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The Diagnostic Yield of Thyroid Function Tests and their Cost-effectiveness in the Student Clinic at Sultan Qaboos University

Retrospective chart review

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الأهمية التشخيصية لإجراء فحص الغدة الدرقية المخبري في عيادة الطلبة بجامعة السلطان قابوس وجدواها من ناحية الفعالية والكلفة

مراجعة منحنيات استعادية

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الملخص: **الهدف:** معرفة مدى أهمية فحص الغدة الدرقية المخبري وجدواه من ناحية الكلفة والفعالية للأعراض المحددة وغير المحددة لأمراض الغدة الدرقية لطلبة الجامعة **الطريقة:** دراسة استعادية للملفات أجريت في عيادة الطلبة بجامعة السلطان قابوس في عمان شملت كل المرضى (319 مريضا) من الجنسين أجري لهم الفحص المذكور لعامي 2008–2007 وتم تجميع كافة البيانات المتعلقة بفحص الغدة الدرقية المخبري من نتائج وأعراض وتشخيص نهائي من ملفات المرضى. **النتائج:** لوحظ أن أكثر الأعراض شيوعا والتي كانت سببا لطلب الفحص هي عدم انتظام الدورة الشهرية (82 مريضا)، الإعياء(49 مريضا)، الخفقان (39 مريضا) وتغير الوزن (22 مريضا) وتغير الشعر (20 مريضا) والشعور بالحرارة والبرودة (18 مريضا) والإسهال والإمساك (13 مريضا) وتورم الرقبة (13 مريضا). وقد شخص معظم المرضى بمتلازمة تكيس المبايض (51 مريضا) وفقر الدم (42 مريضا). ووجد 11 مريضا يعانون من الاكتئاب والقلق، بينما لم يسجل تشخيص محدد لإجمالي 193 مريضا. أما الذين شخصوا بأمراض الغدة الدرقية (قصور الدرقية أو فرط إفراز الدرق السريري ودون السريري وأورام الغدة) فبلغ عددهم 22 مريضا فقط، تشكل نسبة الاناث 7.1% مقارنة ب 2.1% من الذكور وهي ذات دلالة إحصائية معتدة ($P<0.05$). شكلت أمراض الغدة الدرقية 61.5% من الذين عانوا من ورم الرقبة، 7.7% من الذين عانوا من الخفقان، 4.1% من الذين عانوا من الإعياء و 1.2% من المريضات اللواتي عانين من عدم انتظام الدورة. كانت كلفة الفحوصات 20 دولارا أمريكيا. **الخلاصة:** من الضروري إجراء فحص الغدة الدرقية المخبري للمرضى الذين يعانون من أورام الرقبة، وتأجيل إجرائه للمرضى الذين يعانون من الخفقان والإعياء المستمر مؤقتا لحين التأكد من خلوهم من فقر الدم،، وعدم إجرائه للمريضات اللواتي يعانين من عدم انتظام الدورة فقط دون وجود أية أعراض أخرى لعدم وجود علاقة بين ذلك الاضطراب وفحص الدرقية المخبري.

مفتاح الكلمات: فحوصات وظيفة الغدة الدرقية، مرض الدرقية ، الكلفة والفعالية ، عمان.

ABSTRACT: ***Objectives:*** To assess the significance of requesting thyroid function tests (TFT) and their cost effectiveness for specific and non-specific symptoms of thyroid disease in a specific population in Oman. ***Methods:*** A retrospective chart review study was conducted in the student clinic at Sultan Qaboos University in Oman in the year 2007–2008. It included all patients (N = 319) of both sexes for whom TFTs were requested. The patients' main complaints and the final diagnoses were collected from their medical records. ***Results:*** The most common presentations for which TFTs were requested were irregular periods (n = 82); fatiguability (n = 49), palpitations (n = 39); weight changes (n = 22); hair changes (n= 20); sensation of heat and cold (n= 18); diarrhoea and constipation (n = 13), and neck swelling (n = 13).The most common diagnoses reached in relation to these complaints were polycystic ovarian syndrome (n = 51); iron deficiency anaemia (n = 42); anxiety and depression (n = 11); thyroid disease (n = 18), and no specific diagnosis (n = 193). The percentage of thyroid diseases among females (7.1%) compared to males (1.2%) was statistically significant (P <0.05). Thyroid disease accounted for 61.5% of those patient with neck swelling, 7.7% of those with palpitations, 4.1% of those with fatigue, 3% of those with other complaints, and 1.2% of those with irregular periods. The cost of the tests was around 20,000 US dollars. ***Conclusion:*** TFT is necessary for those presenting with neck swelling, but restraint should be used in administering the test for those complaining of palpitations or fatigue. Additionally, irregular periods have little link with TFT abnormality.

Keywords: Thyroid function tests; Retrospective study; Cost-effective; Student clinic; Oman.

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Advances in Knowledge

1. *Some thyroid function tests administered in the Student Clinic at Sultan Qaboos University for both specific and non-specific symptoms of thyroid diseases were unnecessary.*
2. *Most of the symptoms for which these tests were requested proved to be either due to anaemia, or menstrual irregularities.*

application to patient care

1. *Thyroid function tests should be requested at the Student Clinic for students who have an enlarged thyroid gland with or without associated thyroid symptoms.*
2. *It is advisable to exclude anaemia for students who present with fatiguability before requesting this test.*
3. *It is not advisable to administer this test to students who present with irregular periods because dysfunctional uterine bleeding and polycystic ovarian disease are common in this age group.*

Thyroid diseases are common, non-specific, clinical consequences of many medical, neurological and psychiatric conditions and tend to affect women disproportionately. Disorders of the thyroid gland include clinical and subclinical hyperthyroidism, hypothyroidism, goiter and thyroid cancer.[1] Thyroid dysfunction can be diagnosed accurately and is amenable to treatment. Due to the wide range of specific and non-specific symptoms of thyroid diseases, thyroid function tests (TFT) are among the most frequently prescribed laboratory procedures.[2] Because of their relative low cost and widespread availability, TFT are often considered to be a standard work-up procedure.[3] Recently, there has been much criticism of this trend since such screening may not be as reliable as clinical impression. In some professionals' opinion, TFT procedures are seldom essential as a first-level measurement.[4,5] Since the results from clinical laboratories help clinicians to determine diagnoses and monitor responses to therapy, inappropriate use of laboratory tests can lead to poor case management, unnecessary increases in the cost of patient management, and may even result in adverse medical outcomes.[6] The skyrocketing costs incurred by wide usage of TFT is an additional consequence which is often overlooked. Beckett and Toft have reported that in the UK there were approximately 10 million requests for TFT each year, the cost of which has been estimated at £30 million (c. 16 million OR).[7] A number of guidelines have emerged suggesting more prudent ordering of TFT.[8]

To our knowledge, no such studies have been performed on the pattern of routine assessment of thyroid function in the Arab/Islamic part of the world. In order to fill this gap in the literature, this paper aims to examine the pattern of thyroid function test requests for specific and non-specific symptoms at the Student Clinic at Sultan Qaboos University (SQU) in the Sultanate of Oman. Oman, is an Arab/Islamic country situated in the southeastern corner of the Arabian Peninsula, which has experienced a dramatic development of its health care infrastructure in the past few decades. Postnatal coverage in Oman is the highest among Arab nations.[9] In recent estimates, malnutrition and infectious diseases appear to be on the wane as many eradication and immunisation programs are being implemented throughout the country. There have been no studies in Oman to investigate the prevalence of thyroid diseases, but it has been indicated that the prevalence may be inflated due to the cultural practice of consanguineous marriages.[10,11] Anecdotal evidence suggests that rather than relying on clinical impression clinicians tend to employ TFT routinely as an integral part of the work-up procedure. In our experience at the SQU Student Clinic, thyroid function tests are frequently requested for a wide range of complaints including palpitations, irregular periods, fatiguability and non-specific symptoms such as chest pain and headache. There have been no studies on the pattern of routine assessment of thyroid functions. One of the implicit benefits of such studies is to audit the quality of services and to enhance good medical practice in the country. Given this background, the present study aims to investigate the factors that contribute to requesting the use of TFT among university students in Oman, the utility of the test and its cost effectiveness.

Methods

A retrospective chart review was carried out at the SQU Student Clinic in the Sultanate of Oman. This Clinic serves the student population of this national university with an enrollment of more than

Table 1: The number of patients for each main presenting complaint and their percentages, SQU Student Clinic

Complaints	No. of Patients		
	Male	Female	Total
Irregular periods	------	82 (34.7%)	82 (25.7%)
Fatiguability	7 (2.2%)	42 (17.7%)	49 (15.4%)
Palpitations	11 (3.4%)	28 (11.8%)	39 (12.2%)
Neck swelling	1 (0.3%)	12 (5.0%)	13 (4.1%)
Other Complaints	60 (18.8%)	76 (30.5%)	132 (42.0%)
Total	**79 (100%)**	**236 (100%)**	**315 (100%)**

Table 2: The percentages of each diagnosis among the student clinic at Sultan Qaboos University

Diagnosis	No. of patients (percentage)		
	Male	Female	Total
Polycystic ovarian syndrome	------	51(21.5%)	51 (16.0%)
Anaemia	2 (2.5%)	40 (16.8%)	42 (13.3%)
Thyroid Disease	1 (1.2%)	17 (7.1%)	18 (5.7%)
Anxiety and depression	5 (6.3%)	6 (2.5%)	11 (3.4%)
Other Diagnosis	71 (89.8%)	122 (51.4%)	193 (61.2%)
Total	**79 (100%)**	**237 (100%)**	**315 (100%)**

14,000 students. It is staffed by physicians from the Department of Family Medicine and Public Health in the College of Medicine and Health sciences. SQU is the only national university and the student population comes from all parts of the country and all social classes.

The study was carried out between January 2007 and January 2008. The clinic caters to the health needs of approximately 14,000 students at both undergraduate and graduate levels. The total number of consultations during this period was 18,000. The average number of visits per day was around 70 students. The sample size of the study was 319 students (240 females and 79 males) with no known thyroid disease. It involved every student between 18 and 30 years of age of both sexes who visited the student clinic during this period and for whom TFTs were requested. This included thyroid stimulating hormone (TSH), free thyroxin (free T4) and triodothyronine (free T3). Four of these patients were excluded from the study because they had a pre-existing thyroid disease. The information was gathered from electronic medical records with the help of the SQU Hospital Information Systems Department.

The patients' demographic data, the main presenting complaint for which the TFTs was requested, as well as the results of these tests and the different diagnoses reached were noted. The cost of requesting these tests was also calculated. Patients who had already been diagnosed with thyroid diseases were excluded from the study. The consultation in the clinic was carried out by final year residents in family medicine and the study was approved by the Medical Ethics and Research Committee of the College of Medicine & Health Sciences, Sultan Qaboos University, Muscat, Oman.

Results

Table 1 shows the number of patients for each main presenting complaint and their percentages in relation to the total number of patients in the study. Their complaints were either specific thyroid disease complaints such as weight changes (n = 22); hair changes (n = 20); diarrhoea and constipation (n = 13); heat and cold intolerance (n =18), or non-specific complaints such as chronic headache (n =3); chronic chest pain (n = 4), or simply seeking a general check-up (n = 6).

When the two gender groups were compared for complaints including fatiguability, palpitations, and neck swelling, it was observed that the rate of complaints among females was significantly higher as compared to males ($P < 0.01$).

Table 2 represents the number of patients for each diagnosis reached and its percentage in relation to the total number of patients in the study. The most common diagnosis in patients for whom TFT was done was polycystic ovarian disease (n = 51), followed by anaemia (n = 42). When the two gender groups were compared for the various diagnoses reached such as anaemia, thyroid disease, psychiatric problems, and others, it was observed that the potentially anaemic patients included 40 females and only 2 males. Thyroid problems (whether hypothyroidism, hyperthyroidism, sub-clinical hypo- and hyperthyroidism or thyroid

Table 3: The frequency of diagnosis in relation to the main presenting complaints of the the Student Clinic at Sultan Qaboos University

Complaints	Diagnosis	No. of Patients			Total
		Male	Female	Total	
Irregular period	Polycystic Ovarian Syndrome	------	45 (54.9%)	45(54.9%)	82
	Anaemia	------	2 (2.4%)	2 (2.4%)	
	Thyroid Disease	------	1 (1.2%)	1 (1.2%)	
	Psychiatry	------	0 (0.0%)	0 (0.0%)	
	Other Diagnosis	------	34 (41.5%)	34 (41.5%)	
Fatiguability	Polycystic Ovarian Syndrome	------	2 (4.1%)	2 (4.1%)	49
	Anaemia	1 (2.0%)	16 (32.7%)	17(34.7%)	
	Thyroid Disease	------	2 (4.1%)	2 (4.1%)	
	Psychiatry	------	1 (2.0%)	1 (2.0%)	
	Other Diagnosis	6 (12.2%)	21 (42.9%)	27 (55.1%)	
Palpitation	Polycystic Ovarian Syndrome	------	0 (0.0%)	0 (0.0%)	39
	Anaemia	------	14 (35.9%)	14 (35.9%)	
	Thyroid Disease	------	3 (7.7%)	3 (7.7%)	
	Psychiatry	4 (10.3%)	2 (5.1%)	6 (15.4%)	
	Other Diagnosis	7 (17.9%)	9 (23.1%)	16(41.0%)	

nodules) were diagnosed in 18 out of 315 students, of whom 17 were females and only one was a male. Eleven patients were found to be suffering either from psychiatric distress, anxiety or depression. Six of these were females and five were males. There was no specific diagnosis given for 193 students (122 females and 71 males) due to either lack of follow-up or documentation. The percentage of thyroid diseases among the females was 7.1% as compared to males 1.2%. This difference was found to be statistically significant ($P < 0.05$).

Table 3 shows the number of patients in each diagnosis reached for each specific complaint

The cost of the TFTs which were requested for the studied group during the 12 month period was estimated to be around 20,000 US dollars (c. 7,660 OR). Since only 6% of the tests administered had positive results, the unnecessary expenditure for TFTs amounted to 18,800 US dollars during the period of the study.

Discussion

This, to our knowledge, is the first study in the Arab/Islamic part of the world to examine the trajectory between case-finding strategies for thyroid dysfunction as a first-level measurement, the viability of such prescribed laboratory procedures and the cost entailed in administering TFTs. On the whole, the present study has demonstrated that there is a temporal relationship between first-level measurement and eventual diagnosis. There was also a discrepancy between initial diagnosis and subsequent diagnosis confirmed by using TFT. With a few exceptions, the results of the TFT were not remarkable. It is worthwhile noting that most of the cases could have been diagnosed by clinical impression only.

The present findings are similar to the results of an Italian study by Roti *et al.*[12] who reported that there was one abnormal TFT for every fourteen patients tested in their sample population. In a longitudinal study in France, Toubert *et al.*[2] reported that, while there was an increase in 'rate of appropriate ordering' of TFT, actual appropriateness remained low. The incidence of inappropriate ordering has a direct bearing on cost. One plausible implication of this finding is that judicial ordering appears to be essential. Proper history taking, starting with simple and cheaper basic investigations such as haemoglobin to exclude common problems such as anaemia, which appears

to be common in the present cohort, would be the most appropriate approach.

Paula *et al*.[13] have recommended ordering TFT for all patients who present with irregular periods before diagnosing them with polycystic ovarian syndrome; however, since our study is confined to a certain age group, where ovarian dysfunction and polycystic ovarian syndrome are common,[14] this recommendation may not apply within the present context. The main symptom for which TFT was ordered during the period of this study was irregular periods. Although irregular periods are one of the known symptoms of thyroid diseases,[15] only a few students who presented with irregular periods were found to have thyroid problems. There are several explanations for this. First, the majority of the sample population in this study was female. Second, most of the females in this group were in adolescence or early adulthood where irregular periods are a common occurrence.[16] It was found that some students who presented with irregular periods were diagnosed with polycystic ovarian syndrome. Presentations of extremely irregular periods need more evaluation in regard to common differential diagnoses such as ovulation dysfunction and polycystic ovarian disease.[14]

The other common reasons for ordering TFT in this study group were distress symptoms reported by the patient such as fatiguability and palpitations. These complaints were predominantly made by females. As in the case of irregular periods, the diagnosis of thyroid disease accounts for a small number of patients who presented with these symptoms, while most of them were found to have anaemia. Although TFT was one of the recommended tests for patients who present with fatiguability,[17] according to the results of our study and for cost effectiveness, it is advisable to exclude anaemia for this age group before requesting a TFT. On the other hand, from the present study, it appears that ordering TFT for any patient who presents with a neck swelling is appropriate, since most of our patients who presented with neck swelling were females and the majority of them were diagnosed with thyroid diseases. This suggests TFT should be a basic constituent of any thyroid diagnostic work-up. This idea is consistent with Thomas *et al*.[18] who have suggested that a swelling in the neck is a strong indicator of thyroid dysfunction.

It is worthwhile to note that very few patients were found to have thyroid diseases in the large category of patients with other complaints, although TFT was advised for some of these patients who presented with specific complaints of thyroid diseases,[21] such as constipation[19] and hair changes.[20] This study suggests that such requests were overall unnecessary because these thyroid diagnostic work-ups were predominately negative. This led to the issue of cost. Previous studies, mostly from Europe,[12,22,23,24,25] suggested that cost for a first-level measurement in clinical diagnosis still constitutes a large proportion of the public health budget. Moreover, the cost for thyroid function testing can be reduced by ordering TSH only, as FT4 and FT3 add little information in such circumstances. Viera concluded that requesting TSH alone is generally adequate, limiting administration of FT4 tests to those with abnormal TSH.[24] Wastage could be minimised by contemplating strategies to optimise diagnostic tools without loss of efficiency. The cost of TFTs at our Student Clinic amounted to 20,000 US dollars (c. 7,660 OR). If other diagnostic tools had been used in advance of administering TFT, the total necessary expenditure could have been limited to 2,000 dollars.

The limitation of this study is that it includes only the patients' main presenting complaints and excludes other associated complaints which may also be related to thyroid disease. Clinical diagnosis of thyroid dysfunction is based on multiple symptoms rather than on a single symptom, as well as the presence of risk factors for thyroid dysfunction and physical signs. Therefore, the diagnostic yield of thyroid function testing could be improved which has direct bearing on cost-effectiveness. We recommend including these factors in future studies in order to shed light on such important confounding variables. The second obvious limitation is that there were a substantial number of subjects who were not given a specific diagnosis. Because the study was retrospective, some of the required information was missing and follow-up was not performed in some cases. Last but not least, the results of this study may not be fully generalisable because the study's cohort consisted of university students. A prospective study, with a wider population would be essential to circumvent this limitation.

Conclusion

Despite the aforementioned limitations due to the type of the study, one theme emerges in light of the available literature and present data. Judicial use of thyroid diagnostic work-ups would be essential in this particular age group, as it contains many individuals who commonly present with specific and non-specific complaints that have little relation to the presence of thyroid diseases. It is advisable to request TFT for all students who present with thyroid swelling and to eliminate the possibility of anaemia for those who present with palpitations or fatiguability before requesting this test. It is not advisable to administer TFT to students who present exclusively with irregular periods without associated thyroid symptoms, or for students who present with non-specific complaints of thyroid diseases. Education can be an effective tool for modifying clinicians' testing patterns by introducing simple clinical guidelines.

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