

# The Effect of Physician Workload on an Educational Intervention to Increase Vitamin D Screening

Heather Kramm, MD; Ronald Gangnon, PhD; Andrea N. Jones, BS;  
Mark Linzer, MD; Karen E. Hansen, MD

## ABSTRACT

*Rationale, Aims and Objective:* Changes in physician behavior are difficult to accomplish. We hypothesized measuring physicians' vitamin D levels would increase measurement of their patients' levels.

*Methods:* We recruited faculty via e-mail. We measured physicians' serum 25(OH)D levels and asked them to complete a questionnaire created to assess the risk of vitamin D deficiency. Physicians received their vitamin D test results by mail. We monitored physicians' vitamin D testing rate per 100 patient visits in the 12 weeks before and after receipt of their own vitamin D test result.

*Results:* Twenty-eight (22%) of 126 primary care physicians participated in the study; all were Caucasian and 17 (61%) were women. Gender, practice type, and year of graduation from medical school were similar in participants and non-participants. Over half of participants took a multivitamin and a third took a vitamin D supplement. Although 6 (21%) reported a recent fracture, only 1 physician carried a diagnosis of osteopenia or osteoporosis. At baseline, geriatricians ordered 14 vitamin D tests per 100 patient visits, while internists and family practitioners ordered substantially fewer tests (2 and <1 tests per 100 visits, respectively). After study participation, vitamin D testing rates increased significantly among family practitioners (rate ratio 3.27, 95% CI

1.29-8.33) and internists (rate ratio 3.19, 95% CI 1.12-9.07). Physicians with heavier clinic workloads were half as likely (rate ratio 0.50, 95% CI 0.32-0.76) as those with lighter clinic workloads to increase vitamin D testing rates. Surprisingly, physicians with hypovitaminosis D demonstrated no change in vitamin D testing rates.

*Conclusions:* Physicians with low vitamin D testing rates were receptive to a personal intervention involving measurement of their own vitamin D levels. High workload appeared to attenuate this effect. These novel but preliminary observations require confirmation in future studies.

## INTRODUCTION

Hypovitaminosis D, defined as a serum 25(OH)D <30 ng/ml by radioimmunoassay, is common in Americans including inpatients,<sup>1</sup> post-menopausal women with osteoporosis,<sup>2</sup> internal medicine residents,<sup>3</sup> and adolescents.<sup>4</sup> Vitamin D is an essential steroid hormone regulating calcium homeostasis. After skin synthesis, the hormone undergoes 2 hydroxylation steps to a bioactive form [1,25(OH)2D] that increases intestinal calcium absorption.<sup>5</sup> Hypovitaminosis D permits decreased calcium absorption, leading to a decline in serum ionized calcium levels, release of parathyroid hormone, and osteoclastic bone resorption. This cascade of events maintains normocalcemia in the short term, but if untreated may eventually cause bone loss presenting as osteoporosis or osteomalacia.<sup>5</sup>

Individuals at risk of hypovitaminosis D include those with limited exposure to sunlight, low intake of dairy products, malabsorption, malnutrition, and those taking medications that interfere with vitamin D metabolism.<sup>5,6</sup> Although experts suggest measurement of serum vitamin D in these individuals,<sup>6-8</sup> we observed locally that many such patients did not undergo testing. We thus identified the need for an educational intervention to increase the rate of vitamin D testing in patients with risk factors or signs of vitamin D deficiency.

**Author Affiliations:** Colorado Center for Arthritis & Osteoporosis, Longmont, Colo (Kramm); Departments of Population Health and Biostatistics, University of Wisconsin School of Medicine and Public Health, Madison, Wis (Gangnon); Department of Medicine, University of Wisconsin School of Medicine and Public Health; Madison, Wis (Jones, Hansen); University of Wisconsin Department of Medicine, General Internal Medicine Division, Madison, Wis (Linzer).

**Corresponding author:** Karen E. Hansen, MD, Assistant Professor of Medicine, University of Wisconsin Department of Medicine, Rheumatology Division, Mailbox 3244 Clinical Science Center, 600 Highland Ave, Madison, WI 53792; phone 608.263.3457; fax 608.263.7353; e-mail keh@medicine.wisc.edu.

Although educators frequently use didactic lectures to teach physicians, such lectures generally do not affect patient care.<sup>9</sup> Handouts can enhance practice improvement following a didactic lecture.<sup>10,11</sup> Interactive sessions involving learning stations and patients are more successful at changing physician behavior than didactic lectures.<sup>9</sup> A physician's own medical experience might also influence patient care. Indeed, internal medicine residents' health behaviors predicted the preventive services and screening tests they recommended to their patients.<sup>12</sup>

We hypothesized that measurement of physicians' vitamin D levels would increase testing for hypovitaminosis D in their patients. We designed a study to test this hypothesis. The primary study outcome was the change in the frequency by which physicians measured serum 25(OH)D in patients after study participation. Secondary outcomes included whether a handout or the presence of hypovitaminosis D in physicians affected the frequency by which physicians ordered 25(OH)D levels in their patients.

## METHODS

Through mass e-mail, we invited 126 faculty physicians employed by the University of Wisconsin (UW) General Internal Medicine, Geriatric Sections, and Family Practice Departments to participate in this study. Faculty physicians who provided primary care to outpatients at least a half day weekly were eligible for participation. During the consent process, we informed physicians that we would measure their 25(OH)D levels and monitor the frequency by which they ordered 25(OH)D levels in their patients. Each consenting participant received a \$20 honorarium.

Following informed consent, each physician completed a questionnaire<sup>13</sup> created to assess the risk of vitamin D deficiency. Physicians answered questions reflecting intake of nutritional supplements and sun-seeking habits. The questionnaire asked physicians to report chronic diarrhea, Crohn's disease, ulcerative colitis, or celiac sprue, any of which might lead to vitamin D deficiency via malabsorption. On the questionnaire, participants also recorded symptoms or signs of suboptimal vitamin D status including muscle pain or weakness, fracture within 5 years, height loss, or a diagnosis of osteopenia or osteoporosis. Physicians could skip any question they felt uncomfortable answering.

We collected blood from each participant and measured serum 25(OH)D and whole parathyroid hormone (PTH) levels. The UW Clinical Laboratory performed serum 25(OH)D assays using a reverse-phase high-

performance liquid chromatography (HPLC) assay.<sup>14</sup> We defined hypovitaminosis D as a serum 25(OH)D level <25 ng/ml, based on a study showing that a serum 25(OH)D of ~30 ng/ml by radioimmunoassay corresponds to a level of ~25 ng/ml by HPLC (unpublished data). Scantibodies Laboratory, Incorporated (Santee, California) performed whole PTH measurements. Participating physicians received their test results by mail, along with an explanation of the results. Half of the physicians received a handout describing the potential medical consequences of hypovitaminosis D.

The UW Information Technologies Department and UW Laboratory provided the number of vitamin D tests ordered on patients of each physician in the 12 weeks before and following receipt of their test results. Since faculty physicians typically keep a consistent clinic schedule over a span of 3 months, this period served as a reasonable interval for interactions with patients. To adjust for patient volume in each 12-week interval, we determined each physician's vitamin D testing rate per 100 patient visits. The IRB protocol number for this study was 2004-1096.

## ANALYSIS

The primary study outcome was the change in vitamin D testing rate in the 12 weeks after study participation, compared to the 12 weeks prior to participation. We normalized the vitamin D testing rate to clinical workload by calculating the testing rate per 100 patient visits. We estimated sample size based on the assumption that each participant would order serum 25(OH)D in 5 patients over a 3-month span pre-intervention and in 10 patients over a 3-month span post-intervention. Using a 2-sided 5% level test, a sample size of 26 physicians was required to detect this change with 90% power.

Descriptive statistics (mean  $\pm$  SD for continuous variables and n [%] for categorical variables) were tabulated for all participants. Demographic factors included physician gender, specialty practice, year of graduation from medical school, and patient workload (the total number of patient visits in 24 weeks). Health factors included use of multivitamin or vitamin D supplements and presence of prior fracture, height loss, or myalgia. Study factors included receipt of a handout and a diagnosis of hypovitaminosis D in physicians.

We assessed associations between participant characteristics and baseline rates of serum 25(OH)D testing using negative binomial regression models with a log link function. We included the (log) number of patient visits in the model as an offset term. Univariate models were fit including covariates individually. We con-

**Table 1.** Physician Characteristics

	Participants (n=28)	Non-Participants (n=99)
<b>Demographic Factors</b>		
Female Gender	17 (61%) <sup>a</sup>	43 (43%) <sup>a</sup>
<b>Specialty</b>		
Geriatrics, n=16	3 (19%) <sup>b</sup>	13 (81%) <sup>b</sup>
Family Practice, n=30	8 (27%) <sup>c</sup>	22 (73%) <sup>c</sup>
Internal Medicine, n=81	17 (21%) <sup>d</sup>	64 (79%) <sup>d</sup>
Year Graduated Medical School	1986 ± 10 years <sup>e</sup>	1985 ± 10 years <sup>e</sup>
Patient Visits Per Physician	1045 ± 448	
<b>Health Factors</b>		
Multivitamin Use	16 (57%)	
Vitamin D Supplementation	9 (32%)	
Prior Fracture	6 (21%)	
Height Loss	4 (14%)	
Myalgia	3 (11%)	
<b>Study Factors</b>		
Receipt of Handout	14 (50%)	
Hypovitaminosis D Diagnosis	6 (21%)	
25(OH)D, ng/mL	32 ± 10	
PTH, pg/mL	37 ± 12	

Data are presented as mean ± SD for continuous variables and n (%) for categorical variables. We compared participants and non-participants according to various demographic factors.

PTH, parathyroid hormone levels.

<sup>a</sup> P-value of 0.80 for gender

<sup>b</sup> P-value of 1.0 for geriatric specialty

<sup>c</sup> P-value of 0.49 for family practitioners

<sup>d</sup> P-value of 0.70 for internal medicine practice

<sup>e</sup> P-value of 0.80 for year of graduation from medical school

considered 2 multivariate models, 1 including all covariates and 1 including a subset of covariates selected via backward elimination to maximize Aikake's Information Criterion (AIC), a measure of the goodness of fit of 2 statistical models.

We assessed changes in rates of serum 25(OH)D testing post-intervention within participants using logistic regression models. We included the (log) ratio of patient visits post-intervention to pre-intervention in the model as an offset term. Univariate models were fit including covariates individually. We estimated ratios of serum 25(OH)D testing rates, post-intervention relative to pre-intervention, for individual covariate values and estimated potential differential effects by covariate levels using appropriate interaction tests. We again considered 2 multivariate models, 1 including all covariates and 1 including a subset of covariates selected via backwards elimination to maximize Aikake's Information Criterion (AIC).

## RESULTS

We sent letters of invitation via e-mail to faculty physicians in General Internal Medicine (n=81), Geriatrics (n=16), and Family Practice (n=30) Departments. Twenty-eight of 127 physicians, representing 22% of invited faculty, agreed to participate in the study. All physicians were Caucasian, 17 (61%) were women, and 6 (21%) had hypovitaminosis D (Table 1). Participation rates were similar across specialties ( $P>0.05$  for comparisons between participants and non-participants, Table 1) with 21% (n=17) internists, 19% (n=3) geriatricians, and 27% (n=8) of family practitioners participating. Gender did not seem to influence the decision to participate, as 17 of 28 participants and 43 of 99 non-participants were female ( $P=0.11$ , Table 1). Years of experience likewise did not appear to influence participation, as responders completed medical school in (mean ± SD) 1986 ± 10 years, and non-responders completed medical school in 1985 ± 10 years ( $P=0.80$ , Table 1).

Physicians completed a questionnaire created to identify risk factors for and signs of vitamin D deficiency.<sup>13</sup> As shown in Table 1, over half of participants took multivitamins and a third took vitamin D supplements. Although 6 physicians (21%) reported a fracture within the past 5 years, none had a diagnosis of osteoporosis, and only 1 participant reported osteopenia. Three participants reported muscle pain but none endorsed muscle weakness. Two participants reported a diagnosis of inflammatory bowel disease or celiac sprue, 1 of whom also reported diarrhea within the past 2 weeks.

When investigating factors associated with the baseline vitamin D testing rates, physician specialty and number of patient visits were significant in both univariate and multivariate analyses (Table 2). Geriatricians ordered 13.7 tests per 100 patient visits. By contrast, internists ordered 1.6 tests per 100 visits (RR 0.11, 95% CI 0.02-0.69 univariate; RR 0.22, 95% CI 0.04-1.32 multivariate), and family practitioners ordered only 0.2 tests per 100 visits (RR 0.01, 95% CI 0.00-0.11 univariate; RR 0.02, 95% CI 0.00-0.18 multivariate). Physicians with heavier workloads ordered fewer vitamin D tests (RR 0.24, 95% CI 0.06-0.95 univariate; RR 0.33, 95% CI 0.11-1.04 multivariate). Other demographic, health, and study factors did not associate with baseline vitamin D testing rates.

Univariate analyses revealed small changes in vitamin D testing rates in the 12 weeks following study participation (Table 3). We found a significant reduction in vitamin D testing rates post-intervention in physicians with heavy workloads (over 1000 patient visits in the 24-week study period) (RR 0.75, 95% CI 0.58-0.97), which persisted after adjustment for other factors (RR

**Table 2.** Physician Characteristics Associated with Vitamin D Testing Rates at Baseline

		Univariate		Multivariate <sup>c</sup>	Multivariate <sup>d</sup>
		Rate <sup>a</sup>	RR <sup>b</sup> (95% CI)	RR <sup>b</sup> (95% CI)	RR <sup>b</sup> (95% CI)
<b>Demographic Factors</b>					
Gender	Female	1.25	1.00	1.00	
	Male	0.91	0.73 (0.16, 3.35)	0.82 (0.17, 3.92)	
Specialty	Geriatrics	13.69	1.00	1.00	1.00
	Family Practice	0.20	0.01 (0.00, 0.11)	0.01 (0.00, 0.10)	0.02 (0.00, 0.18)
	Internal Medicine	1.57	0.11 (0.02, 0.69)	0.15 (0.02, 1.46)	0.22 (0.04, 1.32)
Patient Visits	1-1000	2.28	1.00	1.00	1.00
	1001-2000	0.54	0.24 (0.06, 0.95)	0.54 (0.11, 2.65)	0.33 (0.11, 1.04)
<b>Health Factors</b>					
Multivitamin Use	No	0.84	1.00	1.00	
	Yes	1.34	1.58 (0.35, 7.11)	0.50 (0.13, 1.90)	
Vitamin D Supplement	No	0.88	1.00	1.00	
	Yes	1.76	2.00 (0.42, 9.42)	3.20 (0.69, 14.81)	
Prior Fracture	No	1.27	1.00	1.00	
	Yes	0.64	0.50 (0.08, 3.16)	0.61 (0.08, 4.71)	
Height Loss	No	1.01	1.00	1.00	
	Yes	1.86	0.61 (0.23, 14.53)	2.43 (0.37, 15.96)	
Myalgia	No	1.03	1.00	1.00	
	Yes	1.85	1.79 (0.17, 18.48)	0.97 (0.07, 14.26)	
<b>Study Factors</b>					
Receipt of Handout	No	1.39	1.00	1.00	
	Yes	0.87	0.63 (0.14, 2.74)	1.03 (0.32, 3.32)	
Hypovitaminosis D	Yes	1.70	1.00	1.00	
	No	1.00	0.59 (0.09, 3.96)	0.22 (0.04, 1.18)	

<sup>a</sup> Tests per 100 visits

<sup>b</sup> Rate ratio (relative to reference category)

<sup>c</sup> Adjusted for demographic, health, and study factors

<sup>d</sup> Adjusted for practice and total visits (selected by Aikaike's Information Criterion)

0.50, 95% CI 0.32-0.76). Multivariate analyses showed that, after adjusting for the confounding effects of physician workload and other factors, there were significant increases in vitamin D testing rates among family practitioners (RR 3.27, 95% CI 1.29-8.83) and internists (RR 3.19, 95% CI 1.12-9.07) compared to geriatricians. Notably, these physician groups had very low testing rates at baseline, suggesting that the low testing rate was the primary factor driving the change in testing.

When we designed the study, we hypothesized that physicians diagnosed with hypovitaminosis D would be more likely to increase their vitamin D testing rate. Surprisingly, we found that a physician's vitamin D status had no apparent influence on the change in testing rate. Six physicians had hypovitaminosis D, including 3 physicians who increased their testing rate and 3 who did not increase their testing rate after study participation ( $P=0.72$ ). Receipt of a handout likewise had no effect on vitamin D testing rates. Multivariate analyses controlling for other factors confirmed univariate analyses.

## DISCUSSION

Several studies emphasize a lack of change in patient care following a single didactic lecture.<sup>9,15,16</sup> Interactive programs are most likely to improve patient care.<sup>16</sup> We thus hypothesized that measurement of physicians' own vitamin D levels might alter the frequency by which they ordered the test in their patients. Internist and family practitioners, who at baseline ordered fewer vitamin D tests than geriatricians, showed a 3-fold increase in the rate of testing following study participation thus reducing, but not eliminating, the testing gap. Additionally, clinic workload was associated with change in performance following the intervention. When compared to physicians with a lighter clinic schedule, physicians with a heavier schedule were half as likely to increase vitamin D testing rates following study participation. Thus, our personal intervention appeared to influence testing rates, although the effect seemed limited to physicians with a lighter patient workload.

The impact of workload on physician response to quality improvement efforts is scarcely studied, despite

**Table 3.** Physician Characteristics Associated with Vitamin D Testing Rates per 100 Patient Visits Postintervention

		Univariate		Multivariate <sup>c</sup>	Multivariate <sup>d</sup>
		RR <sup>a</sup> (95% CI)	Effect <sup>b</sup> (95% CI)	Effect <sup>b</sup> (95% CI)	Effect <sup>b</sup> (95% CI)
<b>Demographic Factors</b>					
Gender	Female	0.90 (0.75, 1.09)	1.00	1.00	1.00
	Male	1.03 (0.83, 1.26)	1.14 (0.86, 1.51)	2.46 (0.94, 6.45)	2.46 (0.96, 6.33)
Specialty	Geriatrics	0.97 (0.76, 1.25)	1.00	1.00	1.00
	Family Practice	1.86 (0.83, 4.18)	1.91 (0.82, 4.54)	3.97 (1.43, 11.00)	3.27 (1.29, 8.33)
	Internal Medicine	0.92 (0.77, 1.10)	0.95 (0.70, 1.28)	3.41 (1.04, 11.18)	3.19 (1.12, 9.07)
Patient Visits	1-1000	1.07 (0.90, 1.26)	1.00	1.00	1.00
	1001-2000	0.75 (0.58, 0.97)	0.70 (0.52, 0.96)	0.35 (0.16, 0.78)	0.50 (0.32, 0.76)
<b>Health Factors</b>					
Multivitamin Use	No	0.86 (0.69, 1.07)	1.00	1.00	
	Yes	1.03 (0.86, 1.24)	1.19 (0.90, 1.59)	0.95 (0.44, 2.06)	
Vitamin D Supplement	No	0.97 (0.80, 1.16)	1.00	1.00	
	Yes	0.94 (0.76, 1.17)	0.98 (0.74, 1.30)	0.84 (0.42, 1.67)	
Prior Fracture	No	0.99 (0.85, 1.16)	1.00	1.00	
	Yes	0.83 (0.60, 1.14)	0.84 (0.59, 1.19)	0.87 (0.33, 2.29)	
Height Loss	No	0.94 (0.80, 1.09)	1.00	1.00	
	Yes	1.07 (0.75, 1.53)	1.14 (0.77, 1.68)	0.59 (0.23, 1.48)	
Myalgia	No	0.95 (0.82, 1.11)	1.00	1.00	1.00
	Yes	0.98 (0.64, 1.51)	1.03 (0.65, 1.63)	0.39 (0.08, 1.85)	0.37 (0.13, 1.06)
<b>Study Factors</b>					
Receipt of Handout	No	0.95 (0.79, 1.14)	1.00	1.00	1.00
	Yes	0.97 (0.78, 1.21)	1.02 (0.77, 1.36)	1.61 (0.83, 3.11)	1.32 (0.93, 1.87)
Hypovitaminosis D	Yes	1.02 (0.76, 1.37)	1.00	1.00	
	No	0.94 (0.80, 1.10)	0.92 (0.66, 1.29)	1.55 (0.62, 3.89)	

a Rate Ratio relative to baseline

b Relative change in rate ratio compared to reference category

c Adjusted for demographic, health, and study factors

d Adjusted for gender, practice, handout, myalgia, and total visits (selected by Aikake's information criterion)

ample documentation of time pressures faced by primary care physicians when caring for patients.<sup>17-19</sup> Time constraints might impact patient care directly<sup>20</sup> or indirectly through low morale<sup>17</sup> or other mechanisms. For example, physicians identified lack of time as the greatest barrier to provision of dietary counseling to patients.<sup>20</sup> Our data support the concept that providers with less demanding workloads are more successful at incorporating changes into their clinical practice. These novel but preliminary observations require confirmation in future studies.

Our study has several limitations. The first is a small sample size, which limits the ability to detect all physician factors associated with a change in patient care following an educational intervention. Our study focused on the number of 25(OH)D tests ordered in a specific interval, without regard to whether a patient had risk factors, signs, or symptoms of deficiency meriting such measurement. While experts<sup>6-8</sup> recommend vitamin D measurement in patients taking medications that interfere with vitamin D metabolism and those with lim-

ited sun exposure, lactose intolerance, malabsorption, and malnutrition, we did not review the patient charts of physicians participating in this study to determine which patients met indications for vitamin D testing. Moreover, we studied testing rates in 3 different physician groups. As geriatricians care for elderly patients who commonly suffer from osteoporosis, it is not surprising that they had a higher baseline vitamin D testing rate. Additionally, we studied changes in testing rates over a short interval; whether a similar intervention can alter long-term practice is unknown. Finally, we studied faculty at a single academic institution. Other physician groups or health care professionals might manifest a greater or lesser change in practice performance following measurement of their own vitamin D levels.

## CONCLUSION

Our study suggests that a simple intervention, measuring vitamin D levels in physicians, has an effect on vitamin D testing rates in their patients. Workload, baseline performance, and specialty were associated with

increased vitamin D testing rates following measurement of their own levels. If future research confirms the influence of workload, baseline performance, or specialty on practice improvement efforts, educators could use such knowledge to enhance educational interventions toward physicians.

**Acknowledgments:** We thank the physicians who participated in this study. We thank the American Medical Association for supporting this study through a Seed Grant Award.

**Ethical Approval:** Secured through University of Wisconsin Human Subjects Committee.

**Financial Disclosures:** None declared.

**Funding/Support:** The study was supported by an American Medical Association Seed Grant Award. KEH received salary support during the conduct of this study from the NIH (K23 AR050995) and through a career development award in Geriatric Medicine (T. Franklin Williams Scholar Award) supported by the American College of Rheumatology, Association for Specialty Physicians, Atlantic Philanthropies, and the John A. Hartford Foundation.

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