

# Provider Recommendations in the Face of Scientific Uncertainty: An Analysis of Audio-Recorded Discussions about Vitamin D

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**BACKGROUND:** Little is known about how providers communicate recommendations when scientific uncertainty exists.

**OBJECTIVES:** To compare provider recommendations to those in the scientific literature, with a focus on whether uncertainty was communicated.

**DESIGN:** Qualitative (inductive systematic content analysis) and quantitative analysis of previously collected audio-recorded provider-patient office visits.

**PARTICIPANTS:** Sixty-one providers and a socio-economically diverse convenience sample of 603 of their patients from outpatient community- and academic-based primary care, integrative medicine, and complementary and alternative medicine provider offices in Southern California.

**MAIN MEASURES:** Comparison of provider information-giving about vitamin D to professional guidelines and scientific information for which conflicting recommendations or insufficient scientific evidence exists; certainty with which information was conveyed.

**RESULTS:** Ninety-two (15.3 %) of 603 visit discussions touched upon issues related to vitamin D testing, management and benefits. Vitamin D deficiency screening was discussed with 23 (25 %) patients, the definition of vitamin D deficiency with 21 (22.8 %), the optimal range for vitamin D levels with 26 (28.3 %), vitamin D supplementation dosing with 50 (54.3 %), and benefits of supplementation with 46 (50 %). For each of the professional guidelines/scientific information examined, providers conveyed information that deviated from professional guidelines and the existing scientific evidence. Of 166 statements made about vitamin D in this study, providers conveyed 160 (96.4 %) with certainty, without mention of any equivocal or contradictory evidence in the scientific literature. No uncertainty was mentioned when vitamin D dosing was discussed, even when recommended dosing was higher than guideline recommendations.

**CONCLUSIONS AND RELEVANCE:** Providers convey the vast majority of information and recommendations about vitamin D with certainty, even though the scientific literature contains inconsistent recommendations and declarations of inadequate evidence. Not communicating un-

certainty blurs the contrast between evidence-based recommendations and those without evidence. Providers should explore best practices for involving patients in decision-making by acknowledging the uncertainty behind their recommendations.

**KEY WORDS:** complementary and alternative medicine; provider-patient relations; dietary supplements; vitamin D; qualitative research methods; scientific uncertainty.

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## INTRODUCTION

Medical care is full of uncertainty. Uncertainty is inherent in most diagnostic and treatment decisions.<sup>1,2</sup> Decision-making is complicated by equivocal, insufficient or nonexistent scientific evidence, and by differences in provider or patient interpretations of the evidence. Medical communication guidelines suggest disclosing uncertainty to patients.<sup>3,4</sup> Yet providers typically fail to convey uncertainty,<sup>5</sup> and the scientific literature contains little information about provider recommendations in the context of uncertainty.

Vitamin D supplementation is a good topic for investigating provider-patient communication around scientific uncertainty, because 26–56 % of Americans take it,<sup>6</sup> but the medical literature lacks consensus about the definition of vitamin D deficiency, target optimal vitamin D levels, and the benefits of vitamin D. Vitamin D deficiency screening is increasing,<sup>7,8</sup> yet a 2015 United States Preventive Services Task Force (USPSTF) recommendation stated that current evidence is “insufficient to assess the balance of benefits and harms of screening for vitamin D deficiency” in asymptomatic adults.<sup>8</sup> The Institute of Medicine (IOM) and Endocrine Society agree that the general population does not need routine vitamin D deficiency screening.<sup>9–11</sup> However, the two organizations define vitamin D deficiency differently, and recommend maintaining different serum levels of 25-hydroxyvitamin D.<sup>9–12</sup>

In addition, there is insufficient or mixed evidence to support many of the benefits typically attributed to vitamin D, including its use for primary fracture prevention in premenopausal women or in men.<sup>13</sup> A systematic review showed that even though it reduces falls in older adults, vitamin D supplementation does not decrease fracture risk.<sup>14</sup> Overall, the

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evidence linking vitamin D to health outcomes other than rickets or osteomalacia is mixed or weak.<sup>15</sup>

This study investigates the content of provider–patient discussions about vitamin D testing, treatment and benefits during outpatient office visits with primary care and integrative/CAM providers. We examined transcripts of audio-recorded provider–patient office visits to: 1) describe the content of discussions about vitamin D; 2) compare provider recommendations to those in the scientific literature, with a focus on whether and how uncertainty was communicated; and 3) investigate the effect of provider specialty on explanations about the benefits of vitamin D.

## METHODS

### Study Design, Setting and Participants

This study analyzes data collected in 2011–2013 for a cross-sectional investigation of dietary supplement disclosure. The study protocol was approved by the University of California – Los Angeles and Kaiser Permanente Institutional Review Boards. Study procedure details are described elsewhere.<sup>16</sup> Patients were queried about their demographics, and provider–patient office visits were audio-recorded. Medical records were abstracted for documentation of osteoporosis or osteopenia in the 12 months prior to the day of the audio-recorded office visit.

Data were collected from 61 providers—32 PCPs from UCLA Medical Group (an academic medical setting), Kaiser Permanente (a group model HMO) and LA Net (a practice-based research network consisting of community clinics); 14 integrative medicine providers from an academic medical setting and community-based private practices; and 15 CAM providers (acupuncturists, chiropractors, naturopaths) recruited from private practices. Integrative medicine providers combine mainstream medical therapies with CAM therapies. Up to ten patients were recruited from waiting rooms of each participating provider. Patients were 18 years of age and older, and spoke either English or Spanish. Of 1512 patients approached for the study, 603 provided data used for this study (net response rate of 39.9 % [603/1512]), and 23 were ineligible, giving a 40.5 % study completion rate among eligible patients (603/[1512–23]).

### Qualitative Analysis of Transcripts

Audio-recordings were transcribed verbatim and a research assistant verified the accuracy of the transcriptions prior to analysis. ATLAS.ti (a qualitative analysis software program) was used to systematically search the 603 office visits for all references to the term “vitamin,” and transcripts were assessed for conversational content. Visits were iteratively analyzed and coded if they contained discussions about vitamin D deficiency screening, laboratory results, management, or benefits. Twenty of the 603 visits (3 %) were excluded from in-

depth analyses because they contained mentions of vitamin D supplement use without additional discussion.

We analyzed transcripts using inductive analysis, which involves generating themes from the data. Themes related to: 1) the need for vitamin D deficiency screening; 2) definition of vitamin D deficiency; 3) optimal vitamin D levels; and 4) dosing. We also used content analysis (a method that involves categorizing behavior and counting the number of times the behavior appears) to assess the benefits attributed to vitamin D. For each piece of information conveyed, we determined whether certainty or uncertainty was conveyed. For this analysis, we defined uncertainty very broadly, and included statements reflecting: scientific uncertainty (e.g., equivocal or contradictory evidence), provider uncertainty, discrepancy between a recommendation and existing scientific evidence/guidelines, and provider expressions of uncertainty (e.g., indicating that a vitamin D-related recommendation was not essential to follow).

The lead author (DMT) is a practicing family physician with expertise in provider–patient communication and qualitative analyses of office visits. She generated a list of themes from the data and reviewed them with DAP and NSW for consistency, context, and clinical relevance. DMT then applied codes representing the themes to all of the transcripts containing in-depth vitamin D discussions, and ascertained coding accuracy and consistency by examining lists of quotations assigned to each code. DAP coded 20 % of the transcripts, and inter-rater reliability was calculated (mean kappa score = 0.70).<sup>17</sup> DMT and DAP had complete agreement about the coding of statements for uncertainty. They resolved discrepancies in coding by discussion, and had no consistent patterns in disagreements.

### Comparison of Provider Recommendations and Scientific Evidence

The study examined five vitamin D-related recommendations with differing professional society guidelines and/or conflicting or insufficient scientific evidence:

- Vitamin D deficiency screening in asymptomatic adults
- Definition of vitamin D deficiency
- Optimal range for vitamin D level
- Dosing for vitamin D supplementation
- Benefits of vitamin D

We evaluated the content and categorized each provider statement about vitamin D to characterize how practices followed professional guidelines and available evidence.

### Quantitative Analyses

STATA statistical software, version 14.0, was used for all analyses. We calculated frequencies and cross tabulations to describe the study sample by the occurrence of vitamin D discussions during office visits, and used chi-square tests to assess relationships between categorical variables. Then we

tabulated the number of visits in which vitamin D-related recommendations/statements occurred by the certainty expressed for each recommendation/statement.

We also calculated frequencies with which providers mentioned different benefits of vitamin D (assessed through qualitative analyses of audio-recorded office visits). Multilevel modeling was used to examine the relationships between provider type and each benefit raised. The random provider effect of this model allowed us to control for the possible correlation of discussions within providers.

## RESULTS

Of 603 patient visits, 92 (15.3 %) contained conversations about vitamin D deficiency screening, management, or benefits. The 92 visits were conducted by 29 providers; ten PCPs, 13 integrative medicine, and six complementary and alternative medicine (CAM) providers. Half of the providers were female ( $n=15$ ; 51.7 %) and almost all were white ( $n=18$ ; 62.1 %) or Asian ( $n=9$ ; 31 %). Providers' mean age was 45.2 (SD=10.3).

Patients who had vitamin D discussions were more likely than those without discussions to have seen an integrative/CAM provider (84.8 vs. 41.3 %;  $p<0.001$ ), and to report taking a dietary supplement in the past 30 days (90.2 vs. 77.1 %;  $p=0.001$ ). They also were more likely to be white (67.4 vs. 39.5 %;  $p<0.001$ ) and to have at least some college education (91.3 vs. 72.7 %;  $p=0.001$ ) (Table 1). Medical record abstractions indicated that ten (10.9 %) of the 92 patients had either osteoporosis or osteopenia.

## Content of Vitamin D Discussions

Vitamin D deficiency screening was discussed with 22 (24 %) patients, the definition of vitamin D deficiency with 21 (22.8 %), optimal vitamin D levels with 26 (28.3 %), recommendations for vitamin D dosing with 50 (54.3 %), and benefits of supplementation with 46 (50 %). Providers initiated vitamin D supplementation for 23 of 92 (25 %) patients, increased the dose for 13 (14.1 %), and asked 36 (39.1 %) to continue their current dose.

The risks of taking too much vitamin D were discussed in four office visits. In two of the visits, patients asked their provider about potential risks. In the other two visits, the providers reassured patients about potential toxicity; as one provider stated: "nobody ever has problems taking vitamin D" [visit 253].

The cost of laboratory testing or insurance coverage for obtaining a vitamin D level were brought up in five visits (5.4 %), all by integrative/CAM providers. For example, in response to a query about insurance coverage, one provider responded, "Usually insurance isn't really good about being proactive. Like I like to look at a vitamin D level...so that's one that I don't know if Medicare thinks [is] medically necessary" [visit 510].

## Comparison of Provider Discussions and Scientific Evidence, and Communication of Certainty

For each of the five topics examined, some providers gave information that deviated from professional guidelines and existing scientific evidence. The codes we developed to describe these conversations are described in Table 2.

Table 1. Patient Characteristics

Patient characteristic	Number	Vitamin D lab tests discussed or recommendation made to take vitamin D (study sample)	No vitamin D lab tests discussed, no recommendation made to take vitamin D (excluded from study sample)	<i>p</i> value
Total <i>n</i>	603	92	511	
Age, mean (SD)	603	50.6 (14.5)	46.7 (16.6)	0.03
Gender, <i>n</i> (%)				0.1
Male	189	22 (23.9)	167 (32.7)	
Female	414	70 (76.1)	344 (67.3)	
Race / ethnicity, <i>n</i> (%)				< 0.001
White	264	62 (67.4)	202 (39.5)	
Hispanic	187	13 (14.1)	174 (34)	
Black	57	5 (5.4)	52 (10.2)	
Asian	37	4 (4.4)	33 (6.5)	
Other	58	8 (8.7)	50 (9.8)	
Taking dietary supplements, <i>n</i> (%)				0.004
Taking	477	83 (90.2)	394 (77.1)	
Not taking	126	9 (9.8)	117 (22.9)	
Education, <i>n</i> (%)				0.001
High school or less	147	8 (8.7)	139 (27.3)	
Some college	157	31 (33.7)	126 (24.8)	
College graduate	297	53 (57.6)	244 (47.9)	
Comorbidity score, mean (SD)	595	1.54 (1.5)	1.42 (2.0)	0.56
Hospitalized past 12 months, <i>n</i> (%)				0.99
Hospitalized	98	15 (16.3)	83 (16.2)	
Not hospitalized	505	77 (83.7)	428 (83.8)	
Specialty of provider seen, <i>n</i> (%)				< 0.001
Primary care	314	14 (15.2)	300 (58.7)	
Integrative / CAM	289	78 (84.8)	211 (41.3)	

**Table 2. Comparison of Professional Recommendations / Scientific Evidence versus Provider Recommendations / Statements about Vitamin D**

Professional recommendation / scientific evidence	Examples of provider recommendations and statements
Vitamin D deficiency screening The evidence on screening for vitamin D deficiency to improve health outcomes in asymptomatic adults is insufficient [USPSTF] <sup>8</sup>	Recommend screening for vitamin D deficiency <u>Certain statements</u> “If you don’t check [a vitamin D level], you don’t know how you are doing with that, and it’s so important.” [510] “Let’s get a bunch of labs...we’ve got your comprehensive metabolic panel, your cholesterol panel, blood count, thyroid, and then vitamin D.” [130] “And come back fasting, we’ll do a complete panel on you. I want to check your vitamin D, all your female hormones, cholesterol, everything, because it’s been a year.” [424] “And vitamin D, I like to know everyone’s vitamin D.” [726] <u>Uncertain statement</u> “If you’d like, we can do baseline [vitamin D] just to see kind of how you’re doing with your nutrients as well.” [452]
Definition of vitamin D deficiency There is no consensus about the cut-point values that define vitamin D deficiency – Endocrine society guidelines: all persons with average serum 25-hydroxyvitamin D values < 20 ng/ml are deficient <sup>12</sup> – IOM: there are different definitions of vitamin D deficiency depending on patient disease conditions or health-related considerations <sup>10</sup>	25-hydroxyvitamin D level ≤ 20 ng/ml is deficient <u>Uncertain statement</u> “...you know, if you go to a lab they say 20 is sort of low normal. That’s a lot lower than, you know, where it should be for a lot of, for optimal health. Some people are saying 30, some people are saying 50 for cancer prevention and all of that stuff.” [415] 25-hydroxyvitamin D level < 30 ng/ml is deficient <u>Certain statement</u> “I ran the vitamin D level too, so it’s lower than normal so it’s less than 30...so we may need you to have a supplement with some vitamin D, ok?” [122]  25-hydroxyvitamin D level between 40 and 70 ng/ml is deficient <u>Certain statements</u> “Um, your vitamin D is a little borderline. Yours is 34; I’d like to see it closer to 50.” [575] “Your vitamin D is wonderful, 53.8. So it should be between 50 and 80. That’s what we want, so that’s good.” [134] <u>Uncertain statement</u> “You see, one of the problems...with vitamin D is that the—there’s so much new research, and the labs, what they show is the normal is so far behind...So they’re saying, “Anything over 30 is normal,” and yet, it’s so far from optimum. So what—what I believe and [so do] most of the people who are really doing this, [is that] it’s—it’s anything over 50 is normal... So you could be in your thirties and be way under what you could be.” [930]
Optimal range for vitamin D levels There is no consensus about the optimal level of total serum 25-hydroxyvitamin D – Endocrine Society: target level of 30 ng/ml for maximum benefits <sup>12</sup> – IOM: above 20 ng/ml is sufficient for most people <sup>10</sup>	Recommend optimal vitamin D levels higher than lower end of laboratory range, with discussion of laboratory cutoff values <u>Certain statements</u> “Vitamin D—you’re certainly in the lab ranges. Ideal is about 50–85, so we want to plump that up a little bit.” [356] “You scooted into the lab ranges but you’re certainly far from optimal. I’d like to see you at around 60 or 70 almost.” [832] <u>Uncertain statement</u> “Vitamin D... you know, what the lab says is normal and what—and functioning people find, I mean, in terms of ...[normal levels for] mood, energy is—is a different thing.” [388] Recommend optimal vitamin D levels higher than lower end of laboratory range, without mention of laboratory cutoff values <u>Certain statement</u> “Your vitamin D level is not that bad. It’s 44. We could optimize it and bring it up to 60–100.” [447] Recommend optimal vitamin D levels in laboratory range <u>Certain statements</u> “Over here it says between 30 to 100 is still within normal range.” [357] “What they consider normal is 30 to 100.” [368]

(continued on next page)



Table 2.. (continued)

Professional recommendation / scientific evidence	Examples of provider recommendations and statements
<p>Dosing for vitamin D supplementation</p> <ul style="list-style-type: none"> <li>– Endocrine Society: deficient adults should be treated with 50,000 IU weekly or 6000 IU daily for 8 weeks, followed by 1500–2000 IU/day for maintenance<sup>12</sup></li> <li>– IOM: Recommended Dietary Allowance (amount needed to meet the needs of 97 % of the population) is 600 IU/day (800 IU/day for older adults), and recommended upper level of intake for adults aged 19 and older is 4000 IU/day<sup>10</sup></li> </ul>	<p>Vitamin D levels &lt; 30 ng/ml: Recommended dosing approximates guidelines for treating vitamin D deficiency</p> <p><u>Certain statements</u> “This is 50,000 a week. I need you on that for 4–8 weeks.” [802] “I would recommend 5,000 units day. So, your levels are still low. Your levels were 29, so we’d like to up that, and I want you to definitely stay on that for about 3 months” [920]</p> <p>Vitamin D levels &gt; 30 ng/ml (or not specifically mentioned) Recommended dosing approximates guidelines for RDA or maintenance dosing (between 800–2000 IU daily)</p> <p><u>Certain statement</u> Doctor: “[Vitamin D level] of 60 ...You’re my only patient with good vitamin D levels. How much are you taking?” Patient: “I take about 1000 a day, 1000 IUDs, IU” Doctor: “.. That is normal. That is the amount you should be on.” [560]</p> <p>Recommended dosing is higher than guideline recommendations</p> <p><u>Certain statements</u> “Your vitamin D levels are...in the lab ranges there...So, you know, you’re already on Vitamin D; I think I put you on that last time, right?...Yeah, I recommended—yeah, 5,000 IUs a day last time... I’m probably actually gonna even get you on 10,000 IUs for a couple weeks, and then, drop it down to 5,000 IUs.” [581] “We give that to everybody, 15,000 units a day...you’re 32 [for your vitamin D level]...so 15,000 units a day will definitely take care of that.” [295] “Um, your vitamin D is a very healthy level right now at 89. Have you been taking, um, 10,000? ...You’re great at that level. Um, you can stay there. I’ll recheck you...probably in about 3 months...If you’re hovering a little bit high...we can go to the 5000 marker.” [741]</p>
<p>Benefits of vitamin D</p> <ul style="list-style-type: none"> <li>– USPSTF: there is insufficient evidence to recommend using vitamin D for the primary prevention of fractures in premenopausal women and in men<sup>13</sup></li> <li>– Systematic review prepared for the Task Force indicates that vitamin D treatment is not associated with decreased fracture risk,<sup>15</sup> but observational studies have shown an association<sup>18–24</sup></li> <li>– There is inadequate evidence linking vitamin D to health outcomes such as immune disease, cardiovascular disease, cancer risk, quality of life<sup>15</sup></li> </ul>	<p>Presenting benefits of vitamin D that are not fully substantiated in the literature</p> <p><u>Certain statements</u> “The thing about vitamin D that’s so amazing is...it works on cancer. It works on heart disease. It works on strokes. It works on, you know, the immune system. It works on every system that they’ve ever tested.” [930] “Vitamin D’s very important for a lot of things—preventing of cancer, for one, modulating your immune system, ...it helps with your bones too... vitamin D is also good for the way your brain works. It helps your brain work better. It helps decrease inflammation. It has a lot of really, really good uses.” [855] “So vitamin D is great for immune support, especially for during the cold and flu season...it can also affect your bone growth and bone health as well” [122] “Vitamin D is also for your bones, mood and immunity” [468]</p>

Despite insufficient evidence to recommend vitamin D deficiency screening,<sup>8</sup> some patients were told that screening was very important or routine. In these situations, vitamin D levels were often presented in the context of other routine labs, such as cholesterol levels. Only one of these patients had osteoporosis or osteopenia. The only provider who expressed uncertainty about checking a vitamin D level did so by giving the patient the option of checking the level. None of the other providers mentioned that screening may be unnecessary.

Discussions about the definition of vitamin D deficiency frequently failed to follow the IOM guidelines (different definitions based on patient-specific medical history) or the cut-point values suggested by the Endocrine Society (< 20 ng/ml).<sup>10,12</sup> Some providers used laboratory cut-points (< 30 ng/ml) to guide their discussions about low vitamin D levels, while others used cut-points somewhere between 40 and 70 ng/ml. None of the patients counseled had osteoporosis or osteopenia. Uncertainty about the cut-points was presented in only four of 92 visits (4.3 %). One

provider expressed uncertainty to two patients about using a cut-point of < 20 ng/ml, by claiming that the cut-point was too low. Another provider said that providers have different definitions of vitamin D deficiency, and that his definition was based on “what I believe” and “new research.” He did not comment further about the types or validity of the research cited.

Integrative/CAM providers recommended higher optimal vitamin D levels than the Endocrine Society (30 ng/ml) and the IOM (20 ng/ml) in discussions with all but one patient. For example, some providers told patients that optimal levels started at the laboratory reference range of 30 ng/ml, but they often did not mention laboratory reference ranges or levels suggested by professional guidelines. Even when they described reference ranges in the context of recommending higher optimal ranges, providers did not convey the sort of uncertainty that is present in the scientific literature.

Integrative/CAM providers often recommended taking higher doses of vitamin D than suggested by the IOM and Endocrine Society. The integrative/CAM providers also suggested supplementation when patients had vitamin D levels within laboratory reference ranges. Only one of these patients had osteoporosis or osteopenia. One provider noted that during a previous visit, she had started the patient routinely on vitamin D 5000 IU daily without knowledge of the patient’s vitamin D level. After seeing the test results (which were within the normal laboratory reference range), the provider planned to temporarily increase the patient’s vitamin D dosing. This practice was relatively common for integrative/CAM providers; 9 of 25 (36 %) patients with normal vitamin D laboratory-tested levels were told to start or increase vitamin D supplementation, and six (24 %) were instructed to take 5000 IU or more daily. None of the discussions referenced specific guidelines for supplementation.

Of 165 recommendations or statements about vitamin D, providers expressed uncertainty about six (3.6 %) (Table 3). They

described no uncertainty when stating the benefits of vitamin D or discussing vitamin D supplementation dosing, even when their suggested dosing was higher than guideline recommendations.

## Benefits Attributed to Vitamin D

Providers made 94 statements about vitamin D’s benefits; 18 by primary care providers and 76 by integrative/CAM providers. The most commonly stated benefits were immune support and bone health (Fig. 1). Most discussions of immune support mentioned using vitamin D to decrease inflammation. PCPs cited bone health more often than integrative/CAM providers ( $p \leq 0.01$ ), and referenced immune support less than their counterparts ( $p \leq 0.01$ ). In fact, no PCPs described immune support as one of vitamin D’s benefits.

## DISCUSSION

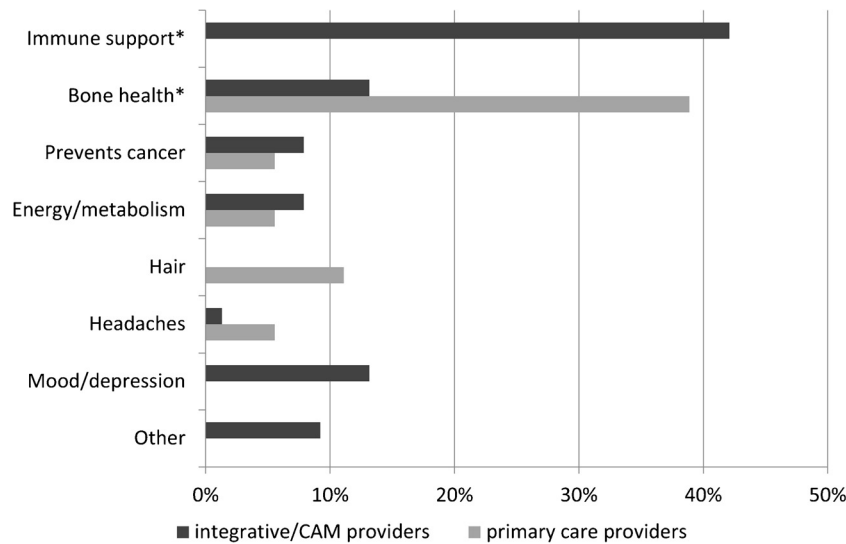
This study empirically examined the certainty with which providers convey information that (based professional guidelines and the scientific literature) is uncertain. Providers conveyed 96 % of the 165 vitamin D-related statements made during office visits with certainty, without mention of any equivocal or contradictory evidence in guidelines or the scientific literature. Even when their recommendations for vitamin D supplementation were inconsistent with professional guidelines, providers did not convey uncertainty or mention other management options.

We speculate a few reasons for this poor transparency in vitamin D-related discussions. First, providers with different training backgrounds and belief systems may use evidence such as personal beliefs, individual clinical experiences, or patient anecdotes to guide their practices, instead of relying on scientific evidence or professional guidelines.<sup>25,26</sup> In

**Table 3. Number of Visits in which Recommendations and Statements about Vitamin D Occurred, by Certainty Expressed for Each Recommendation / Statement\***

Provider recommendations and statements about vitamin D	Certain	Uncertain	Overall
Recommend screening for vitamin D deficiency, <i>n</i> (%)	21 (95.5)	1 (4.5)	22
Definition of vitamin D deficiency, <i>n</i> (%)			
25-hydroxyvitamin D level < 20 ng/ml is deficient	0	2 (100)	2
25-hydroxyvitamin D level < 30 ng/ml is deficient	7 (87.5)	1 (12.5)	8
25-hydroxyvitamin D level < 40–70 ng/ml is deficient	10 (90.9)	1 (9.1)	11
Optimal vitamin D levels, <i>n</i> (%)			
Recommend optimal vitamin D levels higher than lower end of laboratory range, without mention of laboratory cutoff values	15 (100)	0	15
Recommend optimal vitamin D levels higher than lower end of laboratory range, with discussion of laboratory cutoff values	8 (88.9)	1 (11.1)	9
Recommend optimal vitamin D levels in laboratory range	2 (100)	0	2
Vitamin D dosing, <i>n</i> (%)			
Vitamin D levels < 30 ng/ml:			
Recommended dosing approximates guidelines for treating vitamin D deficiency	13 (100)	0	13
Vitamin D levels > 30 ng/ml (or not specifically mentioned)			
Recommended dosing approximates guidelines for RDA or maintenance dosing (between 800 and 2000 IU daily)	9 (100)	0	9
Recommended dosing is higher than guideline recommendations	28 (100)	0	28
Benefits of vitamin D, <i>n</i> (%)	46 (100)	0	46
Total, <i>n</i> (%)	159 (96.4)	6 (3.6)	165

\* Discussions about the benefits of vitamin D were considered on a visit level because even though multiple benefits may have been conveyed during an office visit, they were all conveyed with the same amount of certainty



**Figure 1. Percentage of visits in which vitamin D benefits were mentioned, by provider specialty. Figure legend:  $n = 76$  for integrative/CAM providers and  $n = 18$  for primary care providers. If a bar is not shown, no provider of that type claimed that benefit for vitamin D. For instance, 42 % of integrative/CAM providers stated that vitamin D provided immune support whereas no primary care provider made such a statement. \*  $p \leq 0.01$  for comparison between integrative/CAM and primary care providers.**

particular, patients of integrative/CAM providers often value nonscientific expressions of evidence,<sup>25</sup> which may lead these providers to weigh experiential evidence more heavily than other providers. Second, providers may worry that statements of uncertainty confuse patients or create doubts about other provider recommendations.<sup>27</sup> Third, providers with multiple competing demands during office visits may not prioritize discussions of the uncertainty behind their recommendations.

Regardless of the reasons for nondisclosure of uncertainty, this study raises the larger issue of how and what providers *should* communicate in the face of scientific uncertainty. Based on the principles of shared decision-making, which have come to be expected in clinical encounters, providers should encourage patients to participate in medical decisions to the extent that patients desire.<sup>28</sup> Active participation would involve discussions of uncertainty and alternatives. Some existing studies suggest that when providers express uncertainty during medical encounters, patients are less satisfied and confident in their provider,<sup>29–31</sup> but these studies mostly examined scenarios in which providers indicated that they were unsure about proper treatments. Patient reactions to discussions of medical uncertainty require additional investigation. Future studies could examine strategies for assessing patient preferences for uncertainty discussions and for activating patients to express their discussion preferences.

Beyond misinforming patients, nondisclosure of uncertainty perpetuates the myth of certainty in medicine, and may lead patients to make decisions based on incomplete or potentially inaccurate information. This can lead to unwarranted patient confidence about their treatment, inappropriate decision making, personal regret when patients later wish they had made different choices, and potential resentment if patients feel providers should have helped them better navigate uncertainties.<sup>27</sup> Non-transparency about uncertainty also obscures the fact that some medical screening and treatment actions have a convincing

evidence base and others do not. We examined expressions of uncertainty only about vitamin D, but given the conflicting information around vitamin D, we expect these discussions to contain more expressions of uncertainty than statements about other treatments. Calling out which care processes are scientifically proven is critical to the practice of evidence-based medicine; acknowledging when evidence is lacking or equivocal is equally important and is essential for informed decision making.

On the surface, the content of provider recommendations in this study do not seem problematic. None of the recommendations seem likely to be harmful and none contradicted strongly worded or evidence-based guidelines. After all, Vitamin D intoxication can occur,<sup>32</sup> but it is rare and does not generally occur with oral vitamin D treatment.<sup>8</sup> However, newly emerging evidence suggests that previously unrecognized harms may exist, with recent findings showing that high-dose vitamin D supplementation increases the risk of falls in certain older adults.<sup>33</sup> Other harms involve increased patient and healthcare system costs. The costs of paying for something unnecessary or of limited benefit may be particularly burdensome for low-income patients. The costs of unnecessary testing (and retesting) of vitamin D levels can add up. There is also the emotional cost of worrying about an “abnormal” test. The missing precision in communicating the base of recommendations is also problematic. For example, the manner in which laboratory tests are presented create expectations for testing and treatment. In a broader context, lack of discussion about uncertainty when making recommendations may lead to patient misunderstandings about the necessity and utility of unwarranted bigger ticket tests, such as cardiac screening and whole body screening imaging, and may result in overtesting. We suggest that to more accurately inform patients, providers should temper their recommendations when the scientific evidence is equivocal, insufficient, or is variably interpreted by professional organizations.<sup>3,4</sup>

This study has several limitations. First, data were collected before the USPSTF's "Indeterminate" recommendation about vitamin D deficiency screening in asymptomatic adults was released. Though the evidence behind the recommendation is not new, the recommendation may have led providers to change their practice patterns. Second, providers and patients may have altered their discussions because the visits were being audio-recorded. However, our data were originally collected to address different study aims about supplements, and previous studies have shown no changes in behavior when visits were recorded.<sup>34</sup> Third, this study investigated only what was verbally conveyed during office visits, and did not capture provider beliefs or practices that were not shared with patients or that were shared in visits other than the recorded visit. Lastly, most of the discussions in this study were with integrative/CAM providers, who discussed vitamin D more frequently than PCPs. However, since providers infrequently conveyed uncertainty, it was difficult to assess variations in discussion approaches based on provider type. The effect of provider type on expressions of uncertainty requires further exploration.

When certainty is expressed to patients about information that is uncertain in the scientific literature, patients might unwittingly accept testing and treatment that they may otherwise have declined. Providers have an ethical obligation to share uncertainty with patients, but studies are needed to investigate how uncertainty is best conveyed, patients' desires for hearing about scientific evidence, and the influence of discussions about uncertainty on patient medical decision-making. Regardless of whether scientific evidence is shared with patients, providers should avoid presenting scientifically uncertain recommendations with certainty.

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#### Compliance with Ethical Standards:

**Conflicts of Interest:** The authors declare no conflicts of interest.

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