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Regional Collaboration and Trends in Clinical Management of Thyroid Cancer

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Abstract

Objective. This study examines the trends in the management of thyroid cancer and clinical outcomes in the Southwestern region of The Netherlands from 2010 to 2021, where a regional collaborative network has been implemented in January 2016.

Study Design. Retrospective cohort study.

Setting. This study encompasses all patients diagnosed with thyroid cancer of any subtype between January 2010 and June 2021 in 10 collaborating hospitals in the Southwestern region of The Netherlands.

Methods. The primary outcome of this study was the occurrence of postoperative complications. Secondary outcomes were trends in surgical management, centralization, and waiting times of patients with thyroid cancer.

Results. This study included 1186 patients with thyroid cancer. Median follow-up was 58 [interquartile range: 24-95] months. Surgery was performed in 1027 (86.6%) patients. No differences in postoperative complications, such as long-term hypoparathyroidism, permanent recurrent nerve paresis, or reoperation due to bleeding were seen over time. The percentage of patients with low-risk papillary thyroid carcinoma referred to the academic hospital decreased from 85% (n = 120/142) in 2010 to 2013 to 70% (n = 120/171) in 2014 to 2017 and 62% (n = 100/162) in 2018 to 2021 ($P < .01$). The percentage of patients undergoing a hemithyroidectomy alone was 9% (n = 28/323) in 2010 to 2013 and increased to 20% (n = 63/317; $P < .01$) in 2018 to 2021.

Conclusion. The establishment of a regional oncological network coincided with a de-escalation of thyroid cancer treatment and centralization of complex patients and interventions. However, no differences in postoperative complications over time were observed. Determining the impact of regional oncological networks on quality of care is challenging in the absence of uniform quality indicators.

Keywords

clinical management, oncological network, thyroid cancer

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There has been a shift in the way cancer care has been delivered over the last decades. Modern cancer care increasingly entails collaborations between different institutions and professionals, utilizing regional oncological networks.[1] Oncological networks often contain a structured care pathway and multidisciplinary tumor boards aiming to reduce practice variation, provide educational opportunities for all specialists involved, and reduce individual physician biases.[2,3] Interhospital collaboration also contributes to improved access to evidence-based health care,[4-6] new treatment options, and clinical studies.[7,8] Previously, we have demonstrated the impact of a regional network on referral patterns in patients with thyroid cancer.[9] That

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study showed a more efficient and structured way of patient referral and a decrease in unnecessary second opinions.

It is often hypothesized that collaborative networks improve the quality of care and clinical outcomes in cancer patients. Some studies show that the existence of a collaborating referral network is associated with lower hospitalization costs and fewer readmissions.[10-12] However, there are no quantitative studies examining the impact of collaborative networks on clinical outcomes (eg, waiting times, postoperative complications, and hospitalization times) for patients with thyroid cancer. The aim of this study is therefore to analyze the trends in the clinical management of thyroid cancer and its outcomes in the Southwestern region of The Netherlands between 2010 and 2021, where a regional collaborative network has been implemented in January 2016. While refraining from establishing a causal link between network formation and improvements in clinical outcomes, this research aims to provide valuable insights into the potential role of a regional collaborative network on thyroid cancer management and outcomes.

Methods

Data Collection and Patients

Patients diagnosed with thyroid cancer of any subtype between January 2010 and June 2021 in 10 hospitals in the Southwestern region of The Netherlands (2.1 million inhabitants) were included. These hospitals are currently all part of a regional oncological network centered around thyroid cancer; "the Thyroid Network," which was established in January 2016. As previously described,[9] the foundation of the Thyroid Network was accompanied by the implementation of a biweekly regional multidisciplinary tumor board and uniform care pathway (Supplemental Additional File 1, available online).[13] Detailed information about the foundation of the Thyroid Network can be found in Supplemental Additional File 2, available online.

Data were obtained from The Netherlands Cancer Registry managed by The Netherlands Comprehensive Cancer Organization. Patient characteristics, diagnosis upon presentation, hospital of first thyroid cancer-related contact, waiting times, surgical interventions, and vital status were collected. The Netherlands Cancer Registry did not register postoperative complications. To assess information on postoperative complications and radioiodine therapy, patients from The Netherlands Cancer Registry were linked with unique patient identification numbers to a database study which comprises all patients in the Southwestern region of The Netherlands who underwent total or completion thyroidectomy between January 2010 and December 2019; The Thyroid Network Database (**Figure 1**). From this database, data on patient characteristics, surgical intervention, radioactive iodine therapy, and postoperative complications were retrieved. The Strengthening the Reporting of Observational Studies in Epidemiology reporting guidelines was used.[14]

Groups and Definitions

Patients were divided into 3 different time cohorts: 2010 to 2013, 2014 to 2017, and 2018 to 2021 (**Figure 2**). These timeframes were chosen as the regional collaboration was initiated and finalized between 2014 and 2017. The waiting time for surgery was defined as the number of days between the date of the first cytological or histological confirmation of the thyroid nodule and the date of surgery. Waiting times for radioactive iodine therapy were defined as the number of days between the last surgery to the first day of radioactive iodine therapy. In The Netherlands, maximum recommended waiting

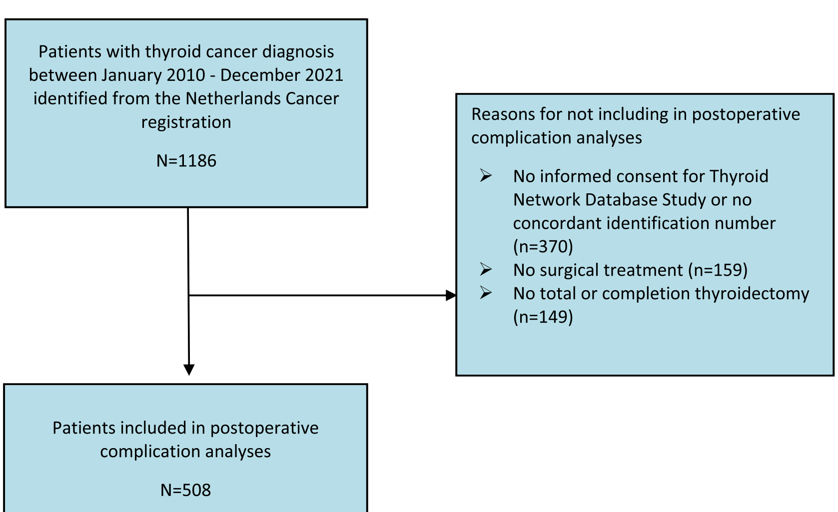

Figure 1. Flowchart of patients assessed for postoperative complications.

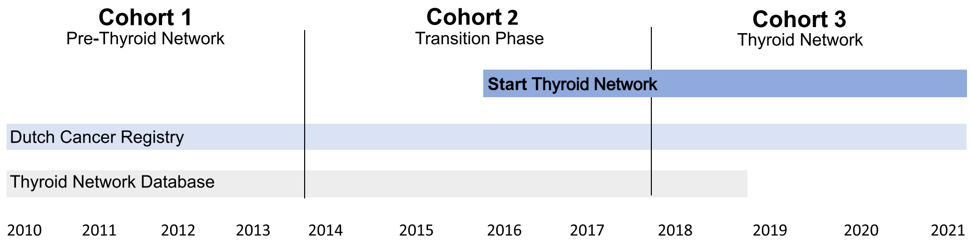

Figure 2. Timeline of the cohorts and databases.

times have been established in the Treek standards by hospitals and insurers.[15] These standards state that 80% of cancer patients have to be treated within 5 weeks (35 days) and the maximum waiting time for oncological treatment should be 7 weeks (49 days). Long-term hypoparathyroidism was defined as the need for active vitamin D supplementation with or without calcium supplementation 1 year after surgery and the inability to be tapered off vitamin D supplementation.[16] Laryngeal recurrent nerve paresis detected on indirect laryngoscopy was considered permanent if the paresis continued beyond 6 months. Low-risk papillary thyroid carcinoma was defined as a cT1/2 papillary thyroid carcinoma without preoperative lymph node or distant metastasis. Patients with complex disease were defined as T3b or T4 papillary, follicular or oncocytic thyroid carcinoma, lymph node metastases (N1a or N1b), distant metastases (M1), and all patients with medullary or anaplastic thyroid cancer. The American Joint Committee on Cancer Staging Manual, 8th edition, primary tumor stage classification (TNM) was used for the classification of thyroid cancer patients.[17]

Outcomes

The primary outcome of this study was the occurrence of postoperative complications, including long-term hypoparathyroidism, reoperation due to bleeding, and permanent laryngeal recurrent nerve paresis. Secondary outcomes were time to discharge, waiting times, and trends in the surgical management of patients with thyroid cancer.

Statistical Analysis

Descriptive statistics were used to express continuous variables with normal distribution as mean with standard deviation or abnormal distribution as median with interquartile range (IQR). Distribution was assessed using the Shapiro-Wilk normality test. Categorical variables are described as count (n) and percentage (%). Differences between the time cohorts were analyzed using Mood's median test for continuous variables and the Pearson χ^2 test or Fisher's exact test for nominal variables. All statistical tests were performed with SPSS Statistics version 28 (IBM Corp) and the R Project for Statistical Computing (version 4.1.2, R Foundation; https://www.r-project.org/). All test hypotheses were 2-sided and $P < .05$ was considered significant.

Results

Thyroid Cancer Patients in the Southwestern Region of The Netherlands (Netherlands Cancer Registry)

Patient Characteristics

In total, 1186 patients were diagnosed with thyroid cancer in the 10 hospitals of the Southwestern region of The Netherlands between January 2010 and June 2021 and were included in this study. The median age was 53 [IQR: 41-68] years and 68.4% (n = 811/1186) was female. Median follow-up was 58 [IQR: 24-95] months. Papillary thyroid carcinoma was the most common histological type (n = 860/1186; 72.5%), followed by follicular thyroid carcinoma (n = 112/1186; 9.4%), medullary thyroid carcinoma (n = 80/1186; 6.7%), anaplastic thyroid carcinoma (n = 52/1186; 4.4%), and oncocytic thyroid carcinoma (n = 34/1186; 2.9%) (**Table 1**).

Trends in Clinical Management

Surgery was performed in 1027 patients; total thyroidectomy was performed in 518 (50%) patients, hemithyroidectomy followed by completion thyroidectomy in 360 (35%) patients, hemithyroidectomy alone in 141 (14%) patients, and an isthmus resection in 8 (0.7%) patients. The percentage of patients undergoing a hemithyroidectomy in 2010 to 2013 was 8.7% (n = 28/323), while this percentage increased to 19.9% in 2018-2021 (n = 63/317; $P < .01$). Especially in patients with low-risk papillary thyroid carcinoma (n = 475), a hemithyroidectomy followed by active surveillance increased (**Figure 3**). The proportion of lymph node dissections among patients who underwent thyroid surgery (n = 1027) increased from 15.8% (n = 51/323) in 2010 to 2013 to 26.5% (n = 84/317) in 2018 to 2021 ($P = .02$). From 2010 to 2013, the percentage of lymph node dissections in which no lymph node metastases were discovered following histological examination was 15.7% (n = 8/51), whereas this percentage was 8.3% (n = 7/84) in 2018 to 2021 ($P = .42$). The median number of total lymph nodes harvested did not significantly change over time 6 [IQR: 1-25] lymph nodes in 2010 to 2013, 3 [IQR: 1-19] in 2018 to 2021 ($P = .43$).

Of the patients with differentiated thyroid cancer who underwent thyroid surgery (n = 901), 713 (79.1%) patients received radioactive iodine therapy at least once after total thyroidectomy or completion of thyroidectomy. The proportion of patients with differentiated thyroid cancer

Table 1. Baseline Characteristics Netherlands Cancer Registry Patients

	2010-2013	2014-2017	2018-2021	*P* value	Total
Number of patients	364	448	374		1186
Age	51 [40-64]	54 [40-68]	53 [41-68]	.177	53 [41-68]
Gender				.049	
Male	111 (30.5)	128 (28.6)	136 (36.4)		375 (31.6)
Female	253 (69.5)	320 (71.4)	238 (63.6)		811 (68.4)
Diagnosis				.947	
PTC	267 (73.4)	326 (72.8)	267 (71.4)		860 (72.5)
FTC	33 (9.1)	43 (9.6)	36 (9.6)		112 (9.4)
MTC	22 (6.0)	29 (6.5)	29 (7.8)		80 (6.7)
ATC	18 (4.9)	22 (4.9)	12 (3.2)		52 (4.4)
Oncocytic thyroid carcinoma	10 (2.7)	12 (2.7)	12 (3.2)		34 (2.9)
Other	14 (3.9)	16 (3.6)	18 (4.8)		48 (4.0)
Follow-up, mo	109 [98-128]	67 [53-81]	24 [15-36]	<.01	58 [24-95]
Treatment				.28	
No surgery	41 (11.3)	61 (13.6)	57 (15.2)		159 (13.4)
Surgery	323 (88.7)	387 (86.4)	317 (84.8)		1027 (86.6)
Type of surgery				<.01	
HT	28 (8.7)	50 (12.9)	63 (19.9)		141 (11.9)
HT + CT	121 (37.5)	148 (38.2)	91 (28.7)		360 (30.4)
TT	173 (53.6)	187 (48.3)	158 (49.8)		518 (43.7)
Isthmus resection	1 (0.3)	2 (0.5)	5 (1.6)		8 (0.7)
CLND	51 (15.8)	103 (23.0)	84 (26.5)	<.01	238 (20.1)
No radioactive iodine therapy	112 (30.8)	162 (36.2)	153 (40.9)		427 (36.0)
Radioactive iodine therapy	252 (69.2)	286 (63.8)	221 (59.1)	.001	759 (64.0)

Data are expressed as numbers (percentage) or as median [IQR]. Missing data are presented in parentheses behind variables.
Abbreviations: ATC, anaplastic thyroid carcinoma; CLND, cervical lymph node dissection; CT, completion thyroidectomy; FTC, follicular thyroid carcinoma; HT, hemithyroidectomy; IQR, interquartile range; MTC, medullary thyroid carcinoma; PTC, papillary thyroid carcinoma; TT, total thyroidectomy.

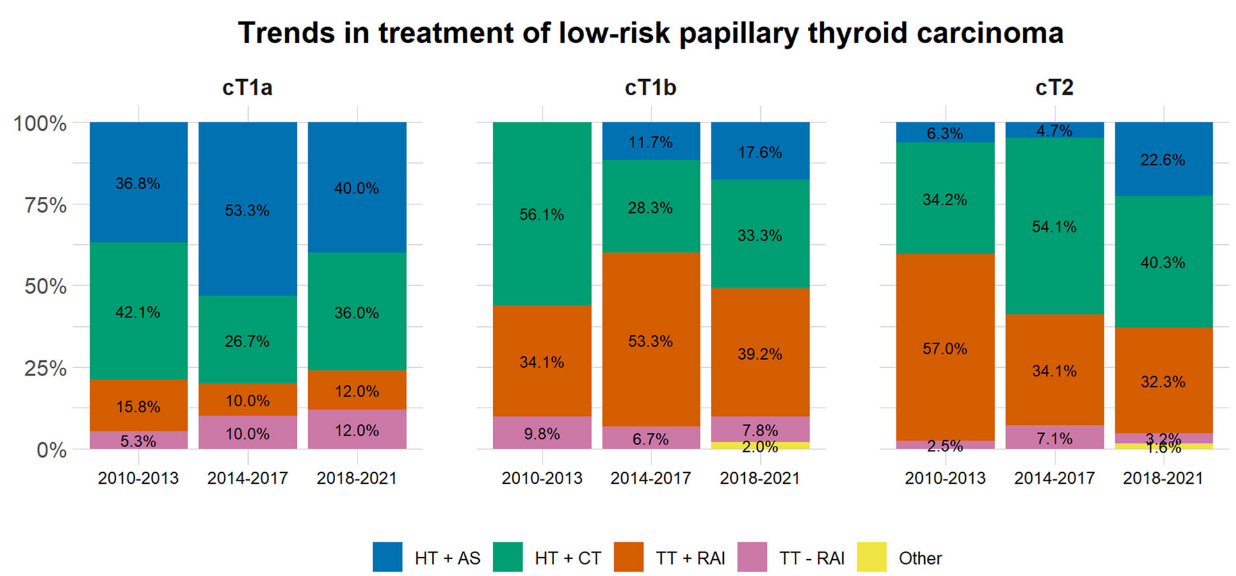

Figure 3. Trends in the treatment of low-risk papillary thyroid carcinoma. AS, active surveillance; CT, completion thyroidectomy; HT, hemithyroidectomy; RAI, radioactive iodine treatment; TT, total thyroidectomy.

who received radioactive iodine therapy after total or completion thyroidectomy decreased over time (84.8%, n = 240/283 in 2010-2013; 79.8%, n = 268/340 in 2014-2017, and 73.7%, n = 205/278 in 2018-2021; $P < .01$).

Waiting Times

Figure 4 displays the average waiting times per quarter of a year for surgery and radioactive iodine therapy. The median waiting time until the first surgery increased from

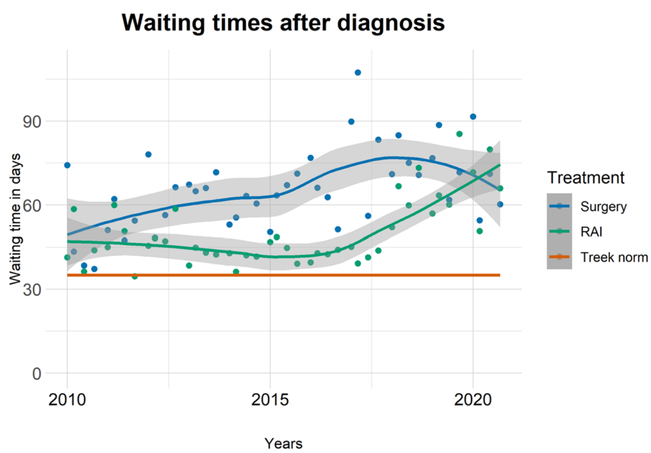

Figure 4. Waiting times after diagnosis: The dots on the plot indicate the average waiting time per quarter of a year. RAI, radioactive iodine treatment.

Table 2. Hospitalization Time After Thyroid Surgery

	2010-2013	2014-2017	2018-2021	*P* value
HT	1 [1-1]	1 [1-1]	1 [1-1]	.59
CT	2 [1-2]	2 [1-2]	1 [1-1]	.01
TT	2 [1-4]	3 [2-5]	1 [1-1]	<.01
TT + CLND	3 [2-6]	3 [2-6]	2 [2-3]	.077

Data are expressed as median [IQR].
Abbreviations: CLND, cervical lymph node dissection; CT, completion thyroidectomy; HT, hemithyroidectomy; IQR, interquartile range; TT, total thyroidectomy.

56 [IQR: 38-82] days in 2010 to 2013 to 62 [IQR: 43-91] days in 2018 to 2021 ($P < .01$). Patients with complex disease had a significantly longer waiting time than patients without complex disease (70 [IQR: 48-98] days complex disease vs 50 [IQR: 35-72] days without complex disease; $P < 0.01$). The median time between surgery and radioactive iodine therapy was 35 [IQR: 34-41] days from 2010 to 2013 and 62 [IQR: 47-76] days from 2018 to 2021 ($P < .01$). The Treek standards were not met in any of the patient cohorts.

Hospitalization Time

The median hospitalization time for all thyroid surgeries was 2 [IQR: 1-3] days after surgery from 2010 to 2013, 1 [IQR: 1-2] day in 2014 to 2017, and 1 [IQR: 1-2] day in 2018 to 2021. The median hospitalization time after total thyroidectomy decreased from 2 [IQR: 1-4] days after surgery in 2010 to 2013 to 1 [IQR: 1-1] day in 2018 to 2021 ($P < .01$, **Table 2**). The median hospitalization time after completion of thyroidectomy significantly decreased from 2 [IQR: 1-2] days after surgery in 2010 to 2013 to 1 [IQR: 1-1] day in 2018 to 2021 ($P = .01$).

Centralization of Patient Care

The number and proportion of patients who visited 1, 2, 3, or 4 different hospitals during their disease period were 75/364 (20.6%), 246/364 (67.6%), 38/364 (10.4%), and 5/364 (1.4%) in 2010 to 2013, respectively. From 2018 to 2021, patients more often were seen in 1 hospital (1 hospital 119/374 [31.8%]; 2 hospitals 238/374 [63.6%]; 3 hospitals 14/374 [3.7%]; and 4 hospitals 3/374 [0.8%]). The total percentage of patients referred to the academic hospital decreased from 83.8% (n = 305/364) in 2010 to 2013 to 72.5% (n = 271/374) in 2018 to 2021 ($P = .01$). The total percentage of patients who underwent surgery in the academic hospital remained stable over time (138/323, 42.7% in 2010-2013; 163/387, 42.1% in 2014-2017; 124/317, 39.1% in 2018-2021; $P = .61$). The percentage of patients with low-risk papillary thyroid carcinoma referred to the academic hospital decreased from 84.5% (n = 120/142) in 2010 to 2013 to 70.2% (n = 120/171) in 2014 to 2017 and 61.7% (n = 100/162) in 2018 to 2021 ($P < .01$). The academic hospital performed 68.6% (n = 35/51) of all lymph node dissections in 2010 to 2013 and this number increased to 91.7% (n = 77/84) in 2018 to 2021 ($P < .01$, **Figure 5**). The proportion of patients treated with radioactive iodine (n = 713) in the academic hospital decreased from 232/240 (96.7%) in 2010 to 2013 to 245/268 (91.4%) in 2014 to 2017 and 182/205 (88.8%) in 2018 to 2021 ($P < .01$). The percentage of patients with complex disease who were referred to the academic hospital did not significantly change: 84.3% (n = 107/127) in 2010 to 2013 to 88.0% (n = 125/142) in 2018 to 2021 ($P = .61$).

Subset of Thyroid Cancer Patients in the Thyroid Network Database (n = 508)

Complications After Thyroid Surgery

Data on postoperative complications was available for 508 patients undergoing 718 thyroid surgeries. The baseline characteristics of the patient cohort are displayed in **Table 3**. Perioperative nerve integrity monitoring was used more frequently over time (n = 115/254, 45.3% in 2010-2013; n = 265/328, 80.8% in 2014-2017; and n = 73/85, 85.9% in 2018-2019; $P < .01$). The prevalence

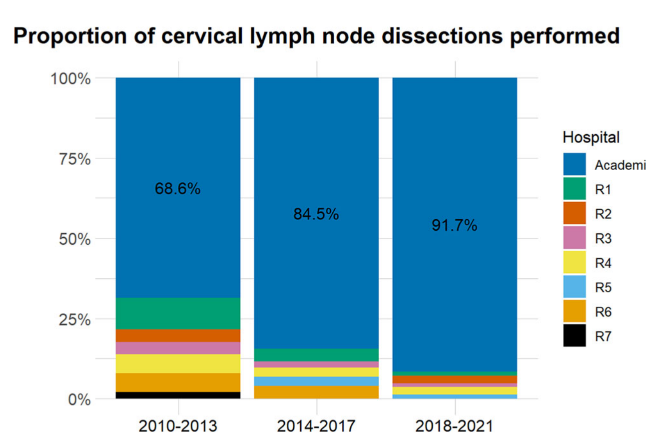

Figure 5. Proportion of cervical lymph node dissections performed. R, regional.

Table 3. Baseline Characteristics of Patients Assessed for Postoperative Complications (Thyroid Network Database)

	2010-2013	2014-2017	2018-2019	*P* value	Total
Number of patients	185	256	67		508
Age	49 [38-61]	50 [37-64]	49 [36-58]	.61	50 [38-62]
Gender				.48	
Male	60 (32.4)	72 (28.1)	23 (34.3)		155 (30.5)
Female	125 (67.6)	184 (71.9)	44 (65.7)		353 (69.5)
Diagnosis					
PTC	139 (75.1)	198 (77.3)	56 (83.6)	.89	393 (77.4)
FTC	18 (9.7)	27 (10.5)	6 (9.0)		51 (10.0)
MTC	16 (8.6)	17 (6.6)	3 (4.5)		36 (7.1)
ATC	1 (0.5)	3 (1.2)	0		4 (0.8)
Oncocytic thyroid carcinoma	6 (3.2)	7 (2.7)	0		13 (2.6)
Other	3 (1.6)	6 (2.4)	2 (3.0)		11 (2.2)
Follow-up in months	111 [100-128]	70 [59-83]	34 [23-41]	<.01	75 [53-101]
Surgical treatment				.16	
HT + CT	88 (47.6)	109 (42.6)	23 (34.3)		220 (43.3)
TT	97 (52.4)	147 (57.4)	44 (65.7)		288 (56.7)
CLND	40 (21.6)	92 (35.9)	67 (38.8)	<.01	238 (20.1)

Data are expressed as numbers (percentages) or as median [IQR]. Missing data are presented in parentheses behind variables.
Abbreviations: ATC, anaplastic thyroid carcinoma; CLND, cervical lymph node dissection; CT, completion thyroidectomy; FTC, follicular thyroid carcinoma; HT, hemithyroidectomy; MTC, medullary thyroid carcinoma; PTC, papillary thyroid carcinoma; TT, total thyroidectomy.

of permanent laryngeal recurrent nerve paresis, long-term hypoparathyroidism, reoperation due to bleeding, and reoperation due to infection did not significantly differ between the time cohorts stratified per type of surgery (**Table 4**). The proportion of patients receiving calcium supplements at discharge decreased (n = 89/180, 49.4% in 2010-2013; and n = 15/65, 23.1% in 2018-2019; $P < .01$) and less patients received intravenous calcium over time (n = 30/177, 16.9% in 2010-2013 and n = 6/60, 10.0% in 2018-2019; $P < .01$). Stratified analysis of patients who underwent cervical lymph node dissection did not show differences in postoperative complications over time.

Discussion

This article shows a trend toward de-escalation in the treatment of thyroid cancer in the Southwestern region of The Netherlands between 2010 and 2021, where a regional collaborative network has been implemented in 2016. Although the 2015 American Thyroid Association (ATA) guideline advocates de-escalation of treatment for patients with low-risk differentiated thyroid cancer,[18] Dutch thyroid cancer guidelines still recommend a total thyroidectomy followed by radioactive iodine therapy in every patient with a differentiated thyroid cancer larger than 1 cm.[19] As observed in our study, the rate of thyroid lobectomy in patients with low-risk differentiated thyroid cancer has increased over time and a growing number of patients did not receive radioactive iodine therapy after total or completion thyroidectomy. This indicates that changes in the 2015 ATA guidelines not only have implications for patients in America but also for patients in countries that have not formally adopted these guidelines such as The Netherlands.[20] While we cannot definitely determine the sole influence of the updated ATA guidelines, it is plausible that the network played a supportive role in enabling the implementation of these de-escalated treatment approaches and ensuring consistent care throughout the region.[21] Notably, de-escalating treatment strategies in the Southwestern of The Netherlands are often backed by the regional multidisciplinary tumor board, which benefits from the input of several experts in the field of thyroid cancer. However, treatment de-escalation in patients with low-risk differentiated thyroid cancer across The Netherlands requires some form of caution, as the Dutch patient cohort seems to include more patients with more aggressive tumor characteristics compared to international populations due to differences in the initial diagnostic workup.[22]

The proportion of patients with high-complex disease who were referred to the academic hospital remained high and stable over time (>85%), while more patients with low-risk papillary thyroid carcinoma received care only in the regional hospitals. This shift can be explained by the establishment of the Thyroid Network and its uniform care pathway which facilitates a standardized way of patient referral in the region.[9] These shifts are in line with a report from the Dutch Ministry of Health, which stressed the importance of centralization of health care.[13,23] Before the implementation of the Thyroid Network, several regional hospitals performed lymph node dissections for patients with thyroid cancer with a median of 1 per year per hospital. After the establishment of the Thyroid Network, it was agreed that all formal lymph node dissections should

Table 4. Complications After Thyroid Surgery

	2010-2013	2014-2017	2018-2019		Total
Number of surgeries	269	359	90		718
HT	n = 84	n = 103	n = 23	*P* value	210 (29.2)
Abcess requiring surgery	0	1 (1.0)	0	.59	1 (0.5)
Chyle leakage	0	0	0	n/a	0
Bleeding requiring surgery	1 (1.2)	1 (1.0)	0	.87	2 (1.0)
Permanent recurrent nerve paresis	2 (2.4)	2 (1.9)	1 (4.3)	.79	5 (2.4)
CT	n = 88	n = 109	n = 23	*P* value	220 (30.6)
Abcess requiring surgery	1 (1.1)	1 (0.9)	1 (4.3)	.42	3 (1.4)
Chyle leakage	0	1 (0.9)	0	.60	1 (0.5)
Bleeding requiring surgery	1 (1.1)	3 (2.8)	0	.55	4 (1.8)
Long-term hypoparathyroidism	6 (6.8)	10 (9.2)	2 (8.7)	.83	18 (8.2)
Permanent recurrent nerve paresis	1 (1.1)	0	0	.47	1 (0.5)
TT	n = 97	n = 47	n = 42	*P* value	288 (40.1)
Abcess requiring surgery	0	1 (2.1)	0	.62	1 (3.5)
Chyle leakage	6 (6.2)	4 (8.5)	4 (9.1)	.17	14 (4.9)
Bleeding requiring surgery	3 (3.1)	8 (17.0)	1 (2.3)	.53	12 (4.2)
Long-term hypoparathyroidism	16 (16.5)	38 (80.9)	6 (13.6)	.09	60 (20.8)
Permanent recurrent nerve paresis	4 (4.1)	17 (36.2)	2 (4.5)	.07	23 (8.0)

Data are expressed as numbers (percentage) or as median [IQR]. Missing data is presented in parentheses behind variables. The number of missing values is displayed with () after the variable name.
Abbreviations: CT, completion thyroidectomy; HT, hemithyroidectomy; n/a, not applicable; TT, total thyroidectomy.

be performed in the level 1 academic hospital, which resulted in a significant decrease in dissections done in the regional hospitals (32% to 9%). In general, centralization of care is known to decrease postoperative morbidity and mortality.[24] However, we did not observe clear decreases in postoperative complications over time in patients with or without cervical lymph node dissections. This could be partly explained by the relatively small sample size of the present study. To identify significant differences between cohorts when examining infrequent outcomes like most complications after thyroid surgery, a large sample size is required.[25] Despite the centralization of lymph node dissections in academic hospitals, our data indicate that 9% of all lymph node dissections have been performed in regional hospitals and 12% of complex patients were treated in regional hospitals after the initiation of the Thyroid Network. Therefore, this study demonstrates the presence of variation in thyroid cancer management, even within the context of a collaborative network structure. This highlights the need for continued efforts to understand and address the underlying factors contributing to such variation, ensuring better adherence to guidelines and ultimately improving patient outcomes.

The time to discharge after total and completion thyroidectomy reduced over time, while the waiting time for surgery and radioactive iodine therapy became longer over time. The longest waiting time for radioactive iodine therapy was observed in the years 2020 and 2021. This could be explained by the impact of the COVID-19 regulations on health care in these years.[26] However, the rise in waiting times was already observed before the start of the COVID-19 pandemic. Another possible explanation could be the implementation of the regional, biweekly multidisciplinary tumor board since 2016. Although patients discussed in multidisciplinary tumor boards are more likely to receive more accurate and complete treatment recommendations in cancer care,[27-30] several studies show that the implementation of multidisciplinary tumor boards could potentially lead to treatment delays.[31,32] However, the median waiting time for surgery in all cohorts was well below 90 days, which is considered safe, as a 12-week delay in treatment does not seem to affect disease-specific or overall survival in patients with differentiated thyroid cancer.[33,34] It should be noted that these studies did not evaluate quality of life which could be decreased due to anxiety for waiting or improved by the assurance that the treatment plan is widely assessed and supported.

The proportion of long-term hypoparathyroidism among patients that underwent total or completion thyroidectomy was 15%, which is in line with several nationwide studies performed in The Netherlands, Spain, and Sweden.[35-37] A total of 29/288 (8.0%) patients that underwent total thyroidectomy experienced permanent RLN injury, which is higher than in most other papers. It is important to note that this patient cohort exclusively comprises individuals with malignant tumors, which are known to be associated with an increased risk of post-surgical complications, including recurrent laryngeal nerve damage and hypoparathyroidism.[38]

This study has limitations. Long-term oncological and survival outcomes in patients with thyroid cancer were not available. In addition, not all operated patients could be evaluated for postoperative complications as not every patient had provided informed consent for the Thyroid Network Database study or missed concordant person identification numbers with The Netherlands Cancer Registry. This could have introduced selection bias of patients analyzed for postoperative complications, potentially limiting the generalizability of our findings. Our study primarily focused on analyzing the trends in thyroid cancer management and clinical outcomes over time, with the intention of understanding the broader picture rather than attributing causality solely to the network. It is imperative to interpret our findings within the context of multiple influences, including the network, the updated guidelines, and other factors that may have influenced the observed trends in thyroid cancer care. Since we did not compare the outcomes of our study cohort with hospitals outside the Thyroid Network, it is unclear whether similar trends in the clinical management of thyroid cancer were observed in nonnetwork hospitals. Lastly, this study was conducted within the Dutch health care system. The results of this study may not extrapolate well to other systems due to possible variations in, for example, patient preferences, health care policies and regulations, and social norms.[39]

In order to continuously improve the quality of thyroid cancer care, it is critical to measure outcome and quality indicators. The International Consortium for Health Outcomes Measurement has reached a consensus on a standard set of outcome measurements for, among others, lung, prostate, and breast cancer.[40-42] For thyroid cancer care such a uniform standard set of outcome measurements has not yet been established. Some have proposed quality indicators for patients who receive surgical intervention for thyroid cancer.[43] However, developing a standardized set of outcome measures is important to allow for valid comparison between and within health care organizations and define and improve the quality of the clinical management of thyroid cancer. National quality registries can play a major role in the prospective monitoring of the quality of care through extensive data registration.[44-46]

Conclusion

This study shows the changes over time in the clinical management of thyroid cancer and its outcomes in the Southwestern region of The Netherlands comprising 2.1 million inhabitants. The establishment of a regional oncological network coincided with a de-escalation of thyroid cancer treatments and centralization of complex patients and interventions. However, no differences in postoperative complications over time were observed. In the absence of uniform quality indicators to measure the quality of care for patients with thyroid cancer, the impact on quality of care is still difficult to report.

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Author Contributions

Sam P.J. van Dijk, led the conception and design of the study, analyzed the patient data, was a major contributor in interpreting the data analysis, wrote the manuscript and revised the manuscript for important intellectual content, and had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis; **Hannelore I. Coerts**, led the conception and design of the study, analyzed the patient data, was a major contributor in interpreting the data analysis and wrote the manuscript and revised the manuscript for important intellectual content, and she had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis; **Ivona Lončar**, was a major contributor in interpreting the data analysis and revised the manuscript for important intellectual content; **Caroline M.J. van Kinschot**, was a major contributor in interpreting the data analysis and revised the manuscript for important intellectual content; **Erik M. von Meyenfeldt**, was a major contributor in interpreting the data analysis and revised the manuscript for important intellectual content; **W. Edward Visser**, was a major contributor in interpreting the data analysis and revised the manuscript for important intellectual content; **Charlotte van Noord**, was a major contributor in interpreting the data analysis and revised the manuscript for important intellectual content; **Hans F. Zengerink**, was a major contributor in interpreting the data analysis and revised the manuscript for important intellectual content; **Marc R.J. ten Broek**, was a major contributor in interpreting the data analysis and revised the manuscript for important intellectual content; **Cornelis Verhoef**, was a major contributor in interpreting the data analysis and revised the manuscript for important intellectual content; **Robin P. Peeters**, was a major contributor in interpreting the data analysis and revising the manuscript for important intellectual content; **Tessa M. van Ginhoven**, led the conception and design of the study, was a major contributor in interpreting the data analysis and wrote the manuscript and revised the manuscript for important intellectual content.

Disclosures

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Data Availability Statement

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Supplemental Material

Additional supporting information is available in the online version of the article.

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References

1. Oates J, Bjerregaard Jensen H. *Building Regional Health Care Networks in Europe*. IOS Press; 2000:238.
2. Anderson BO, Yip C-H, Smith RA, et al. Guideline implementation for breast healthcare in low-income and middle-income countries. *Cancer*. 2008;113(S8):2221-2243.
3. D'cruz A, Lin T, Anand AK, et al. Consensus recommendations for management of head and neck cancer in Asian countries: a review of international guidelines. *Oral Oncol*. 2013;49(9):872-877.
4. Carpenter WR, Meyer A-M, Wu Y, et al. Translating research into practice: the role of provider-based research networks in the diffusion of an evidence-based colon cancer treatment innovation. *Med Care*. 2012;50(8):737-748.
5. Penn DC, Chang Y, Meyer A-M, et al. Provider-based research networks may improve early access to innovative colon cancer treatment for African Americans treated in the community. *Cancer*. 2015;121(1):93-101.
6. Penn DC, Stitzenberg KB, Cobran EK, Godley PA. Provider-based research networks demonstrate greater hospice use for minority patients with lung cancer. *J Oncol Pract*. 2014;10(4):e182-e190.
7. Fouad MN, Lee JY, Catalano PJ, et al. Enrollment of patients with lung and colorectal cancers onto clinical trials. *J Oncol Pract*. 2013;9(2):e40-e47.
8. McAlearney AS, Song PH, Reiter KL. Why providers participate in clinical trials: considering the National Cancer Institute's Community Clinical Oncology Program. *Contemp Clin Trials*. 2012;33(6):1143-1149.
9. van Dijk SPJ, Lončar I, van Veen-Berkx E, et al. Establishing a multicenter network for patients with thyroid nodules and cancer: effects on referral patterns. *Otolaryngol Head Neck Surg*. 2023;168:91-100.
10. Mascia D, Angeli F, Di Vincenzo F. Effect of hospital referral networks on patient readmissions. *Soc Sci Med*. 2015; 132:113-121.
11. Spear SE. Reducing readmissions to detoxification: an interorganizational network perspective. *Drug Alcohol Depend*. 2014;137:76-82.
12. Uddin S, Hossain L, Kelaher M. Effect of physician collaboration network on hospitalization cost and readmission rate. *Eur J Public Health*. 2011;22(5):629-633.
13. De Juiste Zorg op de Juiste Plek. *Taskforce report: the right care in the right place*. 2018. Accessed May 13, 2023. https://www.dejuistezorgopdejuisteplek.nl/.uc/fcef77d2b01028d5c0000bd7ca7026baaac90942d76c900/The%20right%20care%20in%20the%20right%20place_report%20taskforce.pdf
14. Elm E, Altman DG, Egger M, et al. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *BMJ*. 2007;335(7624):806-808.
15. Siciliani L, Moran V, Borowitz M. What works? Waiting time policies in the health sector. *Eurohealth*. 2015;21(4):14-17.
16. Bollerslev J, Rejnmark L, Zahn A, et al. European expert consensus on practical management of specific aspects of parathyroid disorders in adults and in pregnancy: recommendations of the ESE educational program of parathyroid disorders. *Eur J Endocrinol*. 2022;186(2):R33-R63.
17. Edge SB, Byrd DR, Carducci MA, Compton CC, Fritz AG, Greene FL. *AJCC Cancer Staging Manual*. Springer; 2010.
18. Haugen BR, Alexander EK, Bible KC, et al. 2015 American Thyroid Association management guidelines for adult patients with thyroid nodules and differentiated thyroid cancer: the American Thyroid Association guidelines task force on thyroid nodules and differentiated thyroid cancer. *Thyroid*. 2016;26(1):1-133.
19. Links T. *Richtlijn voor de diagnostiek, behandeling en follow-up van patiënten met gedifferentieerd (niet-medullair) schildkliercarcinoom [pdf]*. 2015. Accessed May 13, 2023. https://www.nhg.org/sites/default/files/content/nhg_org/uploads/schildkliercarcinoom.pdf
20. Gordon AJ, Dublin JC, Patel E, et al. American Thyroid Association guidelines and national trends in management of papillary thyroid carcinoma. *JAMA Otolaryngol Head Neck Surg*. 2022;148:1156-1163.
21. Graham RMM, Miller Wolman D, Institute of Medicine (US) Committee on Standards for Developing Trustworthy Clinical Practice Guidelines, et al. *Promoting Adoption of Clinical Practice Guidelines*. National Academies Press; 2011.
22. Metman MJH, Lončar I, Kruijff S, Engelsman AF, van Ginhoven TM. Is less always more in a national well-differentiated thyroid cancer population? *Eur J Surg Oncol*. 2020;46(4):709-711.
23. Ministerie van Volksgezondheid, Welzijn en Sport (VWS) en de NederlandseZorgautoriteit (NZa). *Bestuurlijk Akkoord Plan van aanpak ROBIJN*. VWS, NZa; 2017.
24. Birkmeyer JD, Siewers AE, Finlayson EVA, et al. Hospital volume and surgical mortality in the United States. *N Engl J Med*. 2002;346(15):1128-1137.
25. Papaleontiou M, Hughes DT, Guo C, Banerjee M, Haymart MR. Population-based assessment of complications following surgery for thyroid cancer. *J Clin Endocrinol Metab*. 2017;102(7):2543-2551.
26. de Bock E, Herman ES, Bastian OW, Filipe MD, Vriens MR, Richir MC. Systematic review and meta-analysis determining the effect of implemented COVID-19 guidelines on surgical oncology volumes and clinical outcomes. *Surg Oncol*. 2022;45:101859.

27. Basta YL, Bolle S, Fockens P, Tytgat KMAJ. The value of multidisciplinary team meetings for patients with gastrointestinal malignancies: a systematic review. *Ann Surg Oncol*. 2017;24(9):2669-2678.
28. Ung KA, Campbell BA, Duplan D, Ball D, David S. Impact of the lung oncology multidisciplinary team meetings on the management of patients with cancer. *Asia-Pac J Clin Oncol*. 2016;12(2):e298-e304.
29. Specchia ML, Frisicale EM, Carini E, et al. The impact of tumor board on cancer care: evidence from an umbrella review. *BMC Health Serv Res*. 2020;20(1):73.
30. Pillay B, Wootten AC, Crowe H, et al. The impact of multidisciplinary team meetings on patient assessment, management and outcomes in oncology settings: a systematic review of the literature. *Cancer Treat Rev*. 2016;42:56-72.
31. Basse C, Thureau S, Bota S, et al. Multidisciplinary tumor board decision making for postoperative radiotherapy in thymic epithelial tumors: insights from the RYTHMIC prospective cohort. *J Thorac Oncol*. 2017;12(11):1715-1722.
32. Berardi R, Morgese F, Rinaldi S, et al. Benefits and limitations of a multidisciplinary approach in cancer patient management. *Cancer Manag Res*. 2020;12:9363-9374.
33. Shin DW, Cho J, Kim SY, et al. Delay to curative surgery greater than 12 weeks is associated with increased mortality in patients with colorectal and breast cancer but not lung or thyroid cancer. *Ann Surg Oncol*. 2013;20(8):2468-2476.
34. Chaves N, Broekhuis JM, Fligor SC, et al. Delay in surgery and papillary thyroid cancer survival in the United States: a SEER-medicare analysis. *J Clin Endocrinol Metab*. 2023;dgad163.
35. Lončar I, Noltes ME, Dickhoff C, et al. Persistent postthyroidectomy hypoparathyroidism in the Netherlands. *JAMA Otolaryngol Head Neck Surg*. 2021;147(11):959-965.
36. Díez JJ, Anda E, Sastre J, et al. Prevalence and risk factors for hypoparathyroidism following total thyroidectomy in Spain: a multicentric and nation-wide retrospective analysis. *Endocrine*. 2019;66(2):405-415.
37. Annebäck M, Hedberg J, Almquist M, Stålberg P, Norlén O. Risk of permanent hypoparathyroidism after total thyroidectomy for benign disease: a nationwide population-based cohort study from Sweden. *Ann Surg*. 2021;274(6):e1202-e1208.
38. Christou N, Mathonnet M. Complications after total thyroidectomy. *J Visceral Surg*. 2013;150(4):249-256.
39. Ako-Arrey DE, Brouwers MC, Lavis JN, Giacomini MK, Team A-H. Health systems guidance appraisal—a critical interpretive synthesis. *Implement Sci*. 2016;11:9.
40. Mak KS, van Bommel ACM, Stowell C, et al. Defining a standard set of patient-centred outcomes for lung cancer. *Eur Respir J*. 2016;48(3):852-860.
41. Martin NE, Massey L, Stowell C, et al. Defining a standard set of patient-centered outcomes for men with localized prostate cancer. *Eur Urol*. 2015;67(3):460-467.
42. Ong WL, Schouwenburg MG, van Bommel ACM, et al. A standard set of value-based patient-centered outcomes for breast cancer: the International Consortium for Health Outcomes Measurement (ICHOM) Initiative. *JAMA Oncol*. 2017;3(5):677-685.
43. Liu RQ, Wiseman SM. Quality indicators for thyroid cancer surgery: current perspective. *Expert Rev Anticancer Ther*. 2016;16(9):919-928.
44. Cadilhac DA, Lannin NA, Anderson CS, et al. Protocol and pilot data for establishing the Australian Stroke Clinical Registry. *Int J Stroke*. 2010;5(3):217-226.
45. Centers for Disease Control and Prevention (CDC). Use of a registry to improve acute stroke care—seven states, 2005-2009. *MMWR Morb Mortal Wkly Rep*. 2011;60(7):206-210.
46. Kolias AG, Bulters DO, Cowie CJ, et al. Proposal for establishment of the UK Cranial Reconstruction Registry (UKCRR). *Br J Neurosurg*. 2014;28(3):310-314.