



### Editor's key points

► The objective of this study was to provide an overview of the use and possible overuse of diagnostic neck ultrasound (DNUS) against the backdrop of the increasing rate of thyroid cancer detection and the variation in the rates of thyroid cancer across Ontario. This study found a 7.4-fold difference in the rates of ordering DNUS across the sub-Local Health Integration Network regions of Ontario.

► When the authors examined the outcomes of 77 238 DNUS tests, they found both low yield and that the frequency of important events declined with increasing use of initial tests, suggesting that DNUS might be being used for screening or for testing without indication. The increasing rates of a second DNUS within 1 year suggest that repeat imaging also might have variable indications.

# Use and overuse of diagnostic neck ultrasound in Ontario

## Retrospective population-based cohort study

Stephen F. Hall MSc MD FRCSC Rebecca Griffiths

### Abstract

**Objective** To provide an overview of the use and possible overuse of diagnostic neck ultrasound (DNUS) by describing and comparing both the ordering rates and the downstream results of DNUS by regions across Ontario.

**Design** Retrospective population-based cohort study based on electronic health care data.

**Setting** Ontario.

**Participants** Ontario residents (adults aged >18 years) who had a diagnosis of thyroid cancer between October 1, 1999, and June 30, 2014, and residents who had a DNUS in 2012.

**Main outcome measures** Proportion of Ontario residents in each sub-Local Health Integration Network (LHIN) group who had their first DNUS in 2012 and went on to other relevant tests, diagnoses, and surgery. The sub-LHIN groups were based on increasing age- and sex-adjusted rates of first DNUS.

**Results** There were 77 238 DNUS tests in 2012 and there was a 7.4-fold variation in the rate of test ordering across the sub-LHIN populations leading to variable rates of actual disease, suggesting screening or uncertain indications for tests.

**Conclusion** Across Ontario, the indications for ordering DNUS are variable, and screening or testing without indication might be a common practice. Establishing effective guidelines for the ordering of DNUS would potentially reduce costs and ultimately reduce the rates of thyroid cancer.



# Utilisation et surutilisation de l'échographie diagnostique du cou en Ontario

## Étude rétrospective de cohortes dans la population

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### Résumé

**Objectif** Donner un aperçu de l'utilisation et de la possible surutilisation de l'échographie diagnostique du cou (EDC) en décrivant et en comparant à la fois les taux de prescription et les résultats en aval des EDC selon les régions, en Ontario.

**Type d'étude** Étude rétrospective de cohortes dans la population, fondée sur les données des dossiers médicaux électroniques.

**Contexte** Ontario.

**Participants** Les résidents de l'Ontario (adultes âgés de > 18 ans) qui ont reçu un diagnostic de cancer de la thyroïde entre le 1<sup>er</sup> octobre 1999 et le 30 juin 2014, et les résidents qui ont subi une EDC en 2012.

**Principaux paramètres à l'étude** La proportion de résidents de l'Ontario dans chaque sous-groupe des Réseaux locaux d'intégration des services de santé (RLISS) qui ont eu leur première EDC en 2012, et qui ont poursuivi avec d'autres tests, diagnostics et interventions chirurgicales pertinents. Les sous-groupes des RLISS étaient fondés sur des taux rajustés selon l'âge plus avancé et le sexe lors de la première EDC.

**Résultats** Quelque 77238 examens par EDC ont été effectués en 2012, et il y avait une disparité de l'ordre de 7,4 dans le taux de prescription de tests dans les diverses sous-populations des RLISS, ce qui a entraîné des taux variables de la maladie confirmée et qui porte à croire que ces examens servaient à un dépistage ou à des indications incertaines.

**Conclusion** Dans les diverses régions de l'Ontario, les indications justifiant la prescription d'une EDC sont variables, et le dépistage ou les tests sans indications valables pourraient être une pratique courante. L'élaboration de lignes directrices efficaces s'appliquant à la prescription d'une EDC pourrait potentiellement réduire les coûts et, en définitive, réduire les taux de cancer de la thyroïde.

### Points de repère du rédacteur

► Cette étude avait pour but de donner un aperçu de l'utilisation et de la possible surutilisation de l'échographie diagnostique du cou (EDC) dans le contexte de la hausse du taux de dépistage du cancer de la thyroïde et de la variation des taux de cancers thyroïdiens dans les différentes régions de l'Ontario. L'étude a fait valoir une disparité de l'ordre de 7,4 dans les taux de prescription de l'EDC dans les divers sous-groupes des Réseaux locaux d'intégration des services de santé de l'Ontario.

► Lorsque les auteurs ont examiné les issues des 77238 examens par EDC, ils ont trouvé à la fois un faible rendement, de même que le déclin de la fréquence des événements importants avec le recours accru de l'utilisation des tests initiaux, ce qui porte à croire que les EDC pourraient être utilisés pour un dépistage ou des examens en l'absence d'indications. Les taux accrus d'une deuxième EDC durant la même année suggèrent aussi que l'imagerie répétée pourrait aussi avoir des indications variables.

The *overuse of medical tests* is the ordering of tests that are unnecessary or inappropriate, and represents poor use of resources. Berwick and Hackbarth<sup>1</sup> estimated that 6% to 8% of annual health care expenses in the United States (the equivalent at least \$270 billion) could have been defined as *overuse* in 2013. Research on the overuse of medical tests in inpatient and outpatient medical practice<sup>2-5</sup> has led to the development of campaigns and coalitions such as Choosing Wisely,<sup>6,7</sup> the Right Care Alliance,<sup>8,9</sup> and Wiser Healthcare.<sup>10</sup> Owing to many factors, including the over-reporting of poor evidence by various media, many physicians and members of the public believe that more tests are better, as they might uncover treatable disease,<sup>11,12</sup> and in clinical practice, physicians order routine tests for a variety of reasons.<sup>13</sup>

The diagnosis of thyroid cancer is increasing at epidemic rates throughout Canada,<sup>14-16</sup> the United States,<sup>17</sup> and the world.<sup>18,19</sup> It is now agreed that the increasing “incidence” is actually the increasing detection<sup>19-22</sup> of smaller cancers owing to the increasing use and sophistication of diagnostic neck ultrasound (DNUS), as there is no evidence of increased incidence of thyroid cancer or changes in causation.<sup>19</sup> Although there are indications for DNUS, rates of use vary widely.<sup>15,21</sup>

The objective of this study was to provide an overview of the use and possible overuse of DNUS by describing and comparing both the ordering rates of DNUS and the downstream results of DNUS by regions across Ontario. The universal health care and electronic data holdings at ICES, which include all health care encounters for the population of Ontario, provided the opportunity to perform this audit and feedback study.

## — Methods —

### Data set creation

The electronic data holdings of ICES include all health care-related events for the complete population of insured Ontario residents linked using anonymous unique identifiers. Linkages include all hospital encounters and all physician billing data for treatments, investigations, and procedures thus creating the clinical story for each anonymized patient.

### Setting

The population of the province of Ontario is approximately 14 million. For the funding and provision of health care, Ontario is divided into 14 regions (Local Health Integration Networks [LHINs]); however, as the LHINs vary in size, geography, rurality, and ethnicity of the population, they are subdivided into 97 sub-LHINs to improve homogeneity for analysis.

### Data sources

We used several data sources for this study:

- The Ontario Cancer Registry (OCR) is a population-based cancer registry that includes all incident cases

of cancer, patient demographic characteristics, and dates of diagnoses.

- The Ontario Health Insurance Plan (OHIP) database contains data on all fee-for-service claims submitted by and paid to physicians, including office visits, consultations, laboratory tests, imaging tests, and biopsies. The data include the dates of all encounters, the referring physician, and the physician type or specialty.
- The Registered Person's Database provides demographic information on all residents of Ontario who are eligible for OHIP.
- The Canadian Institute for Health Information includes the Discharge Abstract Database, with information on all hospital discharges, and the National Ambulatory Care Reporting System data set of outpatient hospital visits.

We used version 9 of the sub-LHIN boundaries (Ontario Ministry of Health and Long-Term Care, 2010) for this project.

### Overview and study populations

Based on diagnostic codes in the OHIP fee schedule for DNUS (J105, J405), we identified all patients in Ontario older than 18 years of age who had their first DNUS in 2012. We excluded patients who had had a previous DNUS (within 2 years) or a previous diagnosis (within 10 years) of thyroid cancer, head and neck cancer, or leukemia or lymphoma. We were interested in the use of DNUS as a screening test, so we included only tests ordered by family doctors, emergency department physicians, and geriatricians.

The yearly incidence of thyroid cancer was based on all patients older than age 18 with a diagnosis of thyroid cancer (ICD code 193) in the OCR between October 1, 1999, and June 30, 2014, who had initial therapeutic thyroid surgery (hemithyroidectomy, subtotal thyroidectomy, or total thyroidectomy) based on Canadian Institute for Health Information codes between January 1, 2000, and December 31, 2013 (N=26311). All patients were included regardless of histology findings.

### Outcomes

The outcomes were the downstream tests and diagnoses after the first DNUS in 2012 and included 1 or more events within 1 year (a second DNUS, another imaging test [computed tomography of neck, magnetic resonance imaging of neck, barium swallow, computed tomography of chest], any neck surgery for common benign [eg, branchial cleft cyst] or malignant neck disease [eg, neck dissection]) or the diagnosis of other cancers that present as neck masses, including head and neck cancers, lymphoma, and lung cancer within 2 years. A diagnosis of thyroid cancer was based on the ICD code 193 in the OCR and included only those who had initial therapeutic thyroid surgery (hemithyroidectomy, subtotal thyroidectomy, or total thyroidectomy) (CCP codes 19.1, 19.2, 19.21, 19.29; CCI codes 1FU87,

1FU89). Rates of downstream events are reported as the proportion of those who had the initial DNUS in each sub-LHIN group and are not adjusted for age or sex.

### Analysis

The 97 sub-LHINs of Ontario were divided into 5 evenly spaced groups (fixed bins) based on the range of the increasing age- and sex-standardized rates (age >18 years) of DNUS in 2012, with the denominator of the population of each sub-LHIN in 2012 according to the Registered Persons Database. The Cochran-Armitage trend test was used to assess linear trend in outcome proportions across increasing exposure categories.

### Ethics

Ethics approval was granted by the ethics review boards of Queen's University in Kingston, Ont, and Sunnybrook Hospital in Toronto, Ont.

## — Results —

There were 115 660 DNUS tests in 2012; 37 443 residents who had had a previous DNUS and 979 who had a previous diagnosis of thyroid, head and neck cancer, or hematologic cancer were excluded—leaving a total of 77 238 DNUS tests.

The overall rate of DNUS across the province was 1900.70 per 100 000 people. The rates of DNUS for the 5 sub-LHIN groups in increasing order were 1049.44,

1394.07, 2189.12, 2776.82, and 3512.84 per 100 000 people. The rates across all 97 sub-LHINs ranged from 505.90 to 3715.47 per 100 000 people, representing a 7.4-fold difference across Ontario (Figure 1).

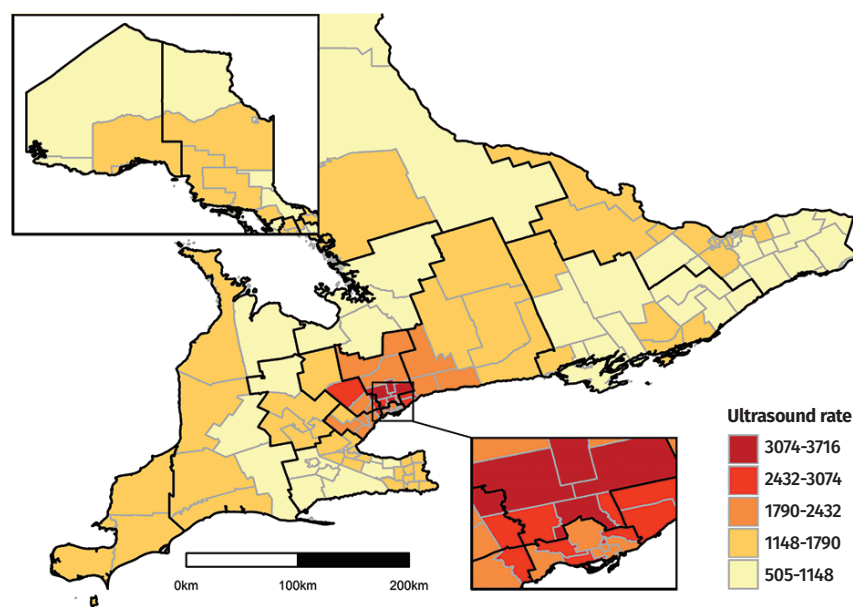
The downstream events (second ultrasound, fine-needle aspiration, other imaging test, neck surgery within 1 year, and new cancer diagnosis within 2 years) overall and the proportion of those who had had the initial DNUS in 2012 (sub-LHIN groups) are presented in Table 1. The rates of subsequent tests (that might suggest a reported abnormality on the initial DNUS) such as needle biopsy or other relevant imaging declined with increasing use of the initial DNUS. The rates of thyroid or neck surgery declined with increasing use of DNUS. Overall, 24.36% of patients had a second DNUS, but paradoxically the rates of a second DNUS increased with increasing rates of the initial DNUS. The true incidence of thyroid cancer in the general population is not known, and interestingly the rates of thyroid cancer initially rose with increasing tests and then declined, suggesting a threshold or saturation effect. The rates of other malignancy declined with increasing use of DNUS.

Figure 2 presents the 180% increase in thyroid cancer diagnosis by year across Ontario.

## — Discussion —

The objective of this study was to provide an overview of the use and possible overuse of DNUS against the

Figure 1. The proportion of a first DNUS in 2012, by sub-LHIN groups



DNUS—diagnostic neck ultrasound, LHIN—Local Health Integration Network.

**Table 1. Downstream events: The proportion of the Ontario patients in each sub-LHIN group who had their first DNUS in 2012 who went on to other relevant tests, diagnoses, and surgery. The sub-LHIN groups are based on increasing age- and sex-adjusted rates of first neck ultrasound in adults.**

EVENT	OVERALL RATE, %	SUB-LHIN GROUP 1 (LOWEST DNUS RATE), %	SUB-LHIN GROUP 2, %	SUB-LHIN GROUP 3, %	SUB-LHIN GROUP 4, %	SUB-LHIN GROUP 5 (HIGHEST DNUS RATE), %	P VALUE*
Needle biopsy (FNAB)	14.06	16.02	14.51	14.16	12.98	13.09	<.001
Another imaging test	9.10	12.51	12.01	8.09	6.98	5.66	<.001
Thyroid surgery	3.04	3.18	3.35	3.06	2.78	2.64	<.001
Other neck surgery	2.97	4.24	3.72	2.72	2.33	1.93	<.001
Any neck surgery	6.01	7.42	7.07	5.78	5.11	4.57	NA†
Second DNUS	24.36	23.36	23.91	24.77	24.17	25.50	.001
Thyroid cancer	1.87	1.83	1.86	2.06	1.77	1.68	.3028
Another neck cancer	0.83	1.19	1.27	0.68	0.55	0.37	<.001
Any neck cancer	2.70	3.02	3.13	2.74	2.32	2.05	NA†

DNUS—diagnostic neck ultrasound, FNAB—fine-needle aspiration biopsy, LHIN—Local Health Integration Network, NA—not available.

\*The Cochran-Armitage trend test was used.

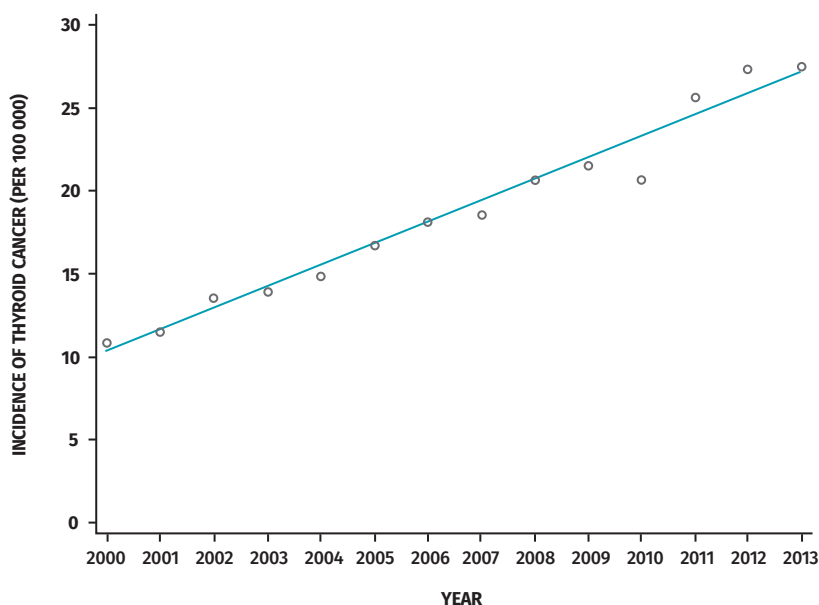
†The trend test was not performed, as results were sums of other values.

backdrop of the increasing rate of thyroid cancer detection and the variation in the rates of thyroid cancer across Ontario.<sup>15</sup> We found a 7.4-fold difference in the rates of ordering DNUS across the sub-LHIN regions, consistent with previous Ontario reports on both DNUS and the geographic differences in rates of thyroid cancer diagnosis.<sup>15,23</sup> When we examined the outcomes of 77238 tests, we found both low yield and that the frequency of important events declined with increasing use of initial tests, suggesting that DNUS might be being used for screening or for testing without indication. The increasing rates of a second DNUS within 1 year suggest that repeat imaging also might have variable indications.

*Overdiagnosis* occurs “when a condition is diagnosed that would otherwise not go on to cause symptoms or death,”<sup>24</sup> and typically refers to the detection of subclinical diseases or conditions by tests that were not indicated.<sup>15,19</sup> The importance of these results is the waste of resources—not only the imaging test but also the subsequent cascade of tests, consultations, surgery, and follow-up when it is clear that most patients were not going to need treatment, as they would never have been diagnosed. There is no evidence that the actual prevalence of thyroid cancer has increased and there is no new pathogenesis or cause.<sup>19</sup> The increased rates of new cases are the result of detection by DNUS of what were previously undetected cases. There is ample evidence from sources such as autopsy studies,<sup>25</sup> incidence versus

mortality curves,<sup>24,26</sup> population-based studies,<sup>27,28</sup> and observational trials<sup>29-31</sup> that a large proportion of thyroid cancer cases behave in a benign way, would never have appeared, and would never have needed treatment. Differentiated thyroid cancer has a 98% 15-year survival<sup>28-32</sup> even after treatment delay.<sup>27,31</sup>

The American Association of Clinical Endocrinologists, American College of Endocrinology, and Associazione Medici Endocrinologi have suggested guidelines for the investigation of thyroid disease: “ultrasound evaluation is recommended for patients who are at risk for thyroid malignancy ... have palpable thyroid nodules or goiter, or have neck lymphadenopathy suggestive of a malignant lesion.”<sup>33</sup> Choosing Wisely Canada, and more specifically the second of 5 recommendations from the Canadian Society of Endocrinology and Metabolism, states, “Don’t routinely order a thyroid ultrasound in patients with abnormal thyroid function tests unless there is a palpable abnormality of the thyroid gland.”<sup>34</sup> For the investigation of a patient with other suspect benign, malignant, or infectious diseases with no previous neck disease, there are at least 6 clinical indications for DNUS (a palpable neck mass, a visible neck mass or asymmetry, the sensation of swelling in the neck, unexplained pain in the anterior or lateral neck, abnormal parathyroid hormone levels, and further investigation of an incidental thyroid abnormality on other imaging). It is unlikely that rates of these indications would vary

**Figure 2.** Increasing incidence of thyroid cancer diagnosis in Ontario, by year

7 times across the sub-LHINS of Ontario, suggesting indistinct indications for DNUS, screening, testing without indications, and test overuse.

The definition of *overuse* by Chassin et al<sup>35</sup> is “the provision of medical services for which the potential for harm exceeds the potential for benefit,” and overuse is particularly relevant in thyroid cancer, in which the rates of complications of treatment exceed the rates of disease-specific mortality.<sup>20,27,32,36,37</sup> Our data suggest that the use of DNUS without clinical indication or as a screening test might be at least partially responsible for the 180% increase in the rate of diagnosis of thyroid cancer from 2000 to 2012 in Ontario.

In our recently published study on medical test variations, we used an entirely different methodology.<sup>38</sup> We divided 6849 Ontario physicians based on their OHIP billing codes for 23 routine laboratory and imaging tests for their 4.9 million patients over 5 years into higher testers (26%), typical testers (41%), and lower testers (33%). We found that the higher testers ordered 80% more imaging tests than typical testers did and, not surprisingly, diagnosed more thyroid (and prostate) cancers than the typical and lower testers did. The lower testers diagnosed fewer thyroid cancers. We also found wide variation in the rates of ordering the 23 common tests.

“A cautionary tale for the rest of the world” about screening has been presented by Ahn et al<sup>18</sup> based on the experience of South Korea. In 1999 South Korea introduced optional routine DNUS screening for thyroid cancer. After 1999, the very slow gradual increase in thyroid cancer cases abruptly changed; the incidence

of thyroid cancer increased 15 times between 1993 and 2011, and thyroid cancer became the most commonly diagnosed cancer in South Korea (in Canada, thyroid cancer is the fifth leading cancer in women behind breast, lung, colon, and uterine cancer<sup>39</sup>). Park et al of the Korean National Cancer Control Institute recommends that “concerted efforts are needed at [a] national level to reduce unnecessary ultrasound examination of the thyroid in the asymptomatic general population, unless clinically indicated.”<sup>40</sup>

### Strengths and limitations

The study design and the complete data set are the strengths of this study. There are 3 potential limitations. In the ideal study, the indications for the test would be included in the analysis but this is not available in the OHIP data set. The second limitation is that we cannot differentiate between thyroid and general neck ultrasound requests, as the OHIP fee code is the same for both. The third limitation is that we cannot assess the effect of access, as we had no data on the density of ultrasound equipment or clinics in Ontario.

There are 2 studies on the appropriateness of thyroid ultrasound and 1 on the appropriateness of general DNUS. Liel and Fraenkel<sup>41</sup> reported that 93% of thyroid ultrasounds were inappropriately ordered based on 208 new patient referrals in an endocrinology clinic. Landry et al<sup>42</sup> reported in a Canadian study that 18.8% of thyroid ultrasounds were inappropriately ordered based on a review of 620 ultrasound requests by GPs. Russell and Madani<sup>43</sup> reviewed 68 neck ultrasound requests at

a single diagnostic facility; they found 16% were inappropriate based on the iRefer guidelines and suggested reducing access to DNUS as a potential solution.

Falchouk et al<sup>44</sup> provided a useful example of the inappropriate use of bone scans in prostate cancer patients. They reported that 21% of patients at low risk and 48% of patients at moderate risk of bone metastases underwent at least 1 scan despite recommendations against screening in these groups. They calculated the estimated cost of the overuse to be more than \$11 million (US) per year. In Ontario, if one-third of the DNUS examinations in 2012 were not performed, the savings would have been almost \$2 million for those 25 746 tests alone,<sup>45</sup> not including the subsequent tests, investigations, treatments, follow-up, and complications of potentially unnecessary treatments.

## Conclusion

Across Ontario, the indications for ordering DNUS are variable and screening or testing without indication might be a common practice. Establishing effective guidelines for the ordering of DNUS would potentially reduce costs and ultimately reduce the rates of thyroid cancer.

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### Contributors

**Dr Hall** designed the study, is responsible for all aspects of data analysis and interpretation, and wrote the manuscript. **Ms Griffiths** performed the data acquisition, performed the analysis, provided critical revisions to the manuscript, and approved the final manuscript.

### Competing interests

None declared

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