade, professional guidance has emerged for risk-adapted initial therapy and dynamic response-to-therapy follow-up in paediatric DTC care. The American Thyroid Association (ATA) 2015 paediatric guideline supports a selective, risk-adapted use of post-operative RAIT, with surveillance without routine RAIT considered appropriate for many patients at lower risk after surgery and post-operative assessment, while RAIT is recommended for iodine-avid persistent or unresectable locoregional disease and distant metastases, and may be considered in selected higher-risk presentations. (17) The European Thyroid Association (ETA) 2022 paediatric guidance likewise endorses risk stratification and multidisciplinary decision-making, but—reflecting acknowledged paediatric evidence gaps—issues a broader low-strength suggestion that $^{131}$I therapy can be indicated after total thyroidectomy, while emphasizing individualized dosing and careful weighing of potential late effects. (18) These differences, rooted in distinct interpretations of a sparse paediatric evidence base rather than in opposing therapeutic goals, provide a plausible substrate for heterogeneity of practice across Europe. (7, 19, 20) Mapping current

practice is therefore essential to identify gaps, prioritize harmonization efforts, and define realistic targets for quality improvement across Europe.

To address this need, the EXPeRT Endocrine Working Group (21) designed a pan-European, cross-sectional survey to capture how centres currently diagnose and treat newly diagnosed paediatric DTC. We aimed to obtain one consolidated response per centre from clinicians with oversight of paediatric DTC management, sampling EXPeRT institutions and affiliated national society networks to achieve broad geographic coverage.

By delivering an up-to-date snapshot of paediatric DTC care across Europe, this survey seeks to (i) quantify real-world variability, (ii) highlight areas of consensus and divergence relative to contemporary recommendations, and (iii) inform practical next steps for EXPeRT-led harmonisation, including shared pathways, centralized review options, and priorities for prospective data collection/registry alignment. Ultimately, such a foundation is intended to support safer, more consistent, and evidence-aligned care for children and adolescents with DTC across diverse European health systems.

## Methods

We conducted a cross-sectional, web-based survey of European centres caring for children and adolescents with DTC. The survey was circulated to all EXPeRT members (86 members across 26 countries) and disseminated via affiliated national societies. Additional snowball dissemination was used to maximise geographic coverage. Because snowball reach could not be precisely quantified, the exact number of centres contacted with this invitation

cannot be stated. One consolidated response was requested per centre, completed by a clinician with oversight of paediatric DTC management. Where helpful for accuracy, respondents could invite co-respondents from other disciplines at the same centre.

Eligible sites were hospitals providing any component of paediatric DTC care (paediatric or adult endocrinology, paediatric oncology, surgery, nuclear medicine). The sampling frame comprised EXPeRT group institutions and affiliated national societies, with snowball sampling used to maximise geographic coverage. Centres reported their country.

The questionnaire was developed by members of the EXPeRT Endocrine Working Group (M.K., J.R., A.R.), iteratively refined through internal piloting, and organised into the following domains: (A) centre profile and multidisciplinary tumour board (MDT); (B) guideline use and risk stratification; (C) diagnostic work-up; (D) surgery; (E) RAIT policy; (F) thyrotropin (TSH) targets and follow-up; and (G) shared-care/transition and system enablers.

Responses were captured via Microsoft Forms® at the coordinating centre. Email addresses were collected solely to facilitate authorship communication and were removed prior to analysis. The analytical dataset contained no personal identifiers and no institution/centre identifiers. Only country and professional specialty were retained. The primary outcomes were centre-level practices in paediatric DTC.

This professional-practice survey was conducted in accordance with the principles of the Declaration of Helsinki. It collected no patient-level or personally identifiable data, targeting instead institutional and professional practice patterns at the centre level. As a survey of

healthcare professionals collecting no patient identifiers, formal independent ethics committee review was not required under applicable local and national regulations.

***Statistical analysis***

Analyses were descriptive at the centre level. Categorical variables were reported as counts and percentages. For single-choice items, percentages were calculated using the number of responding centres for that item as the denominator. For multiple-choice items, each option was coded separately, and its percentage was calculated over the number of responding centres for that item. Because centres could select more than one option, the percentages across options may sum to more than 100%. Missing item responses were treated as missing and excluded from the denominator for that item.

To explore whether resource context relates to practice, we performed a descriptive comparison using the Low Health-Expenditure Average Rate (LHEAR) country grouping as defined by Roganovic et al. (22), which operationalises "low health-expenditure average rate" countries for analyses of paediatric very rare tumour care in Europe. In our survey, LHEAR countries were defined a priori as Croatia, Greece, North Macedonia, Poland, and Turkey; all other participating countries were classified as other. This grouping was used descriptive contrasts only.

Country-level summaries and the LHEAR vs other comparisons are presented descriptively.

## Results

### *Participating centres and respondents*

We analysed 42 centres spanning 18 European countries including three centres with co-respondents from other disciplines. Contributions were concentrated in France, Italy, Spain, Germany, and Portugal, with additional centres from Central/Eastern and Northern Europe. (Table 1)

Among the 42 respondents, 31 (73.8%), worked in university/academic hospitals, 5 (11.9%) in tertiary paediatric hospitals, and 4 (9.5%) in adult hospitals with paediatric pathways. The paediatric age cut-off was ≤15 years in 5/42 (11.9%), ≤18 years in 31/42 (73.8%), ≤25 years in 1/42 (2.4%), and no strict cut-off in 5/42 (11.9%). Annual centre-level volume over the last three years was 0–2 cases in 17/42 (40.5%), 3–5 in 9/42 (21.4%), 6–10 in 13/42 (31.0%), and >10 in 3/42 (7.1%).

Respondents were predominantly paediatric oncologists (26/42, 61.9%), alongside paediatric endocrinologists (5/42, 11.9%), adult endocrinologists (3/42, 7.1%), and paediatric surgeons (2/42, 4.8%). The specialties most often leading initial management were paediatric endocrinology (28/42, 66.7%), paediatric oncology (25/42, 59.5%), nuclear medicine (13/42, 31.0%), adult endocrinology (12/42, 28.6%), endocrine/adult surgery (11/42, 26.2%), and paediatric surgery (10/42, 23.8%).

### *Organisation of care*

A dedicated paediatric DTC MDT operated in 22/42 (52.4%) centres. Among those with an MDT, scope was local in 17/22 (77.3%), regional in 1/22 (4.5%), and national in 4/22 (18.2%). Meeting cadence ranged from weekly (12/22; 54.5%) and monthly (4/22; 18.2%) to ad hoc/on demand/other (6/22; 27.3%). Alongside pathology and radiology, required attendees (where specified) typically included endocrine/adult surgery (19/22; 86.4%), nuclear medicine and paediatric oncology (each 17/22; 77.3%), paediatric surgery (15/22; 68.2%), paediatric (13/22;59.1%) and/or adult endocrinology (12/22; 54.5%), and other disciplines (5/22; 22.7%).

***Diagnostic framework and risk-adaptation***

Centres most often used American Joint Committee on Cancer (AJCC)/Union Internationale Contre le Cancer (UICC) Tumour Nodes Metastases (22/42, 52.4%), followed by ATA paediatric 2015 (8/42, 19.0%), mixed systems (5/42, 11.9%), and ETA 2022 (3/42, 7.1%). (Figure 1A)

The primary guideline informing care was a combination/mixed approach in 15/42 (35.7%) and ATA 2015 in 11/42 (26.2%). (Figure 1B)

A formal risk-stratification system was reported by 36 centres, most commonly ATA 2015 (18/36, 50.0%) and ETA 2022 (10/36, 27.8%). (Figure 1C)

Dynamic response-to-therapy categories were used always in 16/42 (38.1%) and never in 9/42 (21.4%). (Figure 1D)

***Diagnostic work-up and molecular testing***

Neck ultrasound was universal (42/42, 100%) and fine-needle aspiration (FNA) was reported in the standard pre-operative work-up by 39/42 (92.9%) centres. Thyroid function tests (37/42, 88.1%) and thyroglobulin (TG)/anti-TG antibodies (31/42, 73.8%) were commonly obtained. Use of cross-sectional imaging (computed tomography/magnetic resonance imaging) was reported by 13/42 (31.0%) centres and PET scanning by 3/42 (7.1%), while recurrent laryngeal nerve assessment was reported by 13/42 (31.0%) centres.

Regarding tumour genomics, somatic testing was reported selectively in 26/42 (61.9%), routine in 11/42 (26.2%), and not performed in 5/42 (11.9%). Frequently cited targets included *BRAF*, RAS pathway genes, *RET*, *NTRK*, and *ALK fusions,* and *TERT* promoter.

Germline testing for predisposition syndromes was selective in 24/42 (57.1%), routine in 14/42 (33.3%), and not used in 4/42 (9.5%).

***Surgery and lymph-node management***

For presumed unilateral low-risk disease, hemithyroidectomy was the usual initial surgery in 30/42 (71.4%), total thyroidectomy in 11/42 (26.2%), and other in 1/42 (2.4%). Indications for central neck dissection (CND) were predominantly clinico-radiological nodal disease (37/42, 88.1%) and intra-operative findings (35/42, 83.3%), as well as prophylactic in intermediate and high-risk disease (23/42, 54.8%). Five centres (11.9%) also indicated using CND in low-risk settings prophylactically. Lateral neck dissection (LND) followed a similar

pattern, triggered mainly by clinico-radiological evidence (41/42, 97.6%) and intra-operative findings (33/42, 78.6%), with prophylactic LND uncommon (intermediate/high-risk 7/42, 16.7%; low-risk 1/42, 2.4%). Intraoperative nerve monitoring was used always in 28/42 (66.7%), often in 6/42 (14.3%), sometimes and rarely each in 3/42 (7.1%), and never in 2/42 (4.8%).

***Radioiodine (RAI) practice***

For low-risk patients without metastases, most centres reported never using RAI (16/42, 38.1%), selectively (13/42, 31.0%), or rarely (9/42, 21.4%). (Figure 2A)

The primary purpose when given was combined therapeutic/ablation (20/42, 47.6%) or treatment of metastatic disease (18/42, 42.9%). (Figure 2B)

Activity selection varied across centres, including weight-based dosing (13/36, 36.1%), dosimetry-guided (9/36, 25.0%), fixed empiric activities (7/36, 19.4%), and body surface area-based dosing (5/36, 13.9%). (Figure 2C)

Common reasons to omit RAI (multi-response) included guideline recommendation (26/39, 66.7%), concerns about toxicity (16/39, 41.0%), lack of evidence for benefit (13/39, 33.3%), and patient/family preference (6/39, 15.4%). (Figure 2D)

Long-term follow-up for potential RAI late effects was reported by most centres: 27/42 (64.3%) within routine paediatric oncology/endocrinology follow-up and 4/42 (9.5%) within structured survivorship clinics, while 11/42 (26.2%) described limited or symptom-based

programmes. Among centres specifying which domains are monitored (n=31), the most frequent were salivary-gland (21/31, 67.7%), pulmonary function and screening for secondary malignancies (each 20/31, 64.5%), with additional attention to haematologic (17/31, 54.8%) and gonadal/fertility (16/31, 51.6%) effects.

***TSH targets and follow-up***

TSH goals were risk-adapted: for low-risk disease, most centres aimed to keep values within the reference range (0.5–2.0 mU/L; 27/41, 65.9%); for intermediate-risk, mild suppression (0.1–0.5 mU/L) was most common (24/41, 58.5%); and for high-risk, full suppression (<0.1 mU/L) predominated (36/41, 87.8%). (Figure 3)

Routine clinical/biochemical surveillance intervals were every 3 months in year 1 (30/42, 71.4%) and every 6 months in year 2 (29/42, 69.0%) and 3 (22/42, 52.4%).

Shared-care with local providers was reported by 13/42 (31.0%) centres, while 29/42 (69.0%) continued follow-up exclusively within the treating centre. Among centres specifying transition/discharge criteria (n=13), the most common trigger was age (e.g., 18 years) in 8/13 (61.5%), followed by sustained excellent response (e.g., after ≥3 years) in 4/13 (30.8%). A minority indicated that patients are never discharged (2/13, 15.4%) or transition after a stable intermediate response (1/13, 7.7%), or transition on patient preference (1/13, 7.7%).

***National frameworks and access to targeted therapies***

A centralised/national board for paediatric DTC was available in 14/42 (33.3%).

Targeted therapies were widely accessible: on-site in 32/35 (91.4%), with additional access via clinical trials or referral (each 8/35, 22.9%). Reported agents spanned *RET* and *NTRK* inhibitors, *BRAF*/*MEK* inhibitors, and multikinase inhibitors. Targeted therapies were currently not available in 2/42 (4.8%) centres and 5/42 (11.9%) centres indicated that such cases were not treated.

***Country-level variation*** *(countries with ≥3 centres)*

Across the five countries with at least three responding centres (n=33 total), adoption of a formal risk framework showed patterned differences. France was ETA-leaning (ETA 3/7, ATA 1/7), Italy reported no ATA use (ETA 3/5), Spain was ATA-leaning (ATA 3/5; ETA 2/5), Germany was predominantly *other* (other 3/4), and Portugal was mixed (ATA 1/4; ETA 1/4). Overall, pooling these countries and considering only centres naming either ATA or ETA (n=22), usage was evenly split: ATA 11/22 (50%) and ETA 11/22 (50%). (Figure 4A)

For unilateral presumed low-risk disease, hemithyroidectomy predominated overall (23/33, 69.7%), with total thyroidectomy in 9/33 (27.3%) and other approaches in 1/33 (3.0%). By country, France was mainly hemithyroidectomy (5/7); Italy was mixed (3 hemithyroidectomy, 2 total); Spain (4/5) and Germany (3/4) favoured hemithyroidectomy; and Portugal was evenly split (2 hemithyroidectomy, 2 total). (Figure 4B)

Policies for RAI in low-risk patients were roughly split between de-escalation (*never/rarely* 18/33, 54.5%) and *selective/routine* use (15/33, 45.5%). De-escalation predominated in Italy (3 *never*, 1 *rarely*) and Portugal (3 *never*, 1 *rarely*). France and Spain leaned toward *selective/routine* use, while Germany showed mixed policies. (Full country counts shown in Figure 4C)

***Centres in countries with low health-expenditure average rates (LHEAR)***

To explore resource context, we contrasted centres from LHEAR countries (n=6) with other European centres (n=36). (Figure 5) LHEAR sites reported fewer MDTs (MDT present 2/6, 33.3% vs 20/36, 55.6%), but similar or greater uptake of risk-adapted concepts: any RAI use in low-risk (4/6, 66.7% vs 22/36, 61.1%; *never* RAI 2/6, 33.3% vs 14/36, 38.9%), dynamic response used *always/often* (4/6, 66.7% vs 21/36, 58.3%), and dosimetry-guided activity when RAI is given (1/6, 16.7% vs 8/36, 22.2%). For initial surgery in presumed unilateral low-risk disease, hemithyroidectomy was the usual approach in 3/6 (50.0%) LHEAR centres versus 28/36 (77.8%) in others. Notably, ATA 2015 was far more frequently the formal risk-stratification system in LHEAR (5/6, 83.3%) than elsewhere (13/36, 36.1%), while ETA 2022 was less common (1/6, 16.7% vs 9/36, 25.0%). The RAI policy mix also differed: among LHEAR centres the distribution was *never* 2, *rarely* 0, *selectively* 4, *routinely* 0, whereas other countries showed *never* 14, *rarely* 9, *selectively* 9, *routinely* 4. Taken together—and acknowledging the small LHEAR sample—these contrasts suggest organizational gaps (MDT

availability) alongside broad application of risk-adapted care, with a stronger ATA orientation in LHEAR settings.

Taken together, these findings are summarised schematically in Figure 6, which illustrates the reported sequence from diagnostic evaluation through MDT-based treatment decisions to follow-up.

## Discussion

This pan-European survey demonstrates substantial heterogeneity in how paediatric DTC is staged, risk-stratified, and treated across centres and countries. Variation was most evident in the choice of formal risk framework (ATA vs ETA vs national/institutional), (17, 18) the extent of initial thyroid surgery, and policies for post-operative RAIT in presumed low-risk disease. These findings are consistent with a broader structural reality in paediatric thyroid oncology: excellent survival, limited paediatric-specific evidence, and non-identical guidance frameworks that reasonably interpret the same evidence base differently. (14, 17, 18)

Several interacting forces explain this variation. Guideline plurality is the most direct driver: ATA 2015 and ETA 2022 reach different default conclusions for RAIT in low-risk disease despite sharing the same limited evidence base. (17, 18) National regulatory context adds a further layer, as radiation-protection regulations for minors, dosimetry access, and

reimbursement structures differ across jurisdictions. (The 2013/59/Euratom Directive (https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32013L0059, accessed on 13 April 2026) Organisational factors—case volume, MDT composition, and specialty leadership—shape which framework becomes the institutional default. Historical training trajectories contribute inertia, as institutional protocols often lag guideline cycles. Finally, genuine evidentiary gaps mean that for key decision nodes, clinicians reasonably weigh competing risks differently. Variation therefore reflects convergence of these forces in a low-incidence disease with limited paediatric-specific data.

Two contemporary pillars frame practice in Europe. The ATA 2015 paediatric guideline formalises risk tiers and permits de-escalation, including omission of RAI in many low-risk children to limit late effects without compromising disease control. (17) The ETA 2022 recommendations are likewise risk-aware and MDT-centred but—explicitly citing very low paediatric evidence—issue weak suggestions and adopt a more conservative default for RAI after total thyroidectomy. (18) A concise comparison of convergences and divergences is provided in Supplementary Table S1. Both frameworks share the goals of excellent control and minimising late effects. Their principal divergence lies in the routine use of remnant ablation in low-risk disease, where definitive paediatric trials are lacking. (7, 14, 17-20, 23, 24)

Country-level patterns were coherent with this backdrop: among nations with ≥3 centres, frameworks ranged from ETA-leaning (e.g., France, Italy) to Spain more ATA-leaning and Germany mainly using national/institutional schemas. For unilateral presumed low-risk disease, hemithyroidectomy predominated overall, though its uptake varied by country.

Policies for RAI in low risk split between de-escalation and risk-adapted use: Italy and Portugal favoured de-escalation, Spain reported any use in all centres, and France/Germany lay between these poles. Taken together, these differences mirror guideline anchoring and national/institutional board customs rather than case-mix alone.

Within Europe, national adaptation offers useful perspective. The Dutch position statement employed a structured AGREE-based process anchored to ATA 2015 to provide an accessible multidisciplinary pathway aimed at harmonisation and centralisation, while emphasising European regulatory context, late-effect minimisation, and the need for algorithms that evolve with emerging data. (14) Our results—showing divergent use of risk frameworks and RAI thresholds—underscore the value of such context-sensitive adaptation and its potential scalability.

Although this is a survey rather than a guideline, several practice signals emerge that may help reduce unwarranted variation while new evidence accrues. First, because a substantial fraction of paediatric nodules are malignant, structured referral pathways for paediatric thyroid nodules and systematic high-quality thyroid ultrasound with cervical lymph-node mapping are likely to standardise pre-operative staging and inform the extent of surgery. (17, 18) Second, multidisciplinary decision-making at diagnosis and again post-operatively appears central to how European centres operationalise risk-adapted care. In many programmes, a minimum MDT quorum includes paediatric endocrinology/oncology, thyroid pathology, expert thyroid radiology, paediatric surgery, and a high-volume thyroid cancer surgeon. Concentrated surgical expertise is associated with fewer complications and more complete nodal management in thyroidectomy. (25-28) Third, the post-operative MDT

provides a consistent forum to reassess risk, decide on RAI (or its omission), select activity/dosimetry approaches, and plan surveillance balancing recurrence risk and late-effect burden. To illustrate these steps, we include an example pathway from presentation to follow-up (Figure 6), reflecting common sequences reported by centres.

The EXPeRT infrastructure can enable pragmatic harmonisation without foreclosing clinical judgement. (21) Through the European Reference Network (ERN) for Paediatric Cancer (PaedCan), the EXPeRT Clinical Patient Management System (CPMS) offers a platform for cross-border case discussions, particularly valuable for complex or rare cases, and helps delineate zones of equivalence (where ATA- and ETA-concordant choices are both reasonable) versus zones of preference many centres favour (e.g., omitting RAI in clearly low-risk disease). (29) Building on this, the development of national MDTs is essential to ensure consistent, locally coordinated care following shared principles—as demonstrated by the German MET reference program and the Dutch national recommendations. (6, 14) In parallel, the European Standard Clinical Practice (ESCP) initiative under ERN PaedCan can use the results of this survey to develop a dedicated ESPC document on paediatric thyroid carcinoma, incorporating harmonised definitions of complete remission and recurrence as recently established by international Delphi consensus. (21, 30, 31) The Paediatric Rare Tumours Network–European Registry (PARTNER) Registry—endorsed by the European Society for Paediatric Oncology (SIOPE) and already including paediatric thyroid carcinoma—serves as the established platform to implement a minimum dataset and core outcomes (surgical extent, nodal management, RAI intent/activity method, dynamic response-to-therapy categories, late-effect domains) to benchmark care. (32) Prospective

data accrual through this registry will first establish precise, stratum-specific recurrence rates across Europe—a prerequisite for, and potential run-in to, a future randomised trial addressing the most contested question in low-risk disease: RAIT versus active surveillance after total thyroidectomy. Power estimates (assumed recurrence rate without RAIT in low-risk disease: ~10-15% at 5 years; assumed reduction with RAIT: ~5% points) suggest that ~300-400 patients per arm would be required, implying a feasible 5-7 year recruitment window across an EXPeRT/PARTNER network given current European incidence (~200-250 new cases/year across Europe; approximately 40-50% low-risk).

***Strengths and limitations***

Strengths include the broad geographic participation across diverse health systems, the centre-level granularity, and the coverage from diagnostics to survivorship. Limitations include modest numbers within some countries, which makes the findings susceptible to centre effects, reliance on self-reported data without case-level validation, and a possible responder bias toward more engaged or specialised programmes. The study was descriptive and therefore did not support causal inference. In addition, because most respondents were paediatric oncologists, centres in which paediatric thyroid cancer care is primarily led by paediatric endocrinologists or adult disciplines are likely underrepresented. Although the survey was disseminated broadly across EXPeRT and affiliated networks, the exact denominator of centres exposed to the invitation cannot be defined because snowball dissemination was used. Nonetheless, the consistency of country-level patterns and their

alignment with known guidance differences in guidance support the external validity of the main signals.

***Interpretation***

European centres broadly endorse risk-adapted principles yet diverge at decision nodes that matter—particularly the extent of surgery and RAI use in low-risk disease—reflecting guidance plurality and organisational context. Presenting a succinct ATA–ETA comparison (Supplementary Table S1) and an illustrative care pathway (Figure 7) may help teams situate their local practice while EXPeRT/CPMS-enabled consultation and prospective, standardised data capture (PARTNER) build the paediatric-specific evidence needed for future consensus.

**Conclusion**

Across Europe, paediatric DTC management shows broad uptake of risk-adapted principles but marked heterogeneity in execution—particularly around staging/guideline choice and RAI indications/dosing.

To reduce unwarranted variation and late-effect exposure while preserving excellent outcomes, we propose: (i) consensus harmonisation of European paediatric DTC pathways that reconcile current guidance; (ii) reference-board infrastructure for complex decisions

and equitable access to expertise; and (iii) prospective data collection to inform future iterations of paediatric-specific recommendations.

These steps would bring paediatric DTC closer to the protocolised standards typical of other paediatric oncology diseases.

## Conflict of Interest

Nicolas Waespe reports educational talk, advisory board and travel reimbursement from Swedish Orphan Biovitrum AB; advisory board and travel reimbursement from NovoNordisk; and advisory board reimbursement from Novartis. None of these activities were in relation to the content of this manuscript.

The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of the research reported

## Funding

The German Malignant Endocrine Tumour Registry is supported by the German Childhood Cancer Foundation (DKS 2021.11, DKS 2024.16, DKS 2025.07, and DKS 2025.16).

The Partner4VRT project has received funding from the European Union's EU4Health Programme under the grant agreement number 101248798.

Nicolas Waespe was supported by Swiss Cancer Research (grant KFS-5992–08-2023), CANSEARCH Foundation; Childhood Cancer Research Switzerland; Bernese Foundation for Children and Adolescents with Cancer; Zoé4life.

**Acknowledgements**

The authors gratefully acknowledge the support of the European Reference Network on Paediatric Cancer (ERN PaedCan) and the continuous collaboration of the wider EXPeRT community. Special thanks to all participating clinicians, whose engagement with rare tumour research contributes to improved care.

**Data Availability Statement**

This study analysed a professional practice survey without patient-level data. Centre identifiers were de-identified; only country was retained. The full questionnaire is provided in the Supplement. Aggregate, de-identified summaries (tables/figures) are included in the manuscript; additional centre-level aggregates are available from the corresponding author on reasonable request. No datasets were deposited in a public repository.

**Author´s Contribution**

The manuscript was conceptualized and coordinated by Michaela Kuhlen and Antje Redlich. All authors contributed to the survey and the final manuscript, approved its content, and agreed to its submission for publication.

## References


1. Kuhlen M, Wellbrock M, Kunstreich M, Trubenbach C, Ronckers C, Redlich A, et al. Incidence and Temporal Patterns of Differentiated Thyroid Carcinoma in Children and Adolescents in Germany: A Pooled Analysis Based on Data from the German Malignant Endocrine Tumor Registry and the German Childhood Cancer Registry. Thyroid. 2024.
2. Kothari R, Donner JR, Balakrishnan K, Hartman G, Pediatric Thyroid Program W, Alazraki A, et al. Composition and Priorities of Multidisciplinary Pediatric Thyroid Programs: A Consensus Statement. Thyroid. 2025;35(4):346-56.
3. Siegel DA, King JB, Lupo PJ, Durbin EB, Tai E, Mills K, et al. Counts, incidence rates, and trends of pediatric cancer in the United States, 2003-2019. J Natl Cancer Inst. 2023;115(11):1337-54.
4. Vaccarella S, Lortet-Tieulent J, Colombet M, Davies L, Stiller CA, Schuz J, et al. Global patterns and trends in incidence and mortality of thyroid cancer in children and adolescents: a population-based study. Lancet Diabetes Endocrinol. 2021;9(3):144-52.
5. Clement SC, Kremer LCM, Verburg FA, Simmons JH, Goldfarb M, Peeters RP, et al. Balancing the benefits and harms of thyroid cancer surveillance in survivors of Childhood, adolescent and young adult cancer: Recommendations from the international Late Effects of Childhood Cancer Guideline Harmonization Group in collaboration with the PanCareSurFup Consortium. Cancer Treat Rev. 2018;63:28-39.
6. Kuhlen M, Kunstreich M, Eilsberger F, Lorenz K, Abele M, Brecht IB, et al. Risk-adapted therapy in pediatric thyroid cancer: initial experience from a national reference program by the MET group. Eur Thyroid J. 2025;14(4).
7. Persons EM, Hussein MH, Herrera M, Pinion D, Webster A, Pineda E, et al. The Impact of Radioactive Iodine on Outcomes Among Pediatric and Adolescent Thyroid Cancer Patients: A SEER Database Analysis. Cancers (Basel). 2025;17(1).
8. Luster M, Lassmann M, Freudenberg LS, Reiners C. Thyroid cancer in childhood: management strategy, including dosimetry and long-term results. Hormones (Athens). 2007;6(4):269-78.
9. Hay ID, Gonzalez-Losada T, Reinalda MS, Honetschlager JA, Richards ML, Thompson GB. Long-term outcome in 215 children and adolescents with papillary thyroid cancer treated during 1940 through 2008. World J Surg. 2010;34(6):1192-202.
10. Hyer SL, Newbold K, Harmer CL. Early and late toxicity of radioiodine therapy: detection and management. Endocr Pract. 2010;16(6):1064-70.
11. Jarzab B, Handkiewicz Junak D, Wloch J, Kalemba B, Roskosz J, Kukulska A, et al. Multivariate analysis of prognostic factors for differentiated thyroid carcinoma in children. Eur J Nucl Med. 2000;27(7):833-41.
12. Jarzab B, Handkiewicz-Junak D, Wloch J. Juvenile differentiated thyroid carcinoma and the role of radioiodine in its treatment: a qualitative review. Endocr Relat Cancer. 2005;12(4):773-803.
13. Kuhlen M, Kunstreich M, Eilsberger F, Luster M, Redlich A. Pediatric differentiated thyroid carcinoma leading to fatal lung fibrosis. Eur Thyroid J. 2025;14(1).

14. Lebbink CA, Dekker BL, Bocca G, Braat A, Derikx JPM, Dierselhuis MP, et al. New national recommendations for the treatment of pediatric differentiated thyroid carcinoma in the Netherlands. Eur J Endocrinol. 2020;183(4):P11-P8.
15. Dekker BL, Newbold KL, Fuhrer D, Waguespack SG, Handkiewicz-Junak D, Links TP, et al. Survey on Paediatric Differentiated Thyroid Cancer Care in Europe. Horm Res Paediatr. 2018;89(1):58-62.
16. Heinzel A, Muller D, van Santen HM, Clement SC, Schneider AB, Verburg FA. The effect of surveillance for differentiated thyroid carcinoma in childhood cancer survivors on survival rates: a decision-tree-based analysis. Endocr Connect. 2022;11(12).
17. Francis GL, Waguespack SG, Bauer AJ, Angelos P, Benvenga S, Cerutti JM, et al. Management Guidelines for Children with Thyroid Nodules and Differentiated Thyroid Cancer. Thyroid. 2015;25(7):716-59.
18. Lebbink CA, Links TP, Czarniecka A, Dias RP, Elisei R, Izatt L, et al. 2022 European Thyroid Association Guidelines for the management of pediatric thyroid nodules and differentiated thyroid carcinoma. Eur Thyroid J. 2022;11(6).
19. Toraih E, Webster A, Pineda E, Pinion D, Baer L, Persons E, et al. Radioactive iodine ablation therapy reduces the risk of recurrent disease in pediatric differentiated thyroid carcinoma. Surg Oncol. 2024;56:102120.
20. Castellanos LE, Zafereo ME, Sturgis EM, Wang JR, Ying AK, Waguespack SG. Pediatric Papillary Thyroid Carcinoma: Outcomes After Surgery Without Adjuvant Radioactive Iodine. J Clin Endocrinol Metab. 2024.
21. Kuhlen M, Ferrari A, Abele M, Reguerre Y, Bien E, Cesen Mazic M, et al. The European Cooperative Study Group for Paediatric Rare Tumours (EXPeRT group): a model for collaborative research and clinical care in very rare paediatric tumours. ESMO Rare Cancers.
22. Roganovic J, Virgone C, Ben-Ami T, Reguerre Y, Ferrari A, Orbach D, et al. Paediatric very rare tumours registration and management in European countries with low health expenditure average rates. Clin Transl Oncol. 2025;27(4):1779-88.
23. Sawka AM, Brierley JD, Tsang RW, Thabane L, Rotstein L, Gafni A, et al. An updated systematic review and commentary examining the effectiveness of radioactive iodine remnant ablation in well-differentiated thyroid cancer. Endocrinol Metab Clin North Am. 2008;37(2):457-80, x.
24. Bojarsky M, Baran JA, Halada S, Isaza A, Zhuang H, States L, et al. Outcomes of ATA Low-Risk Pediatric Thyroid Cancer Patients Not Treated With Radioactive Iodine Therapy. J Clin Endocrinol Metab. 2023;108(12):3338-44.
25. Adam MA, Thomas S, Youngwirth L, Hyslop T, Reed SD, Scheri RP, et al. Is There a Minimum Number of Thyroidectomies a Surgeon Should Perform to Optimize Patient Outcomes? Ann Surg. 2017;265(2):402-7.
26. Baumgarten HD, Bauer AJ, Isaza A, Mostoufi-Moab S, Kazahaya K, Adzick NS. Surgical management of pediatric thyroid disease: Complication rates after thyroidectomy at the Children's Hospital of Philadelphia high-volume Pediatric Thyroid Center. J Pediatr Surg. 2019;54(10):1969-75.
27. Yu VJ, Sasson DC, Scholfield D, Woods R, Wong R, Shaha A, et al. Hospital volume as a predictor of outcomes following pediatric thyroidectomy. J Surg Oncol. 2023;128(1):16-22.
28. Olson SL, Ingram ME, Graffy PM, Murphy PM, Tian Y, Samis JH, et al. Effect of surgeon volume on pediatric thyroid surgery outcomes: A systematic review. J Pediatr Surg. 2022;57(9):208-15.
29. Schneider DT, Ferrari A, Orbach D, Virgone C, Reguerre Y, Godzinski J, et al. A virtual consultation system for very rare tumors in children and adolescents – an initiative of the European Cooperative Study Group in Rare Tumors in Children (EXPeRT). EJC Paediatric Oncology. 2024;3:100137.
30. Kuhlen M, Kunstreich M, Redlich A. Towards Harmonised Paediatric Thyroid Cancer Care: Adult Comparisons and Gaps. Endocr Relat Cancer. 2025.

31. Kuhlen M, brecht IB, Orbach D. Turning Expert Consensus Into Evidence: European Standards of Clinical Practice for Very Rare Pediatric Tumors in the Era of Big Data, Artificial Intelligence, and Patient Partnership. Pediatr Blood Cancer. 2026:e70078.
32. Orbach D, Ferrari A, Schneider DT, Reguerre Y, Godzinski J, Bien E, et al. The European Paediatric Rare Tumours Network - European Registry (PARTNER) project for very rare tumors in children. Pediatr Blood Cancer. 2021;68 Suppl 4:e29072.

## Figure legends

**Figure 1. Diagnostic framework and risk-adaptation across European centres.**

(A) Staging system used. (B) Primary guideline informing care. (C) Formal risk-stratification among respondents. (D) Use of dynamic response-to-therapy categories.

Values are centre counts with percentages.

**Figure 2. Radioiodine (RAI) practice.**

(A) Use of RAI in low-risk patients without metastases. (B) Primary purpose when RAI is given. (C) How administered activity is determined. (D) Reasons to omit RAI (multiple response; percentages calculated over responding centres).

Values are centre counts with percentages.

**Figure 3. Thyrotropin (TSH) suppression targets by risk group.** (n=41 centres)

**Figure 4. Country-level variation.**

(A) Formal risk-stratification by country (ATA vs ETA vs other). (B) Initial surgical approach in presumed low-risk disease by country (Hemi- vs total thyroidectomy vs other). (C) Radioiodine policy in low-risk disease by country.

Values are centre counts.

Abbreviations: ATA, American Thyroid Association; ETA, European Thyroid Association; RAI, radioactive iodine.

**Figure 5. LHEAR versus other European countries: organisational and practice features.**

Side-by-side bars comparing LHEAR countries (Croatia, Greece, North Macedonia, Poland, Turkey) with other European countries across five metrics: MDT presence, RAI use in low-risk disease, hemithyroidectomy for presumed unilateral low-risk disease, and ATA 2015 and ETA 2022 risk stratification.

Bars show percentages of centres.

Abbreviations: LHEAR, low health-expenditure average rate; MDT, multidisciplinary tumour board; RAI, radioiodine.

**Figure 6. Illustrative MDT-anchored care pathway for paediatric differentiated thyroid carcinoma.**

From initial presentation, children undergo high-quality thyroid ultrasound with systematic cervical lymph-node assessment, followed by multidisciplinary tumour board (MDT) review. Depending on imaging and clinical context, pathways include watchful waiting, fine-needle aspiration, or (hemi-)thyroidectomy. Post-operative MDT re-assessment integrates pathology and dynamic risk to determine whether to omit or offer radioiodine (RAI) and to set risk-adapted follow-up (surveillance and late-effects monitoring). The pathway is illustrative and intended to reflect common steps reported by participating centres.

Created with BioRender.com

## Table Legends

**Table 1. Centre and respondent characteristics.** Total centres: n=42; countries: n=18

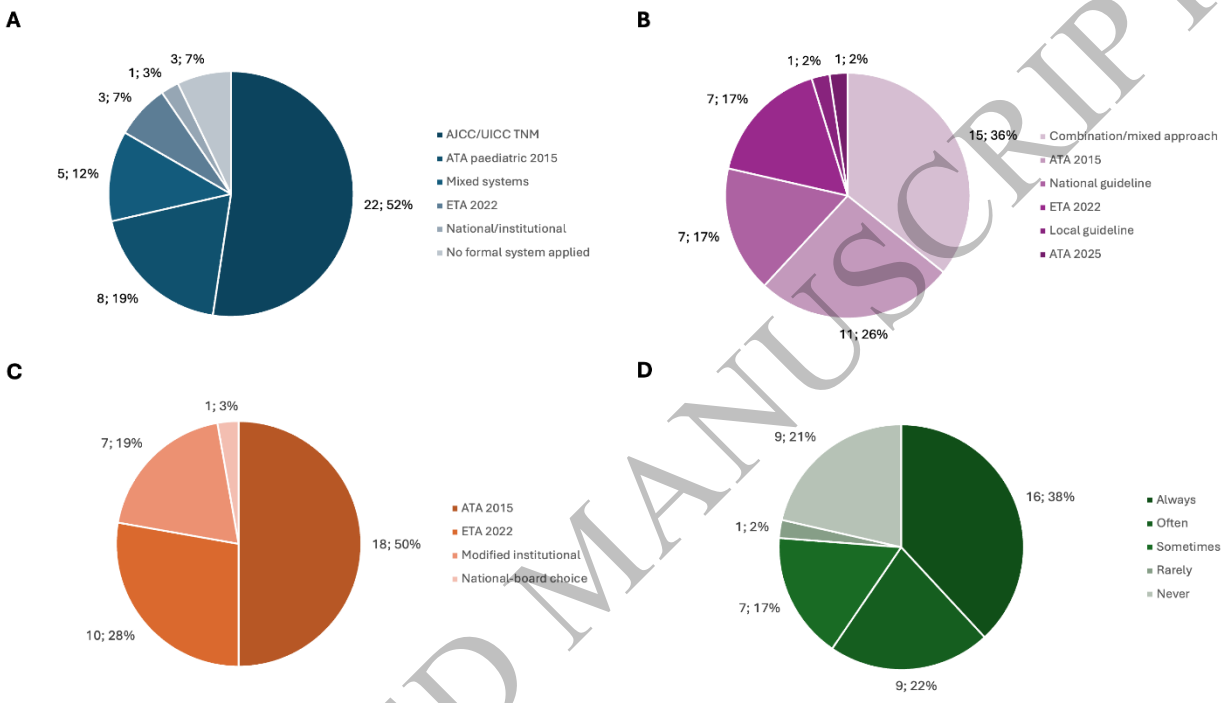


*Figure 1*
*165x93 mm ( x DPI)*

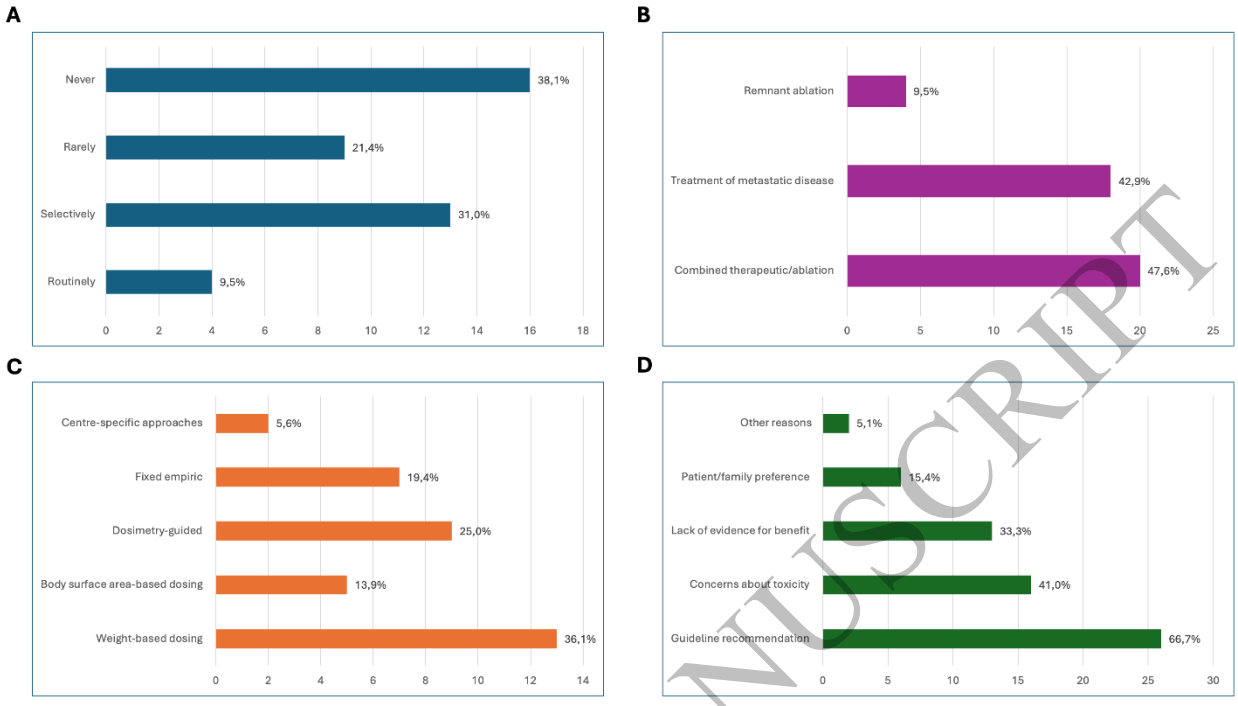


*Figure 2*
*165x93 mm ( x DPI)*

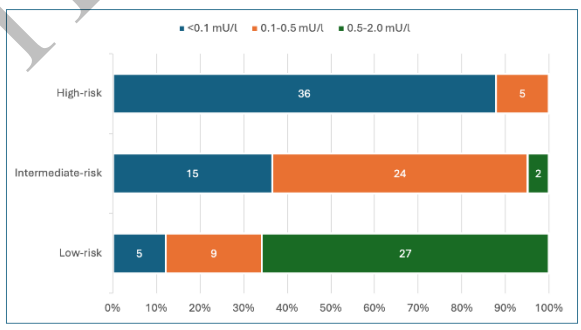


*Figure 3*
*165x93 mm ( x DPI)*

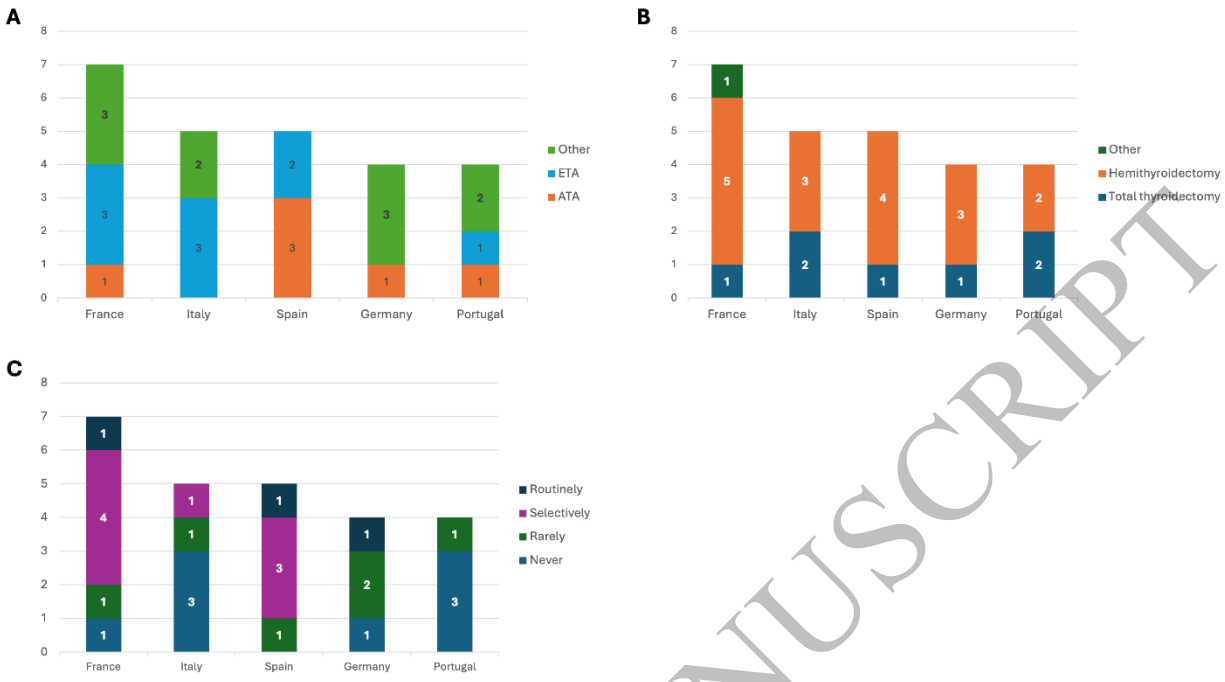


*Figure 4*
*165x93 mm ( x DPI)*

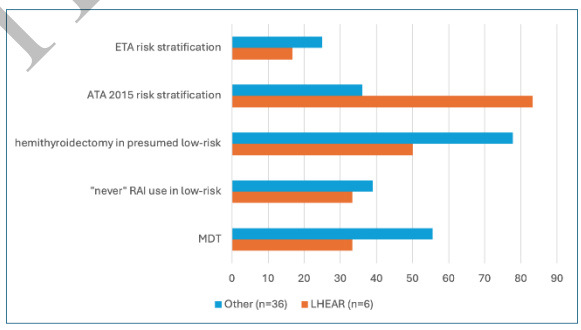


*Figure 5*
*165x93 mm ( x DPI)*

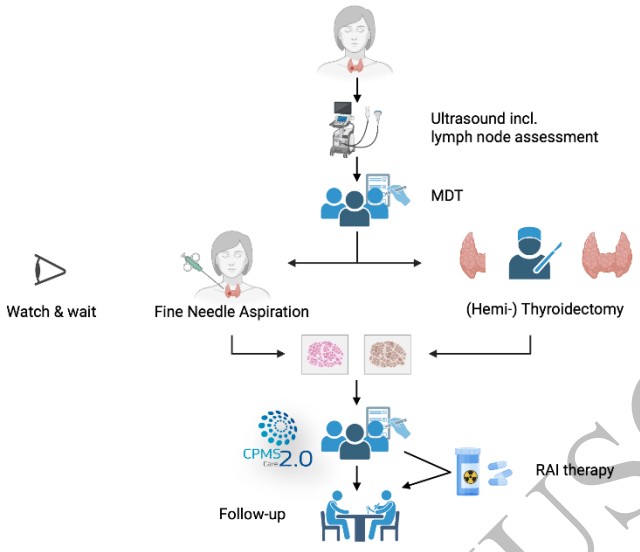


*Figure 6*
*165x93 mm ( x DPI)*

**Table 1. Centre and respondent characteristics.** Total centres: n=42; countries: n=18

| Category / Item | n | % |
|---|---|---|
| **Countries** | | |
| France | 7 | 16.7 |
| Italy | 5 | 11.9 |
| Spain | 5 | 11.9 |
| Germany | 4 | 9.5 |
| Portugal | 4 | 9.5 |
| Croatia | 2 | 4.8 |
| Israel | 2 | 4.8 |
| Sweden | 2 | 4.8 |
| Switzerland | 2 | 4.8 |
| Denmark | 1 | 2.4 |

| | | |
|---|---|---|
| Greece | 1 | 2.4 |
| Netherlands | 1 | 2.4 |
| North Macedonia | 1 | 2.4 |
| Norway | 1 | 2.4 |
| Poland | 1 | 2.4 |
| Slovenia | 1 | 2.4 |
| Turkey | 1 | 2.4 |
| United Kingdom | 1 | 2.4 |
| **Institution type** | | |
| University/academic hospital | 31 | 73.8 |
| Tertiary paediatric hospital | 5 | 11.9 |
| Adult hospital with paediatric pathways/service | 4 | 9.5 |
| Adult Cancer Centre with Paediatric Oncology Unit and paediatric pathways | 1 | 2.4 |
| Secondary or regional paediatric hospital | 1 | 2.4 |
| **Paediatric age cut-off** | | |
| ≤ 15 years | 5 | 11.9 |
| ≤ 18 years | 31 | 73.8 |
| ≤ 25 years | 1 | 2.4 |
| No strict age cut-off (depends on case / referral pattern) | 5 | 11.9 |
| **Annual paediatric DTC volume (last 3 years)** | | |
| 0-2 | 17 | 40.5 |
| 3-5 | 9 | 21.4 |
| 6-10 | 13 | 31.0 |
| >10 | 3 | 7.1 |
| **Respondent primary profession/discipline** | | |
| Paediatric oncologist* | 26 | 61.9 |
| Paediatric endocrinologist | 5 | 11.9 |

| | | |
|---|---|---|
| Adult endocrinologist | 3 | 7.1 |
| Paediatric surgeon | 2 | 4.8 |
| Endocrine/adult surgeon | 1 | 2.4 |
| Adult internal medicine | 1 | 2.4 |
| Adult oncologist | 1 | 2.4 |
| Clinical oncologist | 1 | 2.4 |
| Nuclear medicine physician | 1 | 2.4 |
| Pathologist | 1 | 2.4 |
| **Specialties leading initial management (multiple response)** | | |
| Paediatric endocrinology | 28 | 66.7 |
| Paediatric oncology | 25 | 59.5 |
| Nuclear medicine | 13 | 31.0 |
| Adult endocrinology | 12 | 28.6 |
| Endocrine/adult surgery | 11 | 26.2 |
| Paediatric surgery | 10 | 23.8 |
| Otorhinolaryngology (ear, nose, and throat/head and neck surgery) | 1 | 2.4 |
| Clinical oncology | 1 | 2.4 |

*In four instances, a single centre-level response was jointly submitted by clinicians from multiple disciplines at the same centre.