



## Completeness of ultrasound reporting impacts time to biopsy for benign and malignant thyroid nodules



Alexandra Inman, MD <sup>a</sup>, Kaidi Liu, BKin <sup>b</sup>, Kaye Ong, MSc <sup>b</sup>, Pari Tiwari, MD <sup>c</sup>,  
Patrick Vos, MD <sup>c</sup>, Adam White, MD <sup>a</sup>, Sam M. Wiseman, MD, FRCSC <sup>b,\*</sup>

<sup>a</sup> Department of Medicine, Division of Endocrinology, St. Paul's Hospital & University of British Columbia, Vancouver, BC, Canada

<sup>b</sup> Department of Surgery, St. Paul's Hospital & University of British Columbia, Vancouver, BC, Canada

<sup>c</sup> Department of Radiology, St. Paul's Hospital & University of British Columbia, Vancouver, BC, Canada

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### ABSTRACT

**Background:** The objective was to evaluate reporting of guideline-recommended elements for thyroid ultrasound (US), and to determine whether element reporting was associated with the time to cytological and/or surgical diagnosis.

**Methods:** US reports of adults who underwent thyroid surgery for benign (n = 106) or malignant (n = 105) thyroid nodules between 2009 and 2014 were retrospectively reviewed for inclusion of 11 elements. **Results:** On average 5.1 elements of 11 (46.4%) were included in US reports of all nodules. The setting of the US (academic versus community center) also influenced the number of elements reported (6.3 in academic versus 4.9 in community, p < 0.001). A higher number of reported elements were significantly associated with fewer days between US and FNAB, FNAB and OR, and US and OR (p < 0.001, p = 0.007, and p < 0.001, respectively).

**Conclusions:** Under-reporting of guideline-recommended US elements is associated with delayed cytological diagnosis and surgical treatment of thyroid nodules.

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## 1. Introduction

Thyroid nodules are a common clinical presentation, and 7–15% of these nodules are malignant.<sup>1</sup> Description of thyroid nodule ultrasound (US) characteristics is important as it influences decision-making with regards to performance of fine needle aspiration biopsy (FNAB) and follow up. The thyroid US report is a critically important tool for communication of nodule characteristics between the ultrasonographer and treating physician. Several Thyroid Imaging Reporting and Data Systems (TIRADS) have been developed in order to predict the probability of malignancy based upon specific thyroid nodule US characteristics.<sup>2–4</sup> US features associated with a thyroid malignancy include the presence of: a solid component, hypoechoogenicity, microcalcifications, increased

vascularity, lobulated or irregular margins, infiltrative margins, and taller-than-wide shape on transverse view.<sup>1</sup> US features reported to have the highest specificities (median >90%) for a thyroid cancer diagnosis are microcalcifications, irregular margins, and taller-than-wide shape.<sup>1</sup> The American Thyroid Association, American College of Radiology, the American Institute of Ultrasound in Medicine, the Society for Pediatric Radiology, the Society of Radiologists in Ultrasound, and the Thyroid Head and Neck Cancer Foundation have all outlined the specific elements that should be included in thyroid US reports.<sup>1,5,6</sup> The essential elements that should be reported include: the location, size (measured in three dimensions), number, echogenicity, composition, margins, shape (taller than wide), presence and type of calcifications, localized or diffuse nature of any abnormality, vascularity, and the presence and size of any abnormal lymph nodes in the central or lateral neck compartments.<sup>1,5</sup> If present, lymph node size, presence of calcification, cystic areas, absence of central hilum, shape, and abnormal blood flow should also be documented.<sup>5</sup> The location of abnormal lymph nodes should also be described using an image-based nodal classification system.<sup>5,7</sup>

No studies have specifically evaluated the frequency of reporting

\* Corresponding author. Present address: Room C303, Burrard Building, 1081 Burrard Street, Vancouver, BC, V6Z 1Y6, Canada.

E-mail addresses: [alexandra.inman@medportal.ca](mailto:alexandra.inman@medportal.ca) (A. Inman), [kliu@providencehealth.bc.ca](mailto:kliu@providencehealth.bc.ca) (K. Liu), [ong.kaye@gmail.com](mailto:ong.kaye@gmail.com) (K. Ong), [ptiwari414@gmail.com](mailto:ptiwari414@gmail.com) (P. Tiwari), [pmvos@hotmail.com](mailto:pmvos@hotmail.com) (P. Vos), [aswhite@mail.ubc.ca](mailto:aswhite@mail.ubc.ca) (A. White), [smwiseman@providencehealth.bc.ca](mailto:smwiseman@providencehealth.bc.ca) (S.M. Wiseman).

of guideline-recommended elements for thyroid US, and how this reporting may impact patient care. Our study objectives were to evaluate the completeness of thyroid US guideline-recommended element reporting, and to determine if thyroid US element reporting influenced the time to FNAB and/or operation (OR).

## 2. Material and methods

Adult patients (age  $\geq 18$  years) who underwent a thyroid OR with a final pathological diagnosis of differentiated thyroid cancer (DTC) (papillary carcinoma or follicular carcinoma,  $n = 105$ ) between January 1, 2009 and June 9, 2014 at St. Paul's Hospital in Vancouver, British Columbia, Canada were identified from a prospectively maintained database of thyroid ORs carried out at this center. A similar number of randomly selected cases that underwent thyroid surgery at the same site, during the same time period, for benign thyroid disease ( $n = 106$ ) were also reviewed. Patients were excluded if they had undergone a prior thyroid FNAB or OR, if the indication for OR was not for nodular thyroid disease, if initial biopsy was of a lymph node, or if US or biopsy details were not available. Patient age, gender, pathological diagnosis, and MACIS score (for cancer cases) were collected. The patient's initial thyroid US report, or pre-biopsy diagnostic US, was examined for inclusion of each of the following essential elements: size (largest diameter and three dimension measurements), location, composition, echogenicity, calcification, vascularity, margins, shape (taller than wide versus wider than tall), halo, and lymphadenopathy. Each element was evaluated as being either reported or not reported. Information from the US report was categorized based upon pre-specified criteria, and reviewed independently by two authors who were blinded to each other's interpretation (AI and KO). If a discrepancy existed in determination of the presence of a specific element, or which category a nodule fell within for each element, the US report was again reviewed by both investigators. After this second review, if a disagreement persisted, then a third reviewer (SW) served as the tie-breaker. For patients with multiple nodules, the reported characteristics of the biopsied nodule were evaluated. If two nodules were biopsied in the same patient, these nodules were considered separately. The setting of the US was also noted (academic center versus community center). An academic center was considered one of the two primary teaching hospitals in Vancouver, British Columbia, and community centers were all other hospitals or facilities where diagnostic thyroid US was performed and reported. The time interval between the first thyroid US and the initial FNAB, and between the first thyroid US and thyroid OR, was determined when the initial US report was available. Conduct of this study was approved by the University of British Columbia and Providence Health Care Research Ethics Boards.

Descriptive statistics were carried out summarizing the proportion of each reportable element as percentages. The reporting frequency of specific elements was compared between benign and malignant nodules using Pearson's chi-square analysis where a  $p$ -value  $< 0.05$  was considered statistically significant. Associations between the number of reported elements and: time between initial US and FNAB, FNAB and OR, and initial US and OR, were tested for all subjects, as well as subjects with benign and malignant nodules separately. Days to biopsy and days to OR for individuals undergoing their initial US in an academic center versus a community center setting were also tested for all subjects. Association tests were linear regression in  $R^2$ , with an adjusted  $R^2$  value to account for the variation explained by only those independent variables that affected the dependent variables.

**Table 1**  
Study population characteristics.

Characteristics	All ( $n = 211$ )	Benign ( $n = 106$ )	Malignant ( $n = 105$ )
Average Age (years)	47.8	49.9	45.7
Gender (% female)	75.4	76.4	74.3
Average nodule size (cm) <sup>a</sup>	3.08	3.55	2.58

<sup>a</sup> Nodule size is largest average diameter.

## 3. Results

One hundred and six individuals with benign disease had 111 nodules included in the benign study group. One hundred and six patients with malignant disease had 108 nodules included in the cancer study group. The average age of the entire study population was 47.8 years (range 19–87 years) (Table 1). In the study population 75% of subjects were female, and a similar proportion of males and females had malignant nodules. Amongst cancer cases, 92.6% were papillary carcinoma, and 7.4% were follicular carcinoma. The average MACIS score for the thyroid cancer patients was 4.78. There were 66 patients who were low risk (MACIS  $< 6$ ), 9 patients who were moderate risk (MACIS 6–7), and 2 patients who were high risk (MACIS  $> 7$ ). On average, 5.1/11 (46.4%) of essential elements were included in the US reports of the study population. The average number of elements included in US reports of benign nodules was 4.9/11 (44.5%), significantly less than the average number of elements reported for cancers, 5.4/11 (49.1%) ( $p = 0.012$ ). Of the 11 US elements evaluated, composition was more frequently reported for benign nodules ( $p = 0.025$ ), and echogenicity and calcification were frequently reported for malignant nodules ( $p = 0.003$  and  $p < 0.001$ , respectively) (Figure 1). US reports from academic centers included a higher number of reported elements on average when compared to community centers (6.3/11 (57.2%) versus 4.9/11 (44.5%) elements respectively,  $p < 0.001$ ). The proportion of benign thyroid lesions and cancers that included each of the elements in their US reports are summarized in Table 2.

For cases where the first thyroid US report was available ( $n = 193$  subjects with 201 nodules), the average time from initial US to FNAB was 62.0 days. The time from first thyroid US to FNAB was not significantly different for benign nodules ( $n = 106$ ; 65.0 days) compared to malignant nodules ( $n = 95$ ; 58.6 days) ( $p = 0.230$ ). The time from initial US to FNAB was significantly shorter for academic versus community centers (36.8 days versus 66.1 days,  $p < 0.001$ ). The average time between FNAB and OR was 236.5 days. The average time from FNAB to OR was significantly shorter for malignant nodules (346.3 days for benign nodules versus 114.0 days for cancers,  $p < 0.001$ ). There was no significant difference between academic and community centers for time from FNAB to OR (216.6 days versus 239.8 days,  $p = 0.330$ ). The average time from initial US to OR for the entire study population was 298.5 days. The average time from initial US to OR was significantly shorter for malignant nodules (411.3 days for benign nodules compared to 172.6 days for cancers,  $p < 0.001$ ). There was no significant difference between academic and community centers for time from initial US to operation (253.4 days versus 305.8 days,  $p = 0.160$ ). A higher number of reported elements was significantly associated with fewer days between initial US and FNAB ( $p < 0.001$ ), FNAB and OR ( $p = 0.007$ ), and initial US and OR ( $p < 0.001$ ) (Figure 2).

## 4. Discussion

Guideline-recommended essential thyroid US elements were

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