# Clinicians' Values and Preferences for Medication Adherence and Cost Clinical Decision Support in Primary Care: A Qualitative Study

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## Abstract

**Background**   Medication nonadherence and unaffordability are prevalent, burdensome issues in primary care. In response, technology companies are capitalizing on clinical decision support (CDS) to deliver patient-specific information regarding medication adherence and costs to clinicians using electronic health records (EHRs). To maximize adoption and usability, these CDS tools should be designed with consideration of end users' values and preferences.

**Objective**   This article evaluates primary care clinicians' values and preferences for a medication adherence and cost CDS.

**Methods**   We conducted semistructured interviews with primary care clinicians with prescribing privileges and EHR access to identify clinicians' perceptions of and approaches to assessing medication adherence and costs, and to determine perceived values and preferences for medication adherence and cost CDS. Interviews were conducted until saturation of responses was reached. ATLAS.ti was used for thematic analysis.

**Results**   Among 26 clinicians interviewed, themes identified included a high value, but moderate need for a medication adherence CDS and high value and need for cost CDS. Clinicians expressed the cost CDS would provide actionable solutions and greatly impact patient care. Another theme identified was a desire for medication adherence and cost CDS to be separate tools yet integrated into workflow. The majority of clinicians preferred a medication adherence CDS that integrated claims data and actively displayed data using color-coded adherence categories within patients' medication lists in the EHR. For the cost CDS, clinicians preferred medication out-of-pocket costs and a list of cheaper or payor-preferred alternatives to display within the order queue of the EHR.

**Conclusion**   We identified valuable insights regarding clinician values and preferences for medication adherence and cost CDS. Overall, primary care clinicians feel CDS for medication adherence and cost are valuable and prefer them to be separate. These insights should be used to inform the design, implementation, and EHR integration of future medication and cost CDS tools.

### Keywords
► clinical decision support
► medication adherence
► medication costs
► perceptions
► primary care
► medication
► informatics

## Background and Significance

Medication nonadherence and unaffordability contribute to uncontrolled chronic conditions, unnecessary therapy intensifications, and increased health care utilization.[1–4] Approximately 20 to 30% of antihypertensive, antihyperlipidemic, antihyperglycemic prescriptions, and other chronic medications are never filled, and 50% are not taken as prescribed.[5–10] Additionally, 19% of patients intentionally miss or halve medications to reduce prescription costs.[11] In practice, clinicians tend to overestimate medication adherence and underestimate the proportion of patients with cost barriers.[12–14] Given the challenges of accurately assessing barriers to medication adherence and cost at the point of prescribing, clinicians often struggle with addressing these barriers and finding solutions.[15–20]

To address these inconsistencies in patient care, there is increasing interest in providing claims data and prescription benefits pricing information to clinicians through clinical decision support (CDS) embedded within electronic health records (EHRs).[21,22] CDS includes tools that deliver patient-specific information and recommendations to clinicians at the point-of-care, thereby improving quality measures (e.g., increase preventative screenings performed).[23–25] Successful adoption of CDS for medication adherence and cost would enable clinicians to have focused conversations with patients about medication adherence and costs, practice patient-centered prescribing, and improve patient health outcomes. However, CDS is often perceived as a hindrance as the average primary care clinician spends more than an hour processing 77 EHR-related notifications daily.[26] As a result, some clinicians may experience "alert fatigue" and ignore CDS, rendering these tools ineffective.

A user-centered design process can assist in overcoming the negative sequelae of alert fatigue. Incorporating a user-centered design process during CDS implementation that considers end users' values and preferences for medication cost and adherence CDS is especially critical given the novelty and complexity of presenting medication information within already-complex clinical workflows.[27–30] Primary care clinicians represent a key clinician end-user group who are responsible for most chronic disease management and thus would most likely benefit from a CDS for medication adherence and cost. While prior studies have assessed providers' perceptions of medication adherence and costs, to our knowledge, literature evaluating the perceived values and preferences of primary care clinicians regarding CDS as a solution to medication nonadherence and unaffordability is limited.

## Objectives

We sought to identify and characterize primary care clinicians' perceived values and preferences for medication adherence and cost CDS tools.

## Methods

### Setting, Participants, and Objectives

In October and November 2017, we conducted individual, in-person, 30-minute semistructured interviews. We invited primary care clinicians with prescribing privileges and EHR access from diverse settings in Colorado via e-mail. Purposeful sampling was used to ensure representation of clinicians using multiple EHRs and patient populations, which could impact clinicians' opinions regarding medication adherence, costs, and CDS. We used convenience and snowball sampling techniques to conduct interviews until saturation of concepts was reached.[31,32]

Interviews were conducted to (1) identify clinicians' baseline perceptions of and approaches to assessing medication adherence and costs with patients, and (2) determine clinicians' perceived values and preferences for medication adherence and cost CDS. Clinicians' baseline perceptions of medication adherence and costs, although previously studied, were evaluated to stimulate and inform the subsequent discussion regarding CDS considerations.[12–15]

### Interview Content and Structure

We developed a semistructured interview guide informed by the Health Belief Model and Theory of Reasoned Action within an interpretivist/constructivist paradigm.[33–35] One of two primary care clinical pharmacists (C.D., S.B.), trained in qualitative approaches, led each interview. The interview guide was iteratively modified between interviews consistent with a grounded theory approach.[36–38] All investigators discussed and approved interview guide modifications. The Colorado Multiple Institutional Review Board deemed this study quality improvement and waived approval.

At the beginning of interviews, participants were encouraged to speak freely and share honest opinions. Each interview had three components: (1) demographic and practice setting questions, (2) open-ended questions eliciting baseline general perceptions of and methods for assessing medication adherence and costs, and (3) open-ended discussion about values and preferences for medication adherence and cost CDS.[39] Participants were also asked to categorize value (defined as potential impact on patient care) and needs (defined as potential impact on clinicians' ability to provide patient care) using a Likert scale from 1 to 5, in which 5 was "most useful/needed." The interviewers did not specify whether the medication cost CDS would be separate or integrated with the medication adherence CDS. For ease of presentation, we refer to them separately herein as the "medication cost CDS" and the "medication adherence CDS," but clinicians may have expressed during the interview that these two concepts be integrated into one tool.

### Data Analysis

Interviews were audio recorded, transcribed verbatim, deidentified, and analyzed using ATLAS.ti (version 7.5, Oregon, United States). One investigator (C.D.) completed transcription and another investigator (S.B.) validated 20% of

transcripts for accuracy/completeness and deemed further validation was not needed.

Inductive and deductive strategies were employed in a recursive, thematic analysis.[40] An a priori template of codes was deductively developed corresponding to themes for each question in the interview guide.[41,42] During coding, inductive strategies were used to refine the code template.[42] One investigator (S.B.) coded for manifest and latent content meaning and another investigator (C.D.) reviewed 20% of the analyses for validation (further validation was not needed). Disagreements were handled through discussion and consensus with a third investigator (K.T.). Responses using the Likert scale were analyzed and reported as a mean response across all participants.

The Standards for Reporting Qualitative Research Study guided the study design, data collection, analysis, and results reporting.[43] Throughout the study conduct, we utilized several methods such as purposeful sampling, grounded theory, contextual review, domain expertise, audit trail, and triangulation across resources to enhance credibility, transferability, dependability, and confirmability.[44]

## Results

Of 55 clinicians invited to participate, 28 (51%) completed interviews. Two participants who completed interviews were excluded because they did not practice in primary care or for technical recording limitations; thus, 26 interviews were analyzed. Participants were mostly female, physicians, and practicing less than 5 years in an academic setting (►Table 1).

### Medication Adherence: Baseline Perceptions and Assessment Methods

Most clinicians ($n = 25$) generally defined medication non-adherence as "not taking medications as prescribed" or "missing a scheduled dose more than several times." Seven clinicians elaborated that medication nonadherence is multifactorial and caused by things such as "not taking medications prescribed for whatever reasons (intolerance or not wanting to)," "not understanding how to take medications," or "difficulties affording medications." All clinicians expressed uncertainty about the proportion of their patients with uncontrolled chronic conditions and medication nonadherence, predominantly guessing between 15 and 35% when prompted.

All clinicians reported using multiple methods to assess medication adherence, including targeted questions, clinical data (e.g., uncontrolled hypertension despite multiple antihypertensives), inappropriate refill requests (e.g., 90-day prescription filled 6 months ago), internal pharmacy claims data, or letter notifications sent by insurance companies to flag delayed fills. Patient interviews were deemed by all clinicians to be the most frequently used method to assess adherence. Clinicians reported that patient interviews had varying levels of effectiveness to assess medication adherence:

"If I have a continuity relationship with [someone] that trusts me and I trust them, we can get to that point. But if I don't know a patient well, I don't know if they will be

**Table 1** Clinician demographics

| Characteristics | Total $N = 26$ |
|---|---|
| Female | 17 (65) |
| Clinician type | |
|    Physician | 17 (65) |
|    Pharmacist | 6 (23) |
|    Advanced practice nurse practitioner | 3 (12) |
| Time in clinical practice, y[a] | |
|    0–5 | 9 (34) |
|    6–10 | 6 (23) |
|    11–15 | 3 (12) |
|    ≥ 15 | 8 (31) |
| Time in clinical practice weekly, h | |
|    < 10 | 3 (12) |
|    10–20 | 9 (35) |
|    21–30 | 10 (38) |
|    31–40 | 4 (15) |
| Practice setting in metro Denver area | |
|    Academic | 17 (65) |
|    Closed, integrated health system | 2 (8) |
|    Underserved care | 6 (23) |
|    Private practice | 1 (4) |
| Clinician-estimated proportion of patient panel with uncontrolled chronic conditions | |
|    < 15% | 1 (4) |
|    15–25% | 7 (26) |
|    26–35% | 6 (23) |
|    36–45% | 3 (12) |
|    > 45% | 9 (35) |
| Clinician-estimated proportion of patients with government-funded insurance | |
|    < 25% | 4 (15) |
|    25–50% | 10 (38) |
|    51–75% | 7 (27) |
|    > 75% | 5 (20) |

Note: Values are expressed as number (%) unless otherwise stated.
[a]Includes residency and/or fellowship training.

honest. I would like to think that most of them are truthful, but I don't know." (Physician)

Clinicians deemed clinical ($n = 5$, e.g., uncontrolled blood pressure) and prescription refill ($n = 11$) data to be most helpful in evaluating medication adherence due to objectivity. Clinicians with access to internal pharmacy dispensing data commented on limitations in the ability to view external pharmacy fills. Nine clinicians found insurance letter notifications to be inconsistent and inefficient. Six clinicians endorsed calling the pharmacy to obtain fill data, citing this to be effective, but time consuming.

## Medication Costs: Baseline Perceptions and Assessment Methods

All clinicians endorsed caring about medication costs in the context of making treatment decisions, with some defining a "high" cost medication to be patient-specific. When prompted, most clinicians ($n = 14$) estimated 15 to 45% of their patient panel has uncontrolled chronic conditions and medication cost barriers.

Participants reported that conversations about medication costs were primarily initiated by patients after the clinician asked about adherence. While clinicians deemed patient-initiated conversations effective in identifying cost barriers, one clinician noted:

"I don't know the medication was not covered or is too expensive for three months, until the patient comes back. So they tell me, but not at the time I would like to know." (Physician)

Some clinicians stated the frequency of medication cost conversations is limited by time constraints and mutual discomfort in discussing financial matters. One clinician stated:

"I don't want to ask 'can you afford that' because it is going to slow me down as they may say, 'I am not filling that because it is expensive.' Or, 'I am not filling that until the first of the month.' So while knowing costs can be good, I don't want to take over peoples' financial situations. I don't have the time." (Physician)

Twenty-four clinicians felt comfortable recommending resources to resolve cost barriers once identified. Mentioned solutions included prescribing cheaper alternatives, utilizing the "$4 drug list," referring to social workers or pharmacists, or finding patient assistant programs such as those available through third-party companies (e.g., GoodRx) or drug manufacturers.

## Perceived Value of CDS as a Solution

Primary care clinicians expressed a high value (4.2 on Likert scale), but moderate need (3.2) for the medication adherence CDS and high value (4.3) and need (4.1) for the medication cost CDS.

Clinicians generally expressed enthusiasm about using CDS to deliver patient-specific medication adherence and cost information at the point-of-care. For the medication adherence CDS, two clinicians stated:

"Having [adherence] information at the point of care before I find out they are uncontrolled or maybe I haven't seen them in a year and suddenly I get claims data on someone saying I need to get them in, that would be helpful." (Physician)

"I wouldn't rate this '5' because there is so much information that comes to us as clinicians, it is hard to know which information is going to get through. It is not '3' because it sounds a lot better than what I have right now."(Physician)

While clinicians feel the medication adherence CDS could impact patient care, they endorsed a moderate need for such a tool because although this tool would initiate conversations, it would not actively resolve issues. One clinician stated:

"We know what we need to do, but if cost or non-adherence is an issue, then it doesn't matter how much we know. Until we overcome these things, we are always going to have patients who are uncontrolled and will spend a lot of time overcoming these things." (Advanced Practice Nurse)

Conversely, for the medication cost CDS, clinicians expressed significant enthusiasm:

"I would give it a '5' because medication cost is a big issue for everybody, whether they got good insurance or not, so I think it would be very beneficial." (Pharmacist)

"If there was this comprehensive tool that had copays and typical standard industry alternatives, that would be great." (Advanced Practice Nurse)

When asked about CDS impact, one clinician stated the medication cost CDS would target the problem of:

"Waiting for the pharmacist to run the medication script through the insurance, so patients have to leave, go to the pharmacy, find out it is too expensive, then the pharmacy contacts the provider, then I finally get around to it. There are tons of unnecessary delays and it is awful patient care." (Physician)

When asked to provide insight on benefits of a medication adherence and cost CDS, clinicians identified that this tool would encourage them to have conversations about medication costs with patients, promote patient-centered prescribing, and increase patient satisfaction. Alternatively, clinicians were concerned about erosion of patient trust, inaccurate information, and increased time/workload as unintended consequences. As two clinicians reported:

"Time is the biggest barrier. Does it result in more paperwork? Just another website to go to? More time with the computer and less time with the patient? In general, I think a lot of the [electronic] tools are a time sink." (Advanced Practice Nurse)

"You could always make incorrect assumptions, there is always a risk of that. So it [CDS] could make it look like they [patients] are adherent, when they are not." (Pharmacist)

One unique potential unintended consequence identified specifically for the medication cost CDS was the concern that instead of prescribing evidenced-based medications, clinicians may instead start prescribing by cost only. Three clinicians commented:

"Are we recommending the most evidenced-based medicines, or would this [CDS] change our framework? For example, I am going to prescribe this class of medications and look at the cost for each option first, then decide, or am I deciding this is the best agent, then look at the cost?" (Pharmacist)

"I could imagine a scenario where there is a medication that would be strongly indicated and impactful, but you back away from prescribing it [because of cost]. Would this tool prevent us from finding a solution to get that best medication for the patient?" (Physician)

"Certainly, want to be cost conscious, but at the end, it is about providing good, evidenced-based care. So I would hate to be swayed too much about what a medication costs, assuming it is not $100 vs. $10, but actually comparable." (Physician)

## CDS Preferences

Nineteen clinicians expressed a preference for the medication adherence and cost CDS to be separate tools, primarily because of workflow considerations and type of information they wanted displayed. Two participants stated:

"The CDS tools should be separate. Adherence metrics could populate next to specific medication and costs should populate while ordering a medication. These [processes] are separate in my workflow." (Physician)

"I would use the cost information more and sometimes there is just so much stuff out there [in the EHR], that it is just more...more stuff. So separate CDS would be ideal." (Advanced Nurse Practitioner).

Clinicians also voiced that both CDS should integrate into the workflow well, be user-friendly, and provide accurate information that can be practically applied to improve patient care.

For the medication adherence CDS (►Table 2), 13 clinicians desired an active or interruptive alert that popped up when viewing medication lists in the EHR. Nine clinicians expressed a preference for color-coding of adherence information based on certain cutoffs. Ten clinicians perceived that 90-day medication claims data would sufficiently represent patients' medication adherence. Lastly, 15 clinicians felt that embedding recommended strategies on how to optimize medication adherence within the CDS was not necessary because nonadherence is multifactorial.

For the medication cost CDS (►Table 3), most clinicians expressed desire to have information display actively (i.e., automatically presented; $n = 10$) or passively (i.e., click to view; $n = 11$), but some did not have a preference. Twenty-two clinicians desired out-of-pocket cost information at the point of ordering medications. When asked about solutions for the cost CDS to present to the end user at the point of prescribing, 16 clinicians desired a display of alternative, cheaper, or payor-covered medications.

**Table 2** Medication adherence CDS features, benefits/cons, and need

| Characteristics | Total $N = 26^a$ |
|---|---|
| Preferred location to display in electronic health record | |
|     Medication list | 13 |
|     Medication and laboratory orders | 7 |
|     Dashboard | 3 |
|     Vitals | 1 |
| Display features | |
|     Assessment adherence rate using colors (e.g., red/yellow/green) | 9 |
|     Assessment of adherence rate generating a score or percentage | 3 |
|     List as "taking/not taking" or "purchased/not picked up" | 1 |
| Flow | |
|     Active | 13 |
|     Passive | 9 |
| Information source | |
|     Claims data (90 d) from all pharmacies | 10 |
|     Medication possession ratio or proportion of days covered | 4 |
|     Embedded pictures of tablet or capsule for patients to identify what they are not taking | 1 |
| Targeted patients | |
|     Chronic conditions only | 1 |
|     Patients taking five or more medications | 1 |
| Proposed solution(s) presented by CDS | |
|     None | 15 |
|     Alternative medications | 5 |
|     Patient-worded suggestions | 2 |
|     Consult a pharmacist | 1 |
|     Refer to health coaching | 1 |
|     Adherence assistance tools (e.g., text message reminders) | 1 |
| Benefits | |
|     Initiates conversation about barriers to care | 17 |
|     Permits better/safer prescribing/monitoring | 7 |
|     Additional tool to investigate uncontrolled disease | 4 |
|     Improves medication reconciliation | 2 |
| Cons | |
|     Erodes trust between patient and clinician | 11 |
|     More tasks and time in workflow | 10 |
|     Inaccurate information | 8 |

(*Continued*)

**Table 2** (*Continued*)

| Characteristics | Total N = 26[a] |
|---|---|
| Alert fatigue/clinical inertia | 7 |
| Reduces patient satisfaction due to stigma | 1 |
| Essential features to optimize use | |
| Integrated into the electronic health record/workflow | 14 |
| Minimal extra clicks | 3 |
| Trustworthy information | 1 |
| Minimal need to input information | 1 |
| Remember prior information/action | 1 |
| Must be beneficial – not just another tool to look at or another thing to do | 1 |
| Overall value for CDS – mean Likert score (range) | 4.2 (3–5) |
| Overall need for CDS – mean Likert score (range) | 3.2 (1–5) |

Abbreviation: CDS, clinical decision support.
[a]Responses may not add up to 26 because participants may have provided multiple responses or no response at all.

**Table 3** Medication costs CDS features, benefits/cons, and need

| Characteristics | Total N = 26[a] |
|---|---|
| Preferred location to display in electronic health record | |
| Medication and laboratory orders | 16 |
| Medication list | 3 |
| Separate tab/screen in EHR | 3 |
| Dashboard | 2 |
| Vitals | 1 |
| Display features | |
| Color-coded if copay is beyond certain threshold | 3 |
| Estimated cost using a Yelp format (e.g., $ is cheapest, $$$$ is most expensive) | 2 |
| Flow | |
| Passive | 11 |
| Active | 10 |
| Information for CDS to display | |
| Out of pocket cost for medication | 22 |
| Whether medication is covered or not by insurance | 9 |
| Cash price of medications | 3 |
| Total monthly cost of medications | 3 |
| Targeted patients | |
| Chronic conditions only | 1 |
| Patients taking five or more medications | 1 |

**Table 3** (*Continued*)

| Characteristics | Total N = 26[a] |
|---|---|
| Proposed solution(s) presented by CDS | |
| Alternative cheaper or covered medications | 16 |
| Available pharmaceutical assistance programs | 6 |
| Coupon assistance programs (e.g., GoodRx) | 5 |
| Link to $4 medication list | 4 |
| Link to pharmacist or social worker | 1 |
| Link to prior authorization forms | 1 |
| Benefits | |
| Avoid inefficient process of having patient find out medication cost at pharmacy, not picking it up, and/or not telling the clinician until the follow-up visit a few months later | 9 |
| Improve patient adherence/outcomes and cost-savings for the health care system | 8 |
| Increased patient satisfaction | 6 |
| Improve clinician efficiency and workflow | 2 |
| Increase awareness about medication costs | 3 |
| Cons | |
| Inaccurate information | 6 |
| Deviate from evidence-based medications and start prescribing based on cost | 6 |
| Extra time/longer visit to address issues | 6 |
| Decreased patient satisfaction due to belief that "inferior" medication is being prescribed or trust issues | 3 |
| Patients may not be comfortable having a conversation about finances | 2 |
| Need additional training/knowledge to talk to patients about cost | 1 |
| Alert fatigue | 1 |
| Essential features to optimize use | |
| Integrated into the electronic health record/workflow | 12 |
| Easy, reliable, quick to use | 3 |
| Focuses on specific medications prescribed by clinician's office | 1 |
| Overall value for CDS – mean Likert score (range) | 4.3 (1–5) |
| Overall need for CDS – mean Likert score (range) | 4.1 (3–5) |

Abbreviations: CDS, clinical decision support; EHR, electronic health record.
[a]Responses for each characteristic may not add up to 26 because participants may have provided multiple responses or no response at all.

Lastly, although participants were not asked to explicitly comment on feasibility of implementing the CDS, eight participants (predominantly pharmacists) voiced concerns about how and where the information relating to medication adherence and costs would pull in. Participants commented that obtaining this information was much easier if the pharmacy was located and/or affiliated with their institution, but expressed concern that claims data from external pharmacies would not be readily available due to lack of connectivity between systems. Participants also mentioned that prescriptions filled outside of insurance could affect adherence metrics. For the cost CDS, three participants inquired if the CDS would have the capability to contain accurate information for all the existing insurance plans and recognize if patients had a deductible to meet.

## Discussion

This study identified the key perspectives of primary care clinicians pertinent to the design and implementation of CDS for medication adherence and cost. Overall, clinicians deemed CDS interventions for medication adherence and costs to be highly valuable, but expressed a greater need for the medication cost CDS, given its inclusion of actionable solutions. For the adherence CDS, clinicians felt it would only help with initiating conversations, but not resolve nonadherence given its multifactorial nature (e.g., adverse reactions, medication cost, patient beliefs, dosing frequency, route of administration) and need for specific targeted interventions. Given design considerations, clinicians stated there should be two separate CDS for medication adherence and costs, but believed each CDS should be integrated into the EHR to optimize workflow. The majority of clinicians preferred a medication adherence CDS that integrated claims data and actively displayed within patients' medication lists in the EHR using color-coding to categorize adherence. For the cost CDS, clinicians preferred medication out-of-pocket costs and a list of cheaper or payor-preferred medications to display within the medication and laboratory order section of EHRs. These preferences can be used to guide future user-centered design conduct to create CDS solutions specific to the local context of a given health system. Health systems aiming to create such CDS or improving such existing CDS can use our findings to inform the line of questioning when eliciting input from their end users. Additionally, some health systems already have CDS for medication adherence and costs, but adoption is not always optimal.[21,22] Our findings can be used to optimize those CDS that already exist and improve adoption.

Although not explicitly addressed in our study, feasibility of implementing reliable CDS for medication adherence and cost is an important consideration and was noted by some participants. For integrated health systems, such CDS have fewer limitations in providing reliable and complete information. However, in the United States, many health systems are not integrated or patients may pay out of pocket for medications, which poses limitations of missing or incomplete data regarding adherence or cost. While health information exchange and networks such as SureScripts can provide a more complete record of medication claims information to inform adherence and cost estimates, the data are still not comprehensive, thus subject to the same limitations.[21,22]

With the insights discovered in this study, CDS implementation and integration for medication adherence and cost can be optimized. For example, clinicians considered CDS integration into workflow to be essential. Given that workflows vary by clinician and EHR, integration of the CDS at multiple areas within the EHR may increase CDS acceptance and enhance adoption. However, CDS integration into different areas of the workflow needs to be done in a manner that does not increase obtrusiveness and worsen alert fatigue. For example, integration of CDS that interrupt workflow at multiple points should be avoided and preference given to noninterruptive CDS.[28–30] Based on the findings of this study, the development, implementation, and integration of a medication cost CDS should be prioritized over a medication adherence CDS but must contain accurate information and actionable solutions to be useful and well-received. Prior studies have demonstrated that the provision of formulary and cost materials reduces yearly drug costs, increases clinician awareness of medication costs, promotes conversations about out-of-pocket costs, and improves cost-conscious prescribing.[22,45,46] Especially within the context of providing this information via the EHR, clinicians in our study echoed these potential benefits and believed the medication cost CDS would have significant impact on patient care. One potential consequence of the medication cost CDS identified was the concern that cost data could influence clinician decision making more than evidenced-based data, leading to inferior treatments being prescribed. A cross-sectional survey of 296 physicians found that 81.8% of respondents agreed it was important to prescribe the drug with the lowest total costs.[47] However, another study assessed potential savings of prescribing evidenced-based antihypertensives in elderly Americans and found 40% of prescriptions could have been written for an alternative regimen and reduce the cost to payors by 11.6 million dollars.[48] While it is unclear what are the real-world implications of prescribing second or third line treatment options in favor of cost, this potential prescribing behavior should be taken into account when designing a medication cost CDS.

The recognition of end users' values and preferences in building and implementing a successful CDS is vital. In 90% of randomized controlled trials assessing CDS effectiveness, CDS has been shown to significantly improve clinical practice when integrated into workflows and contains actionable, patient-specific recommendations at the time and location of decision making.[23] However, barriers to adoption and uptake include poor usability, excessive alerts, inadequate human–computer interface, and missing or unreliable information or recommendations. To address these challenges, several publications regarding best practices for CDS design and implementation are available and emphasize the need to understand end users' values, preferences, and workflow.[30,49–52]

This study offers valuable insights into the design and potential adoption of medication adherence and cost CDS in

primary care. These findings reflect variability in clinicians' perceived value and preferences for medication-related CDS and highlight the importance of engaging with stakeholders when developing CDS. Future studies may utilize our findings to inform the design and implementation of CDS interventions targeted to medication adherence and cost in primary care. However, these findings should be interpreted within the context of some limitations. First, clinicians who participated in the interviews may differ from those who did not; however, to increase generalizability of our findings, we included clinicians with varying practice responsibilities and settings. We acknowledge that our findings may not be widely representative of the national primary care clinician workforce and pertain largely to the demographics of our interview panel. For example, 65% of our panel worked in academic medical centers, but only 26% of primary care providers nationally are employees of a nonphysician-owned practice, of which, only 42% are employees of an academic health center.[53] Second, although we attempted to establish a professional and open rapport and minimized potential bias with the use of a structured interview guide, some participants may have altered their responses for fear of scrutiny. We also took measures to maximize rigor of the study methods and analysis.[44] Further, our study was done in one area of Colorado and findings may not be applicable to other settings in rural locations, others states, or other countries. While medication nonadherence is a universal issue, the burden of medication cost on the patient may vary in other countries due to different health care system models being utilized (e.g., universal health care system vs. subsidized vs. mixed).[54–57] Additionally, drug prices in the United States are high due to lack of regulation or negotiation about prices of new prescription medications introduced into the market, whereas other countries employ methods to control drug pricing.[58] Despite these variations, even patients being cared for within a different health care system model may experience medication cost barriers and, as a result, experience poor outcomes; thus, research on what tools clinicians practicing in those areas would desire to help minimize cost barriers at point of prescribing would be beneficial. Lastly, although our focus was on CDS solutions, it is important to note that CDS within EHRs are not the only means to address cost and nonadherence barriers to medication therapies. Health systems should consider the appropriateness of other solutions both internal and external to the EHR, such as text reminders or behavioral nudges sent to patients.[7–10]

## Conclusion

Clinicians believe current practice and patient care may be improved with a CDS that delivers patient-specific medication adherence and cost information at the point-of-care and are most interested in CDS for medication cost. To maximize integration of CDS within clinical workflows, future CDS interventions for medication adherence and cost in the primary care setting should be informed by clinician preferences including use of claims data to color-code level of adherence and presentation of medication out-of-pocket

costs to facilitate conversations with patients and guide cost-conscious prescribing.

## Clinical Relevance Statement

CDS tools can help patients and clinicians manage medication adherence and affordability; however, adoption and uptake is contingent on designing products that meet users' needs. Clinicians expressed a higher need for medication cost CDS and emphasized the desire to have a product that is accurate, user-friendly, and well integrated into their workflow. We identified CDS design features unique to medication adherence and cost that should be considered when designing and implementing such CDS.

## Multiple Choice Questions

1. Why did clinicians rate a higher need for a medication cost CDS compared with a medication adherence CDS?
   a. Medication cost CDS would present more accurate content.
   b. Medication cost CDS information could be used to resolve issues.
   c. Medication cost CDS would address nonadherence and cost barriers.
   d. Medication cost CDS would be easier to embed into the EHR.

   **Correct Answer:** The correct answer is option b. Clinicians believe that medication adherence CDS would be beneficial in initiating conversations, but not for resolving nonadherence given that nonadherence can be multifactorial. However, a medication cost CDS would allow for clinicians to know the cost of the medication at prescribing and, if needed, identify alternatives instantly, to optimize patient care. A prior study showed that improving clinicians' knowledge of medication costs by providing formulary and cost materials reduced yearly drug costs and promoted patient conversations about out-of-pocket costs.

2. Why is it important to assess users' values and preferences prior to designing and implementing a CDS tool?
   a. To optimize the usability and utility of the tool.
   b. To ensure efficient training prior to going live.
   c. To identify alternative tools to design and implement.
   d. To determine which group of users would benefit.

   **Correct Answer:** The correct answer is option a. Obtaining users' insights and perceptions prior to designing and implementing a CDS tool allows the users' perceived benefits and unintended consequences to be recognized and addressed. While CDS provides the benefits of streamlining workflow and providing information at point-of-care, it can also lead to alert fatigue, thereby rendering the tool ineffective. Additionally, integration of CDS into workflow is an essential feature to successful implementation, thus, understanding users' workflows would be vital prior to CDS implementation.

## Protection of Human and Animal Subjects

The study was performed in compliance with the World Medical Association Declaration of Helsinki on Ethical Principles for Medical Research Involving Human Subjects.

## Conflict of Interest

C.G.D. reports other from Amgen Inc, other from Amarin Corporation, outside the submitted work.

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