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Test ordering in an evidence area zone: Rates and associations of Australian general practice trainees' vitamin D test ordering

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Abstract

Rationale, aims and objectives Indiscriminate health screening is increasingly seen as being problematic. In particular, vitamin D testing rates are increasing rapidly despite recommendations against population screening. The purpose of this study was to determine the level of vitamin D testing among family practice/general practitioner (GP) trainees and to establish associations of this testing.
Methods Cross-sectional analysis of data from the ReCEnT (Registrars Clinical Encounters in Training) cohort study. The setting was GP practices in four Australian states. Data from 60 consecutive consultations per trainee were recorded each 6-month training term (up to four terms).
Results Vitamin D tests were ordered in 726 (1.0%) of encounters ($n = 69\,412$). Vitamin D test ordering was significantly associated with patients being older, female and non-English speaking. Trainees were more likely to test if they worked in a completely bulk-billing practice (i.e. a practice without any patient payment), if more problems were dealt with, more pathology tests were ordered in the consultation and if a lipid profile was ordered. They were less likely to test if they sought in-consultation advice or information. The most common reasons for testing were 'check-up' and 'health maintenance'.
Conclusions In this first report of associations of vitamin D testing in the GP setting, we found that non-targeted vitamin D testing (testing inconsistent with current guidelines) is widespread in GP trainees' practice. Adoption of more rational testing approaches is needed.

Introduction

Indiscriminate screening and overtesting is increasingly being recognized as a problem within developed countries [1,2]. This has led to increased costs for health care systems, as well as potential harms to patients [2]. Vitamin D testing in Australia has increased from 40.6 tests per 100 000 people (costing AUD$1.02 million) in 2000 to 3472.2 tests per 100 000 people (costing AUD$96.7 million) in 2010, an increase of 59% per year [3]. In North America, specifically Ontario, costs increased from approximately CAD$1.7 million in 2004 to over CAD$21 million in 2008 [4]. The degree to which this level of testing is evidence-based is currently unknown.

But the consequent and potential harms, including over-diagnosis, overtreatment and increased costs are recognized [1,5].

Vitamin D deficiency has been linked to a number of diseases (without established causality) including musculoskeletal diseases, infectious diseases, autoimmune diseases, type 1 and 2 diabetes, some types of cancers and, especially, cardiovascular disease [6,7]. The only established causal relationships of health outcomes and low vitamin D, (which have now been disputed [8,9]), are between vitamin D and bone health and falls [10]. Even here, the use of vitamin D supplements for improving bone density and muscle function has not been studied across all age groups [10]. There has, however, been much non-evidence-based promotion in both the lay and medical press of the importance of vitamin D deficiency in the causation of multiple disease states [11,12].

Australian guidelines recommend vitamin D testing only be performed in high-risk groups [10]. The guidelines recommend targeted testing for those who are at risk of osteoporosis and those who are at high risk of vitamin D deficiency, such as older or disabled people who are housebound, people with dark skin and people who do not get adequate skin sun exposure. Population screening is not recommended. In particular, screening for chronic disease prevention and in women who are pregnant is not proven to be beneficial [10,13]. Similar guidelines can be found in the United States and other developed countries, despite differences in population vitamin D status and its determinants, between countries [14,15].

Levels of vitamin D testing have been determined at a population level in Australia [5]. Rates of general practitioners' (GPs) testing have previously been reported in Australia [16,17], but not elsewhere. The clinical associations of testing have not been examined.

Trainees in Australian general practice (GP trainees) function as independent practitioners (with recourse to advice and support from their clinical trainers). They are at a formative stage in their practice [18,19], and might be thought to be singularly influenced by recent non-evidence-based media reporting of the importance of vitamin D testing.

The aim of this study was to determine the current level of vitamin D testing among GP trainees and examine factors associated with this testing in terms of patient, trainee, practice and consultation factors.

Methods

Selection and description of participants

This is a cross-sectional analysis of GP trainee consultations from the Registrars Clinical Encounters in Training (ReCEnT) cohort study, collected over a period from 2010 to 2013. The study methodology has been described in detail elsewhere [20].

Briefly, ReCEnT is undertaken in four geographically based educational organizations – general practice regional training providers (RTPs) – encompassing urban, rural and remote practices in four Australian states. Data collection for the ReCEnT project takes place within mainstream general practices. Informed consent is obtained for trainees' de-identified data to be used as part of the ReCEnT study.

Trainee and practice characteristics are recorded via self-administered questionnaire to the trainees. Participating trainees record the details of 60 consecutive patient encounters, representing approximately 1 week of consultations, each 6-month training term (up to four terms). Consultation data included patient demographics; duration of consultation; problems managed; investigations ordered; prescriptions written; follow-up arranged; and referrals made. Pathology, imaging and problems managed are coded according to the International Classification of Primary Care, second edition classification system (ICPC-2 PLUS) [21].

Outcome factors

The primary outcome of this analysis was whether a vitamin D test was ordered within the consultation. This was classified using the ICPC-2 PLUS coding system.

Independent variables

Independent variables were categorized as patient, trainee, practice or consultation factors.

Patient factors were age, gender, Aboriginal and Torres Strait Islander status, non-English-speaking background, new patient to the trainee and new patient to the practice.

Trainee factors were age, gender, full-time/part-time status (part-time classified as less than eight sessions per week), training term and place of qualification (Australia or international).

Practice factors were rurality [classified by Standard Geographical Classification-Remoteness Area (ASGC-RA) classification] [22], decile of Socioeconomic Index for Area (SEIFA) Relative Index of Disadvantage index [23], number of GPs working in the practice and if the practice entirely bulk bills (i.e. there is no financial cost to the patient for the consultation). Practice postcode was used to define ASGC-RA classification and the SEIFA code of the practice location.

Consultation factors included duration of consultation (in minutes) and number of problems dealt with. Other consultation factors (related to the problem for which the vitamin D test was ordered) that we included in the analysis to explore whether testing was related to the complexity of the consultation were:

- whether the trainee sought in-consultation advice or information (from GP trainer, specialist, hard copy or electronic sources of information) for this problem;
- number of pathology tests ordered for this problem; and
- whether any imaging was ordered for this problem.

Co-ordering of lipid profile tests along with vitamin D for the same problem was also an independent variable. Lipids profile tests were classified using the ICPC-2 PLUS coding system. Rationale for the use of co-ordering as an indicator of 'non-targeted' rather than 'targeted' testing, is that it is very unlikely that both tests would rationally be ordered for the same clinical problem. If both tests were done as part of a general screen, again, vitamin D is not recommended for use as a screening test [13].

Statistical analysis

Analysis was performed on seven rounds of data collection from 2010 to 2013.

For the outcome, ordering of a vitamin D test, initial analysis was performed using chi-square and Wilcoxon rank-sum for categorical and continuous data, respectively. Results of these univariate analyses were used to determine which variables would

Table 1 Characteristics of patients and trainees

Variable	Class	*n*, % [95% CI]
Patients *n* = 69 412		
Age patient	Mean (SD)	40.2 (23.8) [40.0, 40.4]
Patient age group	0–14	11 648 (17.0%) [16.7, 17.3]
	15–24	8770 (12.8%) [12.6, 13.1]
	25–44	18 729 (27.4%) [27.1, 27.7]
	45–64	17 243 (25.2%) [24.9, 25.6]
	65+	11 949 (17.5%) [17.2, 17.8]
Patient gender	Female	41 609 (61.4%) [61.0, 61.8]
Aboriginal or Torres Strait Islander	Yes	670 (1.0%) [1.0, 1.0]
Non-English-speaking background (NESB)	Yes	3765 (5.4%) [5.3, 5.6]
New patient to trainee	Yes	39 015 (56.2%) [55.8, 56.6]
New patient to surgery	Yes	4836 (7.0%) [6.8, 7.2]
Trainee terms *n* = 1169		
Trainee full time or part time	Full time	884 (77.3%) [74.9, 79.8]
Training term/post	Term 1	516 (44.1%) [41.3, 47.0]
	Term 2	329 (28.1%) [25.6, 30.7]
	Term 3	266 (22.8%) [20.3, 25.2]
	Term 4	58 (5.0%) [3.7, 6.2]
Trainees *n* = 593		
Trainee age	Mean (SD)	32.9 (6.8) [33.2, 33.4]
Trainee gender	Female	391 (65.9%) [62.1, 68.0]

Note: Number may not add up to total *n* because of missing data.
Trainee part time is classified as less than eight sessions per week.
CI, confidence intervals; SD, standard deviation.

be included in logistic regression models. Logistic regression was used within a generalized estimating equation framework, to account for clustering of similar patients for individual trainees. Variables with a *P*-value less than 0.2 on univariate analysis were included in the multiple logistic regression model.

Descriptive analysis was performed regarding the problem or diagnosis for which the vitamin D tests were ordered and for which vitamin D tests were co-ordered with a lipid profile test.

All statistical analysis was carried out using STATA v11.2 (Stata Corp, College Station, Texas, USA).

Ethics approval for this study was obtained from the Human Research Ethics Committee of University of Newcastle, NSW, Australia (H-2009-0323).

Results

Data was collected during seven project rounds of ReCEnT, from 2010 to 2013, including 593 trainees (response rate 95.3%), 1169 trainee rounds and 69 412 trainee–patient encounters.

Characteristics of the patients, trainees and practices in this study are presented in Table 1. Of the 69 412 encounters, 26 166 [38.6% (95%CI: 38.2, 39.0)] were with male patients, with a mean age of 40.2 years for all patients. Of all encounters, 670 [1.0% (95% CI: 1.0, 1.0)] were with patients who identified as Aboriginal and Torres Strait Islander and 3765 [5.4% (95% CI: 5.3, 5.6)] were from a non-English-speaking background. 39 015 [56.2% (95% CI: 55.8, 56.6)] patients were new to the trainee and 4836 [7.0% (95% CI: 6.8–7.2)] were new to the surgery.

Trainees had a mean age of 32.9 years with 444 [74.9% (95% CI: 71.4, 78.4)] having qualified as a doctor in Australia. Female trainees' constituted 391 [65.9% (95% CI: 62.1, 68.0)] of all trainees.

Table 2 Problems associated with vitamin D testing

	n, % [95% CI]
Health check	433 (31.9) [29.0, 35.1]
Tiredness/fatigue/lethargy	124 (9.1) [7.6, 10.9]
Vitamin D deficiency	104 (7.7) [6.3, 9.3]
Blood test	55 (4.1) [3.1, 5.3]
Depression	34 (2.5) [1.7, 3.5]
Pregnancy	32 (2.4) [1.6, 3.3]
Hypertension	30 (2.2) [1.5, 3.2]
Diabetes	25 (1.8) [1.2, 2.7]
Hypercholesterolaemia/dyslipidaemia	25 (1.8) [1.2, 2.7]
Anxiety	21 (1.5) [1.0, 2.4]

CI, confidence intervals.

Vitamin D test ordering

Vitamin D tests were ordered in 1.0% of consultations [95% CI: 1.0–1.1] (726 of 69 412).

Vitamin D tests were ordered most often for the following diagnoses/problems: check-up or health maintenance (31.9%), tiredness or fatigue or lethargy (9.1%) and vitamin D deficiency (7.7%). The top 10 problems are listed in Table 2.

The results of the regression model with vitamin D test ordering as the outcome factor are presented in Table 3. Vitamin D test ordering was significantly associated in an adjusted model with the patient being older, female and from a non-English-speaking background. Trainees were less likely to order vitamin D tests if they are in a practice from an inner regional area when compared with a major city. They were more likely to test if they are working in a practice that entirely bulk bills their patients. They were more likely to order a vitamin D test if they deal with more problems in

Table 3 Associations of ordering a vitamin D test

		Univariate		Adjusted	
Variable	Class	OR (95% CI)	*P*	OR (95% CI)	*P*
Patient age group	0–14	0.1 (0.1, 0.2)	<0.001	0.7 (0.4, 1.2)	0.25
Referent 25–44	15–24	0.7 (0.6, 0.9)	0.009	0.9 (0.7, 1.2)	0.53
	45–64	0.8 (0.7, 1.0)	0.051	1.2 (1.0, 1.6)	0.12
	65+	0.7 (0.6, 0.9)	0.001	1.4 (1.1, 1.9)	0.013
Patient gender	Female	1.8 (1.5, 2.1)	<0.001	1.5 (1.2, 1.9)	<0.001
NESB	Yes	1.8 (1.4, 2.4)	<0.001	1.6 (1.1, 2.3)	0.007
Patient practice status	New to registrar	1.3 (1.1, 1.5)	0.002	0.9 (0.8, 1.2)	0.51
Referent: returning patient	New to practice	2.8 (2.2, 3.5)	<0.001	1.2 (0.9, 1.7)	0.26
Registrars age	–	0.98 (0.96, 0.99)	0.012	0.99 (0.97, 1.01)	0.36
Registrar gender	Female	1.3 (1.0, 1.7)	0.044	1.2 (0.9, 1.5)	0.20
Training term/post	Term 2	1.1 (0.9, 1.3)	0.36	1.0 (0.8, 1.3)	0.84
Referent: term 1	Term 3	1.1 (0.9, 1.4)	0.22	0.9 (0.7, 1.1)	0.300
	Term 4	0.9 (0.6, 1.3)	0.56	0.5 (0.3, 0.9)	0.014
Qualified as a doctor in Australia	Yes	1.8 (1.3, 2.4)	<0.001	1.0 (0.7, 1.3)	0.98
Rurality	Inner regional	0.4 (0.3, 0.6)	<0.001	0.4 (0.3, 0.6)	<0.001
Referent: major city	Outer regional remote	0.5 (0.3, 0.7)	<0.001	0.8 (0.6, 1.2)	0.24
Practice bulk bills	Yes	1.5 (1.2, 1.8)	0.001	1.5 (1.1, 1.9)	0.003
Consultation duration	–	1.04 (1.03, 1.04)	<0.001	1.00 (0.98, 1.01)	0.48
Number of problems	–	1.5 (1.4, 1.7)	<0.001	1.6 (1.4, 1.7)	<0.001
Sought help from any source	Yes	0.4 (0.3, 0.5)	<0.001	0.4 (0.3, 0.5)	<0.001
Number of pathology ordered	–	1.9 (1.9, 2.0)	<0.001	2.0 (1.9, 2.0)	<0.001
Imaging was ordered	Yes	1.9 (1.5, 2.3)	<0.001	0.5 (0.4, 0.7)	<0.001
Lipids also ordered	Yes	35.2 (29.3, 42.3)	<0.001	1.8 (1.4, 2.3)	<0.001

CI, confidence intervals; NESB, non-English-speaking background; OR, odds ratio.

that consultation, if they ordered more pathology tests and if they also ordered a lipid profile test for the same problem. They were less likely to order vitamin D if they seek in-consultation advice or information and if they order imaging.

Vitamin D testing being co-ordered with lipids

Vitamin D tests were co-ordered with lipids in 34.0% [95% CI: 30.6–37.5] (247 of 726) of all of vitamin D tests ordered.

Vitamin D tests were co-ordered with a lipid most often for the following problems or diagnoses: check-up or health maintenance (46.1%), blood test (4.9%) and tiredness or fatigue or lethargy (4.9%). The top 10 diagnoses/problems are listed in Table 4.

Table 4 Problems associated with vitamin D test being co-ordered with lipids

	n, % [95% CI]
Health check	113 (46.1) [38.0, 55.5]
Blood test	12 (4.9) [2.5, 8.6]
Tiredness/fatigue/lethargy	12 (4.9) [2.5, 8.6]
Diabetes	10 (4.1) [2.0, 7.5]
Hypertension	9 (3.7) [1.7, 7.0]
Cardiovascular risk factor	6 (2.4) [0.9, 5.3]
Hypercholesterolaemia/dyslipidaemia	6 (2.4) [0.9, 5.3]
Prescription	5 (2.0) [0.7, 4.8]
Depression	3 (1.2) [2.5, 3.6]
Pain; chest	3 (1.2) [2.5, 3.6]

CI, confidence intervals.

Discussion

Summary of principal findings

We found that GP trainees ordered vitamin D tests in 1.0% of consultations. A trainee ordering a vitamin D test for a patient was significantly associated with older patient age, female gender and non-English-speaking patient background. Consultations in which vitamin D tests were ordered differed from other consultations, with trainees dealing with more problems, and ordering more pathology tests for the same problem. Trainees commonly co-ordered vitamin D and a lipid profile for the same problem. Trainees were less likely to order a vitamin D test if they sought in-consultation assistance or information or if they ordered any imaging tests.

The problems for which vitamin D tests were most commonly ordered were 'general' rather than 'specific' (check-ups, health maintenance and blood tests in 36% of instances and tiredness or lethargy or fatigue in 9.1% – see Table 2).

Strengths and limitations

Our study has a number of strengths. The trainee participants had very similar demographics (age, gender and international medical graduate status) to the national GP trainee cohort [24]. Also, the study was conducted in four RTPs across four Australian states, making the findings broadly generalizable to Australian general practice training. The external validity of the findings is further enhanced by the response rate of 95.3%. This is a singularly high response rate in studies of GPs [25].

A limitation is that our study, being a practice-based consultation study, specifically excluded nursing home patients and housebound patients. Including these high-risk groups may have increased the proportion of 'targeted' vitamin D tests. But it should also be noted that many authorities recommend treating all such patients without testing, and that testing may thus be inappropriate in these groups [26,27].

Another limitation is that we defined 'co-ordering' to be ordering of vitamin D and lipid profile for the same diagnosis/problem and not when ordering vitamin D and lipid profile in the same consultation but for a different diagnosis/problem. We recognize that it is possible that both tests were 'targeted'. For example, a patient being at risk of both vitamin D deficiency and vascular disease on the basis of ethnicity – but this was anticipated to be very infrequent.

Interpretation of findings and comparison with existing literature

The rate of vitamin D test ordering in trainees is similar to, but slightly higher than, their established GP colleagues. A comparable study in established Australian GPs reported a rate of Vitamin D testing in 0.8% of encounters [16] compared with trainees rate of 1.0%. To our knowledge, this is the first study that also looks at factors associated with primary care practitioners' vitamin D test ordering.

Certain factors in our analysis are suggestive of targeted testing. For example, older females are more likely to have, or be at risk of, osteoporosis [28], and non-English-speaking patients may be more likely to have darker skin and be less exposed to the sun for cultural reasons [29,30]. Countering this, current Australian guidelines also state that patients with osteoporosis may not need testing, as their treatment should include vitamin D supplementation irrespective of the results of the test [26].

However, we have also found evidence of non-targeted testing. The association of vitamin D testing with a higher number of pathology tests ordered for the same diagnosis/problem could suggest non-targeted testing, where vitamin D is being included among a host of tests as a health screen. Further evidence of non-targeted ordering of vitamin D tests comes from the high rate of co-ordering with lipid profiles and the prominence of 'check-up', and 'health maintenance' as the problem/diagnosis for which vitamin D was ordered.

Further, though less direct, support for the interpretation of non-targeted testing may be found in the negative associations of vitamin D testing with in-consultation recourse to advice and information. This may suggest that these were non-challenging 'routine' problems/diagnoses, as more complex presentations are more likely to elicit information or advice seeking. An alternative explanation is that if advice or information was obtained (e.g. from guidelines) this may have discouraged testing. The association of vitamin D testing with more pathology testing but less imaging may also be related to the complexity of the problem being addressed – vitamin D testing tending to be for 'routine' health checks and 'health maintenance,' with co-ordering of other pathology, rather than more 'active' problems (noting that imaging is employed in screening far less than are pathology tests).

The prominence of cardiovascular diseases (hypertension, risk factor cardiovascular disease and hypercholesterolaemia or dyslipidaemia) on the list of problems/diagnoses involving lipids co-ordered with vitamin D, when compared with the list for all problems associated with vitamin D testing, may suggest that vitamin D is ordered as an 'after-thought' when test ordering to stratify cardiovascular risk status. The wider context of this finding is the scant evidence causally linking vitamin D deficiency with cardiovascular problems. The current evidence is from observational studies, and any randomized controlled trial results are inconclusive [6,7,31], but the associations have been given prominence in the lay and popular medical presses. Recent systematic reviews have suggested that low vitamin D levels could be a marker of ill health rather than the cause of ill health, so testing and supplementation would have no effect on the disease itself [32]. Fatigue and tiredness problems also feature as prominent reasons for vitamin D testing – indications, which, similarly, are unsupported by Australian guidelines [13,33,34].

An overall interpretation of our results is that non-targeted vitamin D testing (i.e. testing inconsistent with current guidelines) is prevalent in GP trainees' practice. There has been concern expressed regarding the increasing economic burden of an unnecessary increase in vitamin D testing over the past 10 years. Disturbingly, this may be largely related to media prominence and unproven links [3,35].

Implications for practice and policy

Current vitamin D testing in general practice appears at present to be highly prevalent and poorly targeted. Even in some at-risk groups, it may not be necessary, irrespective of vitamin D levels, if supplementation can be put in place [3,13,27]. With GPs being responsible for initiating 70% of Medicare-funded pathology tests [36], they have a clear role to play in reducing the cost and harms of overtesting.

Interventions could be aimed at promoting the use of evidence-based guidelines for appropriate vitamin D testing among GP trainees. They are at a stage of career development where evidence-based practice patterns can be established.

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