Global Advances in Integrative Medicine and Health
Volume 12: 1–14

DOI: 10.1177/27536130231215029
journals.sagepub.com/home/gam
Sage

Healthcare Professionals' Perspectives on Improving Dietary Supplement Documentation in the Electronic Medical Record: Current Challenges and Opportunities to Enhance Quality of Care and Patient Safety

Zachary O. Kadro, ND, MPH[1,2,3,4], Aisha Chilcoat, ND, MPH[1], Jacob Hill, ND, MS[5], Stephanie Kenney, PharmD[6], Catharine Nguyen, PharmD[7], Elana Post, PharmD[8], Amanda H. Corbett, PharmD[9], Gary N. Asher, MD, MPH[10], and Keturah Faurot, PhD, MPH, PA[1]

Abstract

Background: Around half the US population uses dietary supplements (DS), and concomitant use with medications is common. Many DS include bioactive substances that can interact with medications; therefore, accurate tracking is critical for patient safety. Unfortunately, documentation of patients' DS use is often missing or incomplete in the electronic medical record (EMR), leaving patients susceptible to potential adverse events. Novel approaches to assist healthcare professionals (HCPs) in capturing patients' DS use are needed.
Objective: To assess HCPs' perspectives on challenges and facilitators of DS documentation in the EMR and their opinions on a proposed mHealth application (app) to aid in DS capture.
Methods: HCPs, recruited from professional networks, largely in North Carolina, using purposive sampling, took part in semi-structured interviews. We inquired about HCPs' experiences with DS documentation in the EMR and their opinions about our proposed mHealth app. Interviews were recorded, transcribed, and coded. Thematic analysis included deductive codes based on the interview guide, and inductive codes that emerged during transcript review.
Results: HCPs (N = 30) included 60% females, mean age 46 ± 10; 70% White. Pharmacists (20%), nurses (17%), and physicians (17%) were the most represented professions. Years in practice ranged from 3–35 years. Most HCPs were concerned about DS

[1]Department of Physical Medicine and Rehabilitation, Program on Integrative Medicine, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA
[2]Integrative Medicine Program, Division of Supportive Care, Fred Hutch Cancer Center, Seattle, WA, USA
[3]Division of Public Health Sciences, Cancer Prevention Program, Fred Hutch Cancer Center, Seattle, WA, USA
[4]Division of Medical Oncology, University of Washington School of Medicine, Seattle, WA, USA
[5]Department of Wellness and Preventive Medicine, Cleveland Clinic, Cleveland, OH, USA
[6]University of California San Diego Skaggs School of Pharmacy and Pharmaceutical Sciences, La Jolla, CA, USA
[7]Janssen Pharmaceutical Companies of Johnson and Johnson, Titusville, NJ, USA
[8]Clinical Pharmacologist, Vertex Pharmaceuticals Inc, Boston, MA, USA
[9]Division of Pharmacotherapy and Experimental Therapeutics, University of North Carolina Eshelman School of Pharmacy, Chapel Hill, NC, USA
[10]Department of Family Medicine, Director Integrative Medicine Services, Lineberger Comprehensive Cancer Center, University of North Carolina School of Medicine, Chapel Hill, NC, USA

Corresponding Author:
Keturah Faurot, PhD, MPH, PA, Department of Physical Medicine and Rehabilitation, Program on Integrative Medicine, University of North Carolina at Chapel Hill, 101 Manning Drive, Chapel Hill, NC 27599-7200, USA.
Email: faurot@med.unc.edu

Data Availability Statement included at the end of the article

safety and potential supplement-drug interactions, and cited several barriers to accurate EMR DS documentation including time constraints, database inconsistencies, and poor patient-HCP communication about DS. HCPs' views on our proposed mHealth app were generally positive. They expressed that our proposed mHealth app could streamline documentation processes and enhance patient-provider communication. HCPs expressed desire for a high-quality mHealth app that includes access to evidence-based DS information, integrates with the EMR, and does not increase time burdens.
Conclusion: HCPs believe documentation of patients' DS use is important but not accurately captured in the EMR. Support was expressed for our proposed barcode-scanning DS mHealth app.

Keywords
qualitative research, integrative medicine, dietary supplements, mobile health, medication reconciliation

Received May 18, 2023; Revised November 1, 2023. Accepted for publication October 27, 2023

Introduction

Dietary supplement use is common throughout the United States (US) with an estimated 58% of US adults reporting current use of supplements based on data from the 2017-2018 National Health and Nutrition Examination Survey (NHANES).[1] Concomitant use of dietary supplements and prescription medications in the US is estimated to be between 34% and 66%, and among older adults, aged 62-80 years, 15% are estimated to be at risk of potential major drug-drug, drug-dietary supplement, or drug-herb interactions.[2,3,4] Dietary supplement use is especially common among older adults, especially people taking multiple prescription medications,[5] as well as people diagnosed with cancer, and people with multiple chronic conditions.[6,7] For example, a study using NHANES data from 2003-2016 found that 70% of cancer survivors reported dietary supplement use compared with 51% of people without cancer.[2] Concomitant use of dietary supplements and prescription medications is also more common among people with chronic medical conditions (47% vs. 17%).[2]

Dietary supplements are available without a prescription in the United States, leading many people to presume they have low potential for harm.[8,9] However, there are safety concerns associated with dietary supplement use; these include adverse events, which were estimated to be 22% among users in one study, and the potential for serious drug-supplement interactions which were estimated in another study to be 49% among patients concomitantly using dietary supplements and tetracycline antibiotics or antihypertensive medications.[10,11] There are additional safety concerns about direct toxicity, overdose, and adverse events resulting from ingestion of dietary supplements tainted with pharmaceutical drugs and/or undisclosed ingredients. For example, one woman suffered a hemorrhagic stroke while exercising after ingesting a sports supplement with an undisclosed amphetamine-like ingredient called β-Methylphenyl-ethylamine.[12] Between 2007-2016 the US Food and Drug Administration issued warnings for unapproved pharmaceutical ingredients in 776 dietary supplements.[13] There is also poor communication about dietary supplement use between patients and healthcare professionals (HCPs). For example, one study reported that during inpatient hospital stays, only 6% of patients were asked about dietary supplement use and had this documented in their medical record.[14] A 2019 systematic review and meta-analysis (N = 11,754) estimated patient disclosure rates of dietary supplement use to be 33% (95% CI: 24% to 43%).[15] Patients also often initiate dietary supplement use without consulting a HCP. For example, a study of 2772 adult cancer survivors found that 46% of participants utilized dietary supplements without consulting a HCP.[7] The Joint Commission and the American Society of Health-System Pharmacists recommend monitoring patient use of dietary supplements; however, many health systems lack policies and procedures to accurately document dietary supplement use.[16] These data highlight a gap in patient-provider communication about patients' dietary supplement use and a lack of accurate capture of patients' dietary supplements information in the electronic medical record (EMR); the combination of these factors make it difficult for HCPs to prevent poor safety outcomes related to patients' use of dietary supplements.

Health technology may provide a solution to assist with dietary supplement capture in the clinical setting, but EMR systems do not currently support accurate dietary supplement capture and documentation. For example, medication databases within EMRs are incomplete and do not contain the estimated 85,000 different dietary supplement products available to consumers in the US; they also omit many combination products with multiple ingredients entirely.[17] It can even be difficult to find exact matches for products containing a single vitamin, herb, or mineral. Barcode scanning and product databases have advanced the accuracy and efficiency of data input across several industries including retail and shipping and hold the potential for implementation in healthcare.[18,19] Many healthcare systems have already integrated barcode scanning with handheld devices into medication verification; for example, one study reported significantly higher user satisfaction and quality of information gathered compared to manual medication entry methods.[20] However, utilizing handheld devices or mobile

health (mHealth) applications (apps) to capture dietary supplement information through barcode scanning, QR codes, or image recognition technology have yet to be implemented for capture of dietary supplement information in clinical care.

In a previous publication we reported results from a qualitative focus group study assessing patient perspectives on the development of a novel mHealth app to assist with dietary supplement documentation in the EMR.[21] In this study, we extended our investigation to HCPs where we sought to understand the clinical experiences, opinions, and perspectives of HCPs regarding patients' use of dietary supplements, patient-provider communication about dietary supplements, and current challenges with accurately capturing and documenting patients' dietary supplement use in the EMR. We also sought to obtain HCPs' opinions and recommendations about a proposed mHealth app to improve capture and documentation of dietary supplements in the EMR.

Methods

Participants and Recruitment

Adult participants were recruited through purposive sampling with the intent of recruiting HCPs from differing job roles including physicians (e.g., internists, oncologists, infectious disease specialists, and family medicine practitioners), nurses, pharmacists, dietitians, physician assistants, naturopathic doctors, and medical assistants. A broad representation of the multiple types of HCP stakeholders involved in collecting and assessing dietary supplement information was felt to be important to understanding the challenges and potential solutions to the reconciliation of dietary supplement data. Racial and gender diversity was also considered during the recruitment of participants. For example, utilizing their collective professional networks and a "snowball" approach, the researchers made the decision to contact potential participants from minoritized groups when possible, with the aim of achieving a racial and gender distribution that reflected the larger population from which the sample was recruited. Most recruitment occurred within the University of North Carolina (UNC) Health System but also extended to other organizations across the country to ensure a wide variety of HCP types. These included the VA Health System outside NC, the University of Minnesota, a representative of the dietary supplement industry, and the Goshen Health System. Potential participants were contacted via email about their interest in the study. Participants expressing interest were provided with more information prior to the interview, including the questions that would be asked, the composition of the research team, and the goals of the research study. Many of the study participants had a pre-existing professional relationship with one of the investigators but not necessarily the researchers who conducted the interviews. All participants provided verbal informed consent for participation. This study was approved by the University of North Carolina Institutional Review Board (#18-2099).

Conceptual Model

The HCP interviews were designed to elicit stakeholder input on clinical experiences and perspectives related to dietary supplement tracking and reconciliation and for the development of a mHealth application, including desired features, that could be used to identify and track dietary supplement use. A parallel study, already reported, investigated patients' perspectives on the proposed mHealth application and describes the conceptual model we used for both studies in detail.[21] Briefly, the conceptual model, based on the Unified Technology Acceptance and Use of Technology (UTAUT) model with added constructs from the Health Belief Model, influenced the construction of the interview guide (Appendix 1).[22,24] UTAUT has been applied to studies of technology acceptance among providers.[25] Key constructs include effort expectancy (beliefs about how easy the product would be to use), performance expectancy (beliefs about product features and reliability), social influence (intent to recommend the product to patients), and behavioral intention (intent to use the product in clinical care). Health Belief Model constructs included perceived threat (safety of dietary supplements) and perceived benefit (potential advantages related to the use of the mHealth application).[24] Examples of interview questions included 1) How comfortable are you in discussing supplement use with patients? 2) How do you feel about the importance of documenting dietary supplement use in the clinical record? 3) As described, how easy do you think the proposed app would be to use? 4) If the app were available today, how likely would it be for you to use it or recommend it to your patients? 5) What risks or downsides do you see to this type of mHealth app?

Research Team and Data Collection

Data was collected through a series of investigator-facilitated HCP interviews between 2019 and 2021. At least one investigator and one interviewee took part in each HCP interview, often with a second interviewer to take notes. Interviews were conducted by members of the research team (ZK, JH, KF, AC, KN, EP, SK, and AHC), using an interview guide with scripted questions developed as part of the research protocol (Supplemental file: Interview Guide). Co-investigators JH, KF, and AHC are experienced qualitative researchers and trained the research associates (ZK, KN, EP, SK, and AC). At the time of the interview, HCPs were shown a slide deck that described the research, the proposed app, and assumptions of the research team. HCPs self-reported sociodemographic and professional characteristics from open-ended questions (e.g., "with what race and/or ethnicities do you identify?"). Interviews were conducted either in person,

by telephone, or through video conference using Zoom (*Zoom Video Communications, Inc., San Jose, CA*). Interviews were audio-recorded and transcribed verbatim; they were supplemented by detailed notes taken at the time of the interview about responses and context. Each HCP participated in only one 20-30-minute interview, and HCPs were not re-contacted to review the transcripts. Participants received a $25 gift card as compensation for their time. Confidentiality was protected by careful data management and storage, relying on the use of the REDCap (Research Electronic Data Capture) electronic data capture tools.[25,26] Interviews were conducted until the study team felt that data saturation was achieved.

Data Analysis Methods

After the interviews were transcribed, transcripts were checked by a member of the research team for accuracy and compared with the interview notes. Transcripts were uploaded into ATLAS.ti *(version 8 for Windows, Scientific Software Development GmbH, Berlin, Germany)*. At least two team members coded each interview. Initial codes were related to the conceptual model, but more codes were generated by four team members (ZK, KF, AC, and SK) in response to the data (Supplemental Table 1. Codebook). Codes were compared through team meetings and modified by consensus. A coding tree was developed using grouped codes in Atlas.ti software and by using a virtual whiteboard in Microsoft Teams for visual representation (Supplemental Figure 1: Whiteboard). The analysis used an iterative process, based on within-interview and between-interview examinations by all four team members, to group codes into themes and subthemes using codes from within and between interviews. The team decided on final themes with associated quotations. The consolidated criteria for reporting qualitative research (COREQ) checklist guided the conduct of the study.[27]

Results

Study Participant Characteristics

Thirty HCPs from a variety of clinical backgrounds (e.g., 6 pharmacists, 5 physicians, and 5 nurses participated in interviews) (Table 1). We approached 37 people about participating and had an 81% response rate. We interviewed 30 people; two people declined to be interviewed; one person needed to reschedule the interview but was unable to coordinate a time during additional communications; four people were unresponsive to the invitation to participate. The majority (60%) of the interviewees were female and most (70%) self-identified as White or Caucasian. The average age of interviewees was 46 years and most (81%) reported current use of dietary supplements themselves. Participants came from a variety of practice settings including community pharmacies, emergency medicine, family medicine, oncology, infections disease, bariatrics, physical medicine, and acute care.

Documentation of Dietary Supplements in the EMR

We interviewed HCPs about their clinical experiences and perspectives on patients' use of dietary supplements and documentation of dietary supplement use in the EMR and identified five themes: 1) HCPs felt documentation of patients' dietary supplement use in the EMR is important but not well executed for the following reasons; 2) the time required to enter dietary supplement information into the EMR; 3) the process of entering dietary supplement information into the EMR; 4) communication problems between providers, technicians, and patients about dietary supplement use; 5) provider safety concerns regarding dietary supplement use. Figure 1 illustrates the reasons for inadequate documentation of dietary supplements in the EMR identified by HCPs. Representative quotes illustrating the five themes related to HCPs' clinical experiences and perspectives on patient use of dietary supplements and the challenges of documenting patients' dietary supplement use in the EMR are presented in Table 2.

Theme 1: Documentation of Dietary Supplement use in the EMR is Important to HCPs but is Often not Well-Documented

HCPs expressed that documentation of dietary supplements in the EMR is important but also noted that its documentation, when it is done, is often inaccurate or incomplete (Figure 1 and Table 2). Reasons for the incomplete or inaccurate documentation of dietary supplements in the EMR are further explained in themes 2, 3, and 4 below, and in Figure 1 and Table 2.

Theme 2: Time Required to Enter Dietary Supplement Information into the EMR

HCPs identified time constraints of clinical visits as a hindrance to the documentation of patients' dietary supplements in the EMR (Figure 1 and Table 2). Additionally, the manual process of entering the dietary supplement information into the EMR is time-consuming, and technical reasons for this are presented in theme 3.

Theme 3: Problems With the Technical Process of Entering Dietary Supplement Information into the EMR

HCPs identified problems with the technical process of dietary supplement entry into the EMR (Figure 1 and Table 2). For example, they reported that existing EMR databases do not have complete information on the full range of dietary

Table 1. Sociodemographic and Professional Characteristics of Healthcare Professionals (N = 30)[a,b].

Characteristic[c]	
Gender - no. (%)	
Female	18 (60)
Female to Male	1 (3)
Male	11 (37)
Age – years[c](mean ± SD) (n = 28)	46 ± 10
Race and ethnicity - no. (%)	
African American or Black[d]	6 (22)
Asian	1 (4)
Asian and Caucasian	1 (4)
White or Caucasian[e]	19 (70)
Years in practice - no. (%)[f]	
0-5	3 (10)
6-10	4 (14)
11-15	10 (34)
16-20	7 (24)
21-25	2 (7)
26+	3 (10)
Profession - no. (%)	
Dietitian	3 (10)
Medical assistant	4 (13)
Naturopathic doctor (ND)	3 (10)
Nurse (e.g., RN, nurse practitioner)	5 (17)
Pharmacist	6 (20)
Physician (MD/DO)	5 (17)
Physician assistant	4 (13)
What percentage of your patients do you estimate use dietary supplements?[g] (mean ± SD) (n = 29)	60% ± 26%
In the past 30 days, what percentage of your patient encounters have included a discussion of dietary supplement use? (Mean ± SD) (n = 26)	42% ± 43%
Do you use dietary supplements yourself? (n = 26) - no. (%)	Yes: 21 (81) No: 5 (19)

[a]Healthcare Professionals self-reported sociodemographic and professional characteristics from open-ended questions (e.g., "with what race and/or ethnicities do you identify?").
[b]Plus-minus values are means ± SD (Standard Deviation).
[c]Sociodemographic and professional characteristic data was available for most but not all HCPs: Age (n = 28), Race and/or ethnicity (n = 27), Years in practice (n = 29).
[d]Self-identified as African American (n = 5), Black (n = 1).
[e]Self-identified as White (n = 5), Caucasian (n = 10), White/Caucasian (n = 4).
[f]Total does not add up to 100 because percentages were rounded to the nearest whole number.
[g]There were n = 29 responders to the questions about the percentage of patients using dietary supplements, and n = 26 responders to the question about supplement discussions with patients and personal use of supplements.

supplement products available to consumers. This leads to inaccuracies in the patient's medication and dietary supplement list and can contribute to patient, provider, and technician frustration. If the exact product a patient is taking is not contained in the EMR database, providers and technicians (e.g., medical assistants) will typically employ one of four strategies: 1) enter a generic product they believe is similar to what the patient is taking; 2) add the product as a free-text item in their medication list; 3) document the product in the patient's chart note; 4) leave the product out of the patient's record entirely. We also heard from providers and technicians that poor patient recall of detailed dietary supplement information like product names, dosage, and ingredients also hinders the technical process of their entry into the EMR.

Theme 4: Communication Problems Between Providers, Technicians, and Patients About Dietary Supplement Use

HCPs of all types recognized poor patient-provider communication about dietary supplement use as a major problem (Figure 1 and Table 2). Participants identified that this may occur because HCPs do not always ask about dietary supplement use, and because patients may not volunteer the

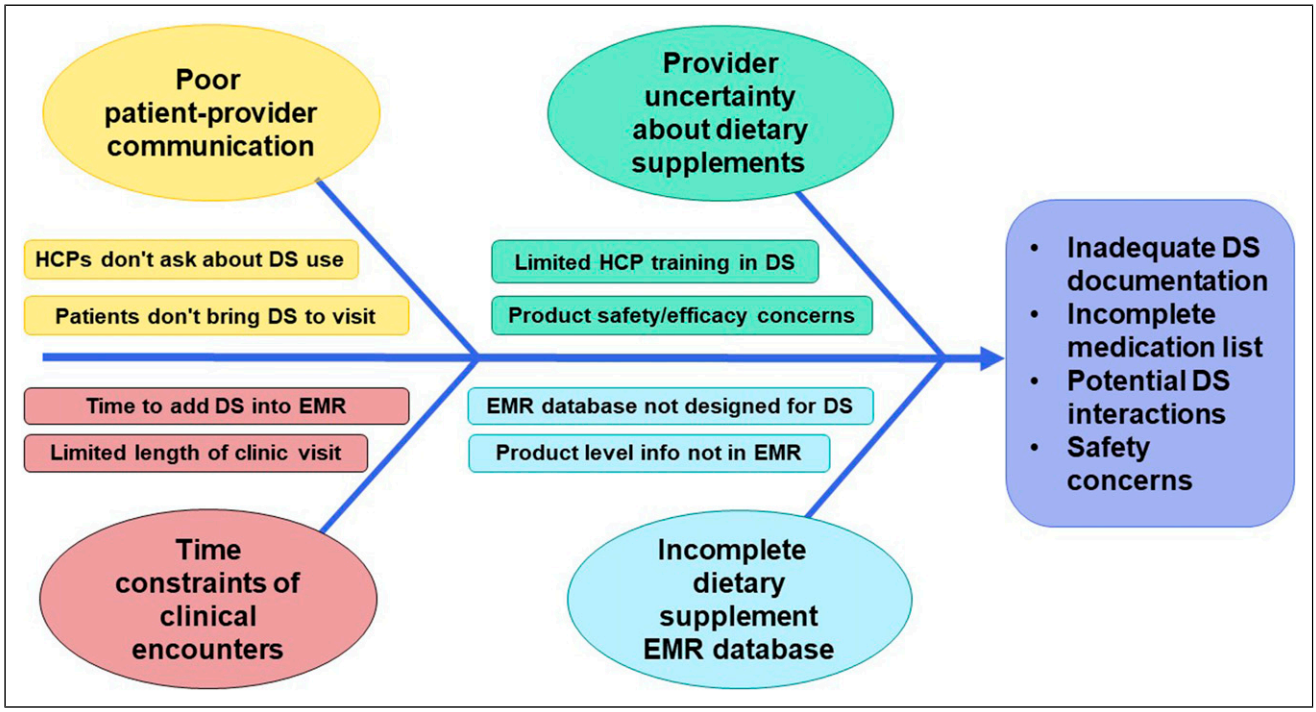

Figure 1. Fishbone diagram depicting themes related to healthcare professionals' (HCPs) clinical experiences and perspectives on patients' use of dietary supplements (DS) and challenges of documenting patients' DS use in the electronic medical record (EMR).

information to providers. HCPs also expressed that some patients do not disclose their use of dietary supplements for fear of provider disapproval.

Theme 5: Provider Safety Concerns of Dietary Supplement use and Supplement-Drug Interactions (SDI)

HCPs of all types expressed concerns over the safety of dietary supplement use and the potential for interactions between dietary supplements and medications, supplement-supplement interactions, and interactions between supplements and medical conditions or disease processes. HCPs identified a common belief among patients that dietary supplements are safe because they are available without prescription; some HCPs also reported seeing abnormal lab values, symptoms, or adverse events that were suspected to be related to their patient's dietary supplement use (Figure 1 and Table 2).

HCP Opinions About App Construction

We elicited opinions and recommendations on the risks, benefits, functionality, and design of a proposed mHealth application to improve tracking and reconciliation of dietary supplement use using qualitative interviews among stakeholders. We identified three main themes: 1) benefits of the proposed app and facilitators of use; 2) risks associated with the proposed app and barriers to use; and 3) recommendations for improvements in the proposed app design. Several subthemes related to these themes are presented below and in Table 3.

Theme 1: Benefits of the Proposed App and Facilitators of Use

Subtheme 1a—App May Improve Reconciliation. HCPs believed that the proposed app would improve reconciliation. Many HCPs felt that the app had the potential to lead to a more accurate list of the dietary supplements their patients were taking.

Subtheme 1b—App May Save Time. Most HCPs expressed a belief that the app would save time in the clinical encounter by streamlining the documentation and reconciliation process. If patients are able to generate their own dietary supplement list and upload their dietary supplement list, the HCP only needs to verify the list with them.

Subtheme 1c—App May Uncover Safety Threats. HCPs who were especially concerned about the safety of dietary supplements said that the app may be able to uncover potential safety threats, either those related to supplement-drug interactions or to adverse effects from the supplements. They saw this as an added benefit of the app.

Table 2. Representative Quotes From HCPs About their Clinical Experiences and Perspectives on Patient Use of Dietary Supplements and Challenges of Documenting Patient's Dietary Supplement Use in the EMR.

Theme	Representative Quote
Theme 1: Documentation of dietary supplement use in the EMR is important to providers and technicians but is often not well-documented	*"I think it's important [to capture dietary supplement use]; I think it's not well done." – ID 27, Naturopathic Doctor* *"I don't know if we have good entries to where they are entering it [dietary supplements] accurately..." – ID 18, Pharmacist*
Theme 2: Time Required to Enter Dietary Supplement Information into the EMR	*"We have so many people that come in and they'll have a mile-long list of medications, and it's hard putting all those medications in, in the short time that we have to room them." – ID 37, Medical Assistant* *"The biggest thing I think is time. You know, we just don't feel like we have enough time, because we push in and push out. I think it's super important." – ID 31, Nurse* *"Some of these lists that patients that we have are, one, they're not being reconciled very frequently. Students and I can take sometimes 15 to 20 minutes just reconciling active medications that patients are on." – ID 39, Naturopathic Doctor* *"And often, in the ER we don't have time to do a full med reconciliation, I'm also a hospitalist, so I do… when I talk to someone in the hospital, usually it's more as a hospitalist, when I do a better med reconciliation, but in the ER with less time, it'd be nice to be able to see that information, just like I can see that they're taking a daily aspirin or Statin." – ID 15, Physician Assistant*
Theme 3: Problems with the technical process of entering dietary supplement information into the EMR	*"I do, I think they [patients] get frustrated during their medical record reconciliations, when the nurse can't find it either [in the EMR]." – ID 15, Physician Assistant* *"Sometimes they don't give me a name or the dose – they do give the dose, but they don't necessarily give me a brand name, they will tell me that they're taking for example magnesium, so I will put it in generic because that's the way they gave it to me." – ID 35, Medical Assistant*
Theme 4: Communication problems between providers, technicians, and patients about dietary supplement use	*"Patients are sometimes hesitant to talk about supplements because they think we are going to automatically say no to using them. But I try to give them a sense that they have power." – ID 9, Dietitian* *"Many people don't share that with their provider unless asked. I mean I have patients in the hospital who bring in their supplements and don't tell anyone." – ID 13, Dietitian* *"Without proper conversation and without the proper training especially for like clinicians like myself, and then you know, then they can be misused by patients and then you may not even know, like, how to guide patients the right way." – ID 10, Pharmacist* *"a lot of patients are taking them, and I don't certainly know exactly why they are taking certain things." – ID 31, Nurse*
Theme 5: Provider safety concerns regarding dietary supplement use.	*"A lot of dietary supplements can have interactions, that I don't know that we know very well yet and they do have significant impact on their health. That's helpful for us to know all medicines [patients] are taking regardless of prescription or not." – ID 15, Physician Assistant* *"One of my major concerns is drug interactions with prescription medications and supplements." – ID 19, Physician* *"So often individuals feel like if you can buy it off the shelf, if it doesn't require a prescription, then it's safe to use and can be used and should be used without any consideration for potential interaction or negative effects" – ID 5, Physician Assistant* *"I've had people who show up in the hospital or show up in a clinic and they have these lab abnormalities, and I might have a concern that the supplement that they're on might be contributing to this…" –ID 11, Physician* *"Yeah, I can you know, I can I've had situations where you know, they [patient] had adverse event and I said it might have been caused by the agent that [contains] the natural supplement." – ID 16, Pharmacist* *"Often, it's hard to tell if [the] adverse event is related to [a] supplement or everything else going on with their history. Definitely something we discuss often to determine if [it's an] adverse event." – ID 27, Naturopathic Doctor*

Table 3. Representative Quotes Related to the Barriers and Facilitators of App Use.

Theme/Subtheme	Representative Quotes
Theme 1. Benefits/Facilitators	
1a. Improve reconciliation	*"It could help make the process of understanding what the patients are taking and what the quality of the product is, ideally in addition to the just the general product information such as certificate of analysis what are they measuring like complex herbal formulary, specific constituent, grams of herb, etc. when making clinical decisions. The ease of getting consistent information and the quality of the information into EMR is huge." - ID 28, Naturopathic Doctor* *"Sounds like it could make our med lists more accurate, especially if I'm not the one importing the information. Would allow the staff to import more quickly and not read labels of things they're unfamiliar with and get all the ingredients and getting them in the EMR." - ID 27, Naturopathic Doctor* *"I would recommend it to everybody because a number one frustration of mine is: why would you come to the doctor if you don't have a list with you, you know, of your medications? I think it would be very handy for both the patient and us, you know, to have that available." - ID 35, Medical Assistant*
1b. Save time	*"…just making my job a little bit easier when I'm putting their information into their chart." ID 38, Medical Assistant* *"I think it would give me more time with the patient and it would allow me to spend less time trying to enter and figure out. And more time to synthesize and work through next steps." ID 13, Pharmacist* *"Definitely decrease time to do that medical reconciliation. Some of these lists that patients that we have are not being reconciled very frequently." ID 39, Naturopathic Doctor*
1c. Uncover safety threats	*"Number one, it would help with safety. I do worry interactions aren't caught and we are not able to accurately able to get the drug in there correctly. So, I think safety would be the biggest thing. So, it would increase accuracy." - ID 31, Nurse* *"…could these supplements interacting with or be contributing to even a... a symptom that a patient might be experiencing and having this information... knowing what they're taking in a very short period of time, for the standard medical appointments that are now commonplace." ID 5, Physician Assistant*
1d. Enhance communication and patient education	*"I'd probably be very, very willing to tell my patients about it because the more you arm a patient about their overall health and what they're putting in their bodies, the better educated they are, and it makes our job as healthcare providers more streamlined." ID 23, Pharmacist* *"As long as that's on there, it's like a lot of information also to help educate the person that's taking it. I think that'd be good." - ID 38, Medical Assistant*
Theme 2: Risks/Barriers to use	
2a. Potential negative impact on workflow	*"Another barrier let's way the workflow within a clinic making sure can be making sure the scanner device is available to speed along the process…certain patients might not be savvy with the app." ID 19, Physician* *"I think it'll be a challenge… for any time you introduce something more that has to be done, even if it's the smallest thing… when you have to click, the benefits outweigh the risks and move on, you still have five clicks." ID 21, Physician Assistant*
2b. DS information inadequate	*"I think that areas where I'm not confident in my knowledge is because there is a large lack of good data on it's on their use in our patient population." ID 8, Physician Assistant* *"…wide variety of DS available and lack of detailed info on components of each DS." ID 4, Physician*
2c. App quality issues	*"I could see it being built really well and being streamlined and um people loving that to – to get a more complete set of what everyone is taking at home. I could also see if it's not built well, and the interface isn't clean, people being upset by it, because then it could be labeled or it could be thought of as just another thing that's leading to more messages in their inbox." ID 12, Physician* *"If I'm having to spend almost as much time verifying everything is I am trying to put them in the first place, I'm not sure that it's saved us very much time on our end…" ID 11, Physician*
Recommendations	
3a. Attention to privacy	*"So, I think the biggest thing is just HIPPA and having it encrypted or whatever it has to be. If people put it on their own phones, then it's gotta be, you know safe." ID 18, Pharmacist* *"Another thing that comes up to me, which I'm sure you've thought of, is the HIPAA compliance; how it links from the app to medical records." ID 39, Naturopathic Doctor*

(continued)

Table 3. (continued)

Theme/Subtheme	Representative Quotes
3b. Enhance accessibility	*"I suppose it would just be if individuals don't have the ability to, you know...scan the app because they don't have the right kind of phone. Or… I think it's mostly just about having the apparatus to scan it and understanding how to use the app." ID 9, Dietitian*
	"So, and then make sure it's kind of friendly to kind of all populations particularly older adults who use a lot of these supplements so big enough digits that they can press it on their phone and read it big enough font." ID 7, Physician
	"Language might be a barrier; I see a fair number of Hispanic patients… Latino patients and they don't speak English, and so that might be a barrier as well." ID 29, Nurse
	"So, very user-friendly interface. Very reliable database very… fast. It has to be fast." ID 7, Physician
3c. Link to DS evidence base	*"…love the idea of if you're able to somehow flag potential drug/supplement interactions or if they're using a product that contains more than the UL tolerable upper intake level for a nutrient, that it flags it for the physicians, and they're not having to look at each product to figure out if it's problematic." ID 41, Dietitian*
	"So, you can kind of do things relatively more efficiently so that patients are not like delaying therapy while we're waiting to check on interactions and things like that." ID 10, Pharmacist
	"I guess if there is a way to track the actual supplement and have something about them, like a warning like shouldn't be taken with BP meds or you shouldn't take this with chemotherapy. So if you had something like right there because in a typical day that we are taking care of patients we don't have time to research because 75% of our patients take some kind of supplement." ID 31, Nurse
	"…it would definitely be helpful to be able to, like, if I'm in a room with the patient and they asked me a question about a supplement that they're taking to use that app to answer that question." ID 37, Medical Assistant
3d. Ensure seamless EMR integration	*"I think that would be… as long as I could interface with our EMR, well, and it wouldn't require a lot of extra changing of dosages or free text …" ID 11, Physician*
	"I can see it being a pro and con... It is yet another med list that has potential to be wrong. I think if it is tied in with Epic/MyChart, it has potential of making it easier for med rec process, as long as all tied together." ID 17, Pharmacist

Subtheme 1d—App May Enhance Patient-Provider Communication. HCPs who endorsed the belief that many of their patients use dietary supplements viewed the app as a tool to facilitate patient education about dietary supplements, particularly in the context of a disease process or potential for supplement-medication interactions.

Theme 2: Risks Associated With the Proposed App and Barriers to Use

Subtheme 2a—App May Have a Negative Effect on the Clinic Workflow. Although the proposed app was viewed as beneficial by most participants, not all HCPs were supportive of integrating the app into a clinical encounter. Their chief concern centered on the potential for increased HCP burden related to interacting with patients about their dietary supplement use. HCPs who stated they do not ask patients about their dietary supplement use felt that obtaining this information would add unnecessary time to visits, especially since they felt ill-prepared to judge the safety of individual products or the potential for SDI. They wondered if improved dietary supplement reconciliation would prompt patients to ask more questions about dietary supplements that would add to their workload.

Subtheme 2b—Dietary Supplement Information May be Inadequate. HCPs expressed concerns about the overall reliability of information about dietary supplements, their complexity, and rapid changes in dietary supplement product formulations. These concerns would reduce the value of the app in clinical encounters.

Subtheme 2c—App Quality Issues. HCPs also worried about the potential for technical glitches that would affect their workflow. They said that a poor-quality product may lead to more questions from patients that they are unable to answer.

Theme 3: HCP Recommendations and Performance Expectations

HCPs had specific recommendations about desired app features: 1) attention to privacy; 2) accessibility; 3) links to the dietary supplement evidence base including SDIs; and 4) seamless integration into the EMR.

Subtheme 3a—Attention to Privacy. Most HCPs stated they would not be concerned about privacy if the proposed app had high-level, HIPAA compliant protections common to healthcare products currently on the market.

Subtheme 3b—Accessibility. Several HCPs pointed out access issues for different patient populations. Some patients may not have a smartphone and others may not have the technical capability to use an app or to scan their information prior to their visit. HCPs also recommended an alternative method for accurate collection of the information such as a point-of-care

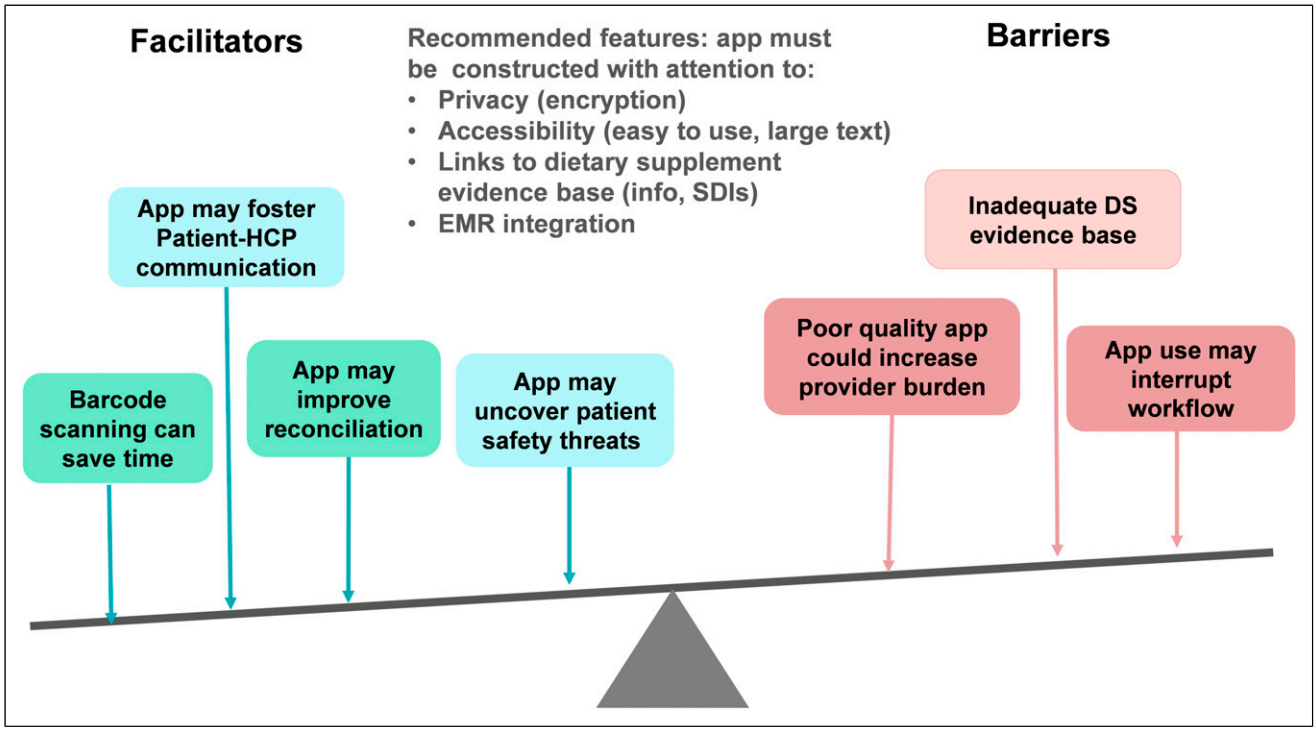

Figure 2. Diagram depicting themes related to the app features recommended by healthcare professionals (HCPs) and technicians and the perceived facilitators and barriers to use of a dietary supplement (DS) application (app). SDI (supplement-drug interactions). EMR (electronic medical record).

scanner or in-clinic tablet linked to the dietary supplement database. In addition, the developers of the app should pay attention to design features that would make it easier to use for patients who are older adults (e.g., large text) or do not speak English (e.g., universal icons).

Subtheme 3c—Links to the Dietary Supplement Evidence Base. Many HCPs expressed the desire to increase access to evidence-based information about dietary supplements, especially notifications of clinically relevant SDIs. This was seen as potentially saving time, educating patients, and assisting them in becoming more knowledgeable about dietary supplements themselves.

Subtheme 3d–Seamless Integration into the EMR. Most HCPs felt that it was essential that the app could integrate into the EMR. Without the integration, they were concerned that the app would cost rather than save them time. Figure 2

More themes were generated related to the facilitators of app use compared to the barriers to app use. Therefore, the balance in Figure 2 is weighted toward facilitators.

Discussion

Summary of Results

HCPs acknowledged the importance of accurate dietary supplement documentation, but also expressed several challenges to implementation. These include inaccurate database entries, wide variations in supplement ingredients and dosing, lack of patient disclosure of supplement use, poor patient recall of dietary supplement information (e.g., brand, dosing, and ingredients), and time requirements for manually entering dietary supplement information into the EMR. Our study shows that HCPs believe there are significant gaps in accurate dietary supplement documentation, tracking, and reconciliation within the EMR. These gaps include technical issues (e.g., inadequate dietary supplement product databases, cumbersome manual dietary supplement entry), and interpersonal issues like absent or inadequate patient-provider communication about dietary supplement use.

Sampled HCPs were largely supportive of an mHealth app solution to assist with dietary supplement documentation, tracking, and reconciliation. If the mHealth app can be integrated into the EMR, most saw it as substantially improving the medication reconciliation process, both in terms of speed and accuracy of documentation. They recognized the app could rapidly reconcile a large volume of dietary supplement information allowing more time for direct patient interaction and face-to-face communication, including counseling on supplement-medication and supplement-disease interactions. However, a small subset of participants expressed concerns that the app may increase their time burden, rather than increasing efficiency. In addition, they expressed specific concerns about access; several participants suggested that

patients who are older, non-English-speaking, or not technically savvy may have difficulty using the app. They also wanted assurance that the app would be linked to high-quality, rapidly accessible information about dietary supplements and their interactions with medications.

Identified barriers to the use of the app included: 1) concerns about privacy and accessibility; 2) the potential negative impact on workflow, particularly if the app is poorly constructed or maintained; 3) increase in burden due to patient questions about dietary supplements; 4) lack of high-quality research on dietary supplements; and 5) challenges integrating the app within the EMR. We believe that many of these barriers could be addressed with technical solutions to improve quality, privacy, and accessibility. In fact, digital health platforms, such as ExerciseRx, are, in practice, using a similar design of a patient app, provider dashboard, and a smart-phone system to sense and detect exercise (https://thesportsinstitute.com/our-work/exercise-rx/). Systems such as ExerciseRx are providing an example of advanced digital interfaces using technical solutions to improve tracking and prescribing of integrative and lifestyle medicine modalities, like exercise or dietary supplements.

However, other operational barriers may be more difficult to address. Implementing a new clinic workflow can be difficult, even for an outcome that could ultimately streamline care; pre-visit uploads of the information may partially mitigate this issue. In addition, increased patient questions about supplements can be both positive and negative. On the positive side, communication is enhanced, but this may contribute to increased provider burden. This barrier may be mitigated by other design strategies including appropriate patient-facing information about dietary supplement safety or utilizing other members of the care team to respond to patient communications, such as pharmacists or mid-level practitioners.

There is truth to the belief among HCPs that sufficient high-quality evidence and information pertaining to safety and efficacy of dietary supplements is lacking. However, our proposed app could contribute to solving this issue by providing information about available evidence-based dietary supplement resources, structure-function claims, and qualified and approved health claims for supplements. For example, an entry for a product containing calcium and vitamin D could include the FDA-approved health claim that "adequate calcium and vitamin D throughout life, along with physical activity, may reduce the risk of osteoporosis in later life".[28] In addition, the app can include a tool to help providers assess the safety of a particular supplement product such as the US Department of Defense "Operation Supplement Safety" tool.[29]

Additional barriers include the challenge of integrating mHealth apps with EMR systems. Most often, data can be exported from EMR systems, but importing external data is often prohibited by governance decisions at the level of the institution. Also, to ensure that the data are integrated into the EMR in a way that is most useful to HCPs, the EMR itself will need to incorporate a dietary supplement database such as the one maintained by the National Institutes of Health Office of Dietary Supplements (ODS). The ODS Dietary Supplements Label Database is updated monthly and can be automatically imported into an EMR, making it a key tool to improve the quality of dietary supplement reconciliation. The database can be searched by ingredient name and/or by product brand name.

Comparisons with Similar Studies

The problem of poor dietary supplement documentation has been known for many years and has been attributed to a lack of provider inquiries and patient disclosures.[12] Both published literature and hospital regulations prompt providers to document dietary supplement use, yet documentation is still poor, possibly due to the challenges identified by our participants. Lee et al., identified supplement-drug interactions as one problem that contributes to the need for adequate dietary supplement documentation. In this study, breast and prostate cancer patients who had completed chemotherapy were questioned about their dietary supplement use. They discovered 1,747 potential medication interactions among 67 participants, 56% of which were related to herbs and dietary supplements.[30]

The aim of our study was to gather stakeholder input on the dietary supplement documentation process and the potential use of a mHealth app to improve reconciliation. We are aware that a few other supplement apps have been developed, but none address EMR integration and accurate reconciliation, and few include product-level databases. We feel that the latter is important due to the variability in multi-constituent supplements. For example, a multivitamin-multimineral supplement may contain amino acids, botanicals, metabolites, and proprietary blends that contain additional herbs and nutrients, but not the amount of each ingredient in the blend. If the app had a product-level database, the ingredient information, including the components of a proprietary blend, would be available to the clinician for review.

Study Limitations and Strengths

Most HCPs we interviewed were affiliated with an academic medical center in North Carolina, which limits generalizability to private practices, particularly those in resource-limited areas. In addition, because most of the HCPs worked in North Carolina, generalizability to other parts of the country where practice patterns may differ is yet uncertain. Although we used theory to guide our interview questions, valuable information may have been omitted by our process or by our participants. A strength of our study was that we aimed for broad participation by a variety of provider types, not only physicians and pharmacists, but also other HCPs involved in the dietary supplement documentation process

who could have had different perspectives on the barriers and facilitators, e.g., naturopathic doctors, dietitians, nurses, and medical assistants. We also talked to providers that work in a variety of specialties and practice settings; for example, providers working in oncology, emergency medicine, family practice, and infectious disease. However, this strategy had some limitations. Due to limited funding and time constraints, we were not able to ensure that we achieved data saturation within each HCP category, especially regarding differences by specialty. Additional research may be needed to address this issue in a larger population of HCPs. Although we did not target saturation within each HCP category, we feel that saturation was achieved across the sample.

Impact and Future Directions

Accurate dietary supplement documentation is essential to setting the stage for understanding the risks and benefits of dietary supplement use at the population level. In the current regulatory environment, which does not require pre-market establishment of safety and efficacy, post-marketing surveillance of dietary supplements is critical. Post-marketing surveillance relies on passive capture of adverse events including disclosure by the manufacturer and reports made by both patients and providers. Hence, current methods only capture a small fraction of the adverse events related to dietary supplement use. It is only through demand for more active data surveillance and high-quality phase II and III clinical trials that dietary supplement product safety and effectiveness can be established. Future development could include direct reporting of adverse events to the FDA either through the electronic record or the mHealth app.

More robust safety monitoring and identification of adverse events would facilitate research into the impact of dietary supplement documentation on certain endpoints including improved or maintained control of chronic diseases, adherence, and protocol compliance. Synchronization of this data with EMRs would also allow for further research into patient and provider experiences, minimization of data silos, and pharmacoepidemiologic analysis, collectively leading to important implications for patients, payers, and providers.

Conclusions

Most participants expressed the belief that dietary supplement documentation is important but inaccurately represented in the EMR. Support was expressed for our proposed barcode-scanning dietary supplement mHealth app. Accurate tracking and reporting of dietary supplements may improve patient safety and quality of care by helping patients and providers make evidence-informed decisions about dietary supplement use and avoid unwanted supplement-drug interactions.

Acknowledgements

The authors would like to thank Kelly Eason from the UNC Program on Integrative Medicine for her role in management of the interview transcripts.

Author Contributions

Concept and design: Faurot, Corbett, Asher, Hill
Acquisition, analysis, or interpretation of data: All authors
Drafting of the manuscript: Kadro, Faurot, Chilcoat, Kenney, Hill
Critical revision of the manuscript for important intellectual content: All authors
Statistical analysis: Kadro, Faurot
Qualitative analysis: Kadro, Faurot, Chilcoat, Kenney
Obtained funding: Asher, Hill.
Administrative, technical, or material support: Faurot, Corbett, Asher.
Supervision: Faurot, Asher, Corbett.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This study was supported through # 2KR1151904, NC Translational and Clinical Sciences Center (NCATS). We acknowledge the data management assistance of the NC Translational and Clinical Sciences (NC TraCS) Institute, which is supported by the National Center for Advancing Translational Sciences (NCATS), National Institutes of Health (NIH), through Grant Award Number UL1TR002489. The authors would also like to acknowledge funding from UNC Family Medicine Innovation Award Funding. Drs Chilcoat, Hill, and Kadro were supported by the National Center for Complementary and Integrative Health National Research Service Award (NRSA) Institutional Research Training Program (T32) at University of North Carolina, grants (T32-AT003378), 5T32AT003378-13, 5T32AT003378-14, and 5T32AT003378-15.

Ethical Statement

Ethical Approval

The study received approval from the University of North Carolina Institutional Review Board (IRB#18-2099).

ORCID iDs

Zachary O. Kadro https://orcid.org/0000-0003-3894-9804
Amanda H. Corbett https://orcid.org/0000-0002-5271-5433
Keturah Faurot https://orcid.org/0000-0001-6122-7821

Supplemental Material

Supplemental material for this article is available online.

Data Availability Statement

Deidentified data from this study are available upon request from the corresponding author subject to a data use agreement with the University of North Carolina at Chapel Hill.

References

1. Mishra S, Stierman B, Gahche JJ, Potischman N. Dietary supplement use among adults: United States, 2017-2018. *NCHS Data Brief*. 2021;399:1-8.
2. Jones CL, Jensen JD, Scherr CL, Brown NR, Christy K, Weaver J. The Health Belief Model as an explanatory framework in communication research: Exploring parallel, serial, and moderated mediation. *Health Commun*. 2015;30(6):566-576. doi:10.1080/10410236.2013.873363.
3. Gahche JJ, Bailey RL, Potischman N, Dwyer JT. Dietary supplement use was very high among older adults in the United States in 2011-2014. *J Nutr*. 2017;147(10):1968-1976. doi:10.3945/jn.117.255984.
4. Falci L, Shi Z, Greenlee H. Multiple chronic conditions and use of complementary and alternative medicine among US adults: Results from the 2012 national health interview survey. *Prev Chronic Dis*. 2016;13:E61. doi:10.5888/pcd13.150501.
5. Kantor ED, Rehm CD, Du M, White E, Giovannucci EL. Trends in dietary supplement use among US adults from 1999-2012. *JAMA*. 2016;316(14):1464-1474. doi:10.1001/jama.2016.14403.
6. Du M, Luo H, Blumberg JB, et al. Dietary supplement use among adult cancer survivors in the United States. *J Nutr. February*;26:2020. doi:10.1093/jn/nxaa040.
7. Farina EK, Austin KG, Lieberman HR. Concomitant dietary supplement and prescription medication use is prevalent among US adults with doctor-informed medical conditions. *J Acad Nutr Diet*. 2014;114(11):1784. doi:10.1016/j.jand.2014.01.016.
8. Pillitteri JL, Shiffman S, Rohay JM, Harkins AM, Burton SL, Wadden TA. Use of dietary supplements for weight loss in the United States: Results of a national survey. *Obesity*. 2008;16(4):790-796. doi:10.1038/oby.2007.136.
9. Lynch N, Berry D. Differences in perceived risks and benefits of herbal, over-the-counter conventional, and prescribed conventional, medicines, and the implications of this for the safe and effective use of herbal products. *Compl Ther Med*. 2007;15(2):84-91. doi:10.1016/j.ctim.2006.06.007.
10. Knapik JJ, Trone DW, Austin KG, Steelman RA, Farina EK, Lieberman HR. Prevalence, adverse events, and factors associated with dietary supplement and nutritional supplement use by US navy and marine corps personnel. *J Acad Nutr Diet*. 2016;116(9):1423-1442. doi:10.1016/j.jand.2016.02.015.
11. Aznar-Lou I, Carbonell-Duacastella C, Rodriguez A, Mera I, Rubio-Valera M. Prevalence of medication-dietary supplement combined use and associated factors. *Nutrients*. 2019;11(10):2466. doi:10.3390/nu11102466.
12. Guzman JR, Paterniti DA, Liu Y, Tarn DM. Factors related to disclosure and nondisclosure of dietary supplements in primary care, integrative medicine, and naturopathic medicine. *J Fam Med Dis Prev* 2019;5(4).
13. Tucker J, Fischer T, Upjohn L, Mazzera D, Kumar M. Unapproved pharmaceutical ingredients included in dietary supplements associated with US food and drug administration warnings. *JAMA Netw Open*. 2018;1(6):e183337. doi:10.1001/jamanetworkopen.2018.3337.
14. Gardiner P, Sadikova E, Filippelli AC, White LF, Jack BW. Medical reconciliation of dietary supplements: Don't ask, don't tell. *Patient Educ Counsel*. 2015;98(4):512-517. doi:10.1016/j.pec.2014.12.010.
15. Foley H, Steel A, Cramer H, Wardle J, Adams J. Disclosure of complementary medicine use to medical providers: A systematic review and meta-analysis. *Sci Rep*. 2019;9(1):1573. doi:10.1038/s41598-018-38279-8.
16. Ventola CL. Current issues regarding complementary and alternative medicine (CAM) in the United States: part 3: policies and practices regarding dietary supplements in health care facilities. *P T*. 2010;35(10):570-576.
17. Dwyer JT, Coates PM, Smith MJ. Dietary supplements: regulatory challenges and research resources. *Nutrients*. 2018;10(1):41. doi:10.3390/nu10010041.
18. Truitt E, Thompson R, Blazey-Martin D, NiSai D, Salem D. Effect of the implementation of barcode technology and an electronic medication administration record on adverse drug events. *Hosp Pharm*. 2016;51(6):474-483. doi:10.1310/hpj5106-474.
19. Palmer JW, Markus ML. The performance impacts of quick response and strategic alignment in specialty retailing. *Inf Syst Res*. 2000;11(3):241-259. doi:10.1287/isre.11.3.241.12203.
20. Greenwald JL, Halasyamani L, Greene J, et al. Making inpatient medication reconciliation patient centered, clinically relevant and implementable: A consensus statement on key principles and necessary first steps. *J Hosp Med*. 2010;5(8):477-485. doi:10.1002/jhm.849.
21. Post E, Faurot K, Kadro ZO, et al. Patient perspectives on the development of a novel mobile health (mHealth) application for dietary supplement tracking and reconciliation-A qualitative focus group study. *Glob Adv Health Med*. 2022;11:21649561221075268. doi:10.1177/21649561221075268.
22. Venkatesh T, Thong X. Consumer acceptance and use of information technology: Extending the unified theory of acceptance and use of technology. *MIS Q*. 2012;36(1):157. doi:10.2307/41410412.
23. Dabliz R, Poon SK, Ritchie A, Burke R, Penm J. Usability evaluation of an integrated electronic medication management system implemented in an oncology setting using the unified theory of the acceptance and use of technology. *BMC Med Inf Decis Making*. 2021;21(1):4. doi:10.1186/s12911-020-01348-y.

24. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap): A metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inf*. 2009; 42(2):377-381. doi:10.1016/j.jbi.2008.08.010.
25. Harris PA, Taylor R, Minor BL, et al. The REDCap consortium: building an international community of software platform partners. *J Biomed Inf*. 2019;95:103208. doi:10.1016/j.jbi.2019.103208.
26. Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): A 32-item checklist for interviews and focus groups. *Int J Qual Health Care*. 2007; 19(6):349-357. doi:10.1093/intqhc/mzm042.
27. eCFR::21 CFR 101.72 – Health claims: calcium, vitamin D, and osteoporosis. https://www.ecfr.gov/current/title-21/chapter-I/subchapter-B/part-101/subpart-E/section-101.72.
28. Operation supplement safety | OPSS. https://www.opss.org/
29. Lee RT, Kwon N, Wu J, et al. Prevalence of potential interactions of medications, including herbs and supplements, before, during, and after chemotherapy in patients with breast and prostate cancer. *Cancer*. 2021;127(11):1827-1835. doi:10.1002/cncr.33324.
30. Qato DM, Wilder J, Schumm LP, Gillet V, Alexander GC. Changes in prescription and over-the-counter medication and dietary supplement use among older adults in the United States, 2005 vs 2011. *JAMA Intern Med*. 2016;176(4):473-482. doi:10.1001/jamainternmed.2015.8581.