Development and Pilot Testing of EHR-Nudges to Reduce Overuse in Older Primary Care Patients

Theresa Rowe, DO, MS[1], Tiffany Brown, MPH[1], Ji Young Lee, MS[1], Jeffrey A. Linder, MD, MPH[1], Daniella Meeker, Ph.D.[2], Jason N. Doctor, Ph.D.[2], Noah J. Goldstein, Ph.D.[3, 4], Craig R. Fox, Ph.D. [3, 4],Stephen D. Persell, MD, MPH[1, 5]

[1]Department of Medicine, Division of General Internal Medicine and Geriatrics, Feinberg School of Medicine, Northwestern University, Chicago, IL, USA.
[2] Schaeffer Center for Health Economics and Policy, University of Southern California, Los Angeles, CA, USA.
[3]Anderson School of Management, University of California at Los Angeles, Los Angeles, CA, USA.
[4] Geffen School of Medicine, University of California at Los Angeles, CA, USA.
[5] Center for Primary Care Innovation, Institute for Public Health and Medicine, Feinberg School of Medicine, Northwestern University, Chicago, IL, USA.

Corresponding Author:

Theresa Rowe, DO, MS
Email: trowe31@gmail.com

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Running head (45 characters or less): Pilot testing of EHR-nudges to reduce overuse

We certify that this work is novel or confirmatory of recent novel clinical research.

BACKGROUND: Unnecessary testing and treatment of common conditions in older adults can lead to significant morbidity and mortality. The primary objective of this study was to develop and pilot test a set of clinical decision support (CDS) alerts informed by social psychology to address overuse in three areas related to ambulatory care of older adults.

Methods: We developed three electronic health record (EHR) CDS alerts to address overuse and pilot tested them from January 17, 2019 to July 17, 2019. We enrolled 14 primary care physicians from three practices within a large health system who cared for adults aged 65 years and older. Three measures of overuse applied to patients meeting the following criteria: ordering of prostate-specific antigen (PSA) for prostate cancer screening in adult men aged 76 years and older, ordering of urinalysis or urine cultures (UA or UC) for non-specific reasons to identify bacteriuria in women aged 65 years and older, and overtreatment of diabetes with insulin or oral hypoglycemic medications in adults aged at 75 years and older (DM). Clinicians received CDS alerts when criteria for any of the three overuse measures were met. We then surveyed clinicians to evaluate their experience with the CDS alerts.

RESULTS: The number of clinical encounters that triggered CDS alerts was 19 for PSA, 48 for UA/UC and 128 for DM. For PSA encounters, 4 (21%) orders were not performed after the alert. In the UA/UC encounters 29 (60%) orders were not performed after the alert. For the DM encounters, 21 (34%) had diabetes therapy reduced following the alert. Survey respondents indicated that the alerts were clinically accurate and sometimes let them to change their clinical action.

CONCLUSIONS: These CDS alerts were feasible to implement and may minimize unnecessary testing and treatment of common conditions in older adults.

KEY WORDS: overuse, behavioral economics, electronic health records, prostate cancer screening, diabetes mellitus, urinary tract infections

TRIAL REGISTRATION: ClinicalTrials.gov Identifier: NCT03704389

INTRODUCTION

The Choosing Wisely Campaign, an initiative of the American Board of Internal Medicine Foundation, endorsed by the American Geriatric Society, developed recommendations to help reduce potentially harmful tests and treatments in older adults.[1] However, clinicians do not often follow these recommendations.[2] Recently, our group found over utilization in three areas of overuse as recognized by Choosing Wisely to be quite common. In that study, clinicians ordered prostate-specific antigen (PSA) testing for prostate cancer screening in men ages 76 years and older 23% of the time. When urine testing was obtained for women ages 65 years and older, women were asymptomatic or had non-specific symptoms 23% of the time. Additionally, we found that 30% of adults ages 75 years and older with diabetes who were treated with insulin and/or an oral hypoglycemic medication had their most recent hemoglobin A1C (HbA1C) less than 7.0. There was also significant variation among clinicians in ordering the above services.[3]

Changes to the design of content that alert clinicians to clinical information or prompt responses from clinicians in the electronic health record, in some situations, may be effective in promoting clinicians' adherence to evidenced based practices.[4,5] Insights from behavioral science may further inform the design of these alerts to improve clinical decisions.[4,6-8] Eliciting clinicians' qualitative reasons for overuse may also aid in effective design.[9]

The primary objective of this study was to develop and pilot test within the electronic health record in a live clinical environment a set of interactive alerts to address three areas related to overuse of ambulatory care for older adults: 1) prostate cancer screening using PSA testing in older men 2) urine testing in asymptomatic older women and, and 3) overtreatment of diabetes with insulin and/or oral hypoglycemic medications in older adults. These alerts were informed by behavioral science insights and qualitative evaluation of physicians' stated reasons for overuse[9] The secondary objective was to survey clinicians to evaluate their experience with the CDS.

METHODS

This was a non-randomized 6-month pilot study conducted within a large health system in downtown Chicago from January 17, 2019 to July 17, 2019. Northwestern University's Institutional Review Board approved the study.

Intervention development

In prior work, we recruited and interviewed physicians who were above the median for one or more measures of overuse and identified themes for why primary care physicians overuse testing and treatment in older adults. Key themes identified included: beliefs about patient preferences, overestimating the negative impact of not taking the action, and a bias toward maintaining the current course of action.[9] Our multidisciplinary team, including experts in decision science and psychology, used this information to inform the design of the interventions. Wording was designed to: (1) promote salience of potential harms; (2) convey social norms, and (3) foster feelings of social accountability, with the intent to nudge clinicians to conform to the clinical recommendations to test and treat judiciously.

When a clinician ordered a PSA for a man age 76 or older without diagnosed prostate cancer, an alert appeared that (1) included language highlighting potential downstream harms of testing, (2) indicated that the current consensus in clinical guidelines is to not take action (sharing an injunctive norm),(3) provided information about low use rates among the health system primary care physicians (sharing a descriptive norm)[10], and (4) made clinicians accountable for their actions by requiring them to justify a deviation from guidelines (Supplement).[9] The alert told clinicians that if they did not provide a justification for PSA ordering an automatic justification stating, "No justification given…," would be added to the chart.[11,12] If the clinician subsequently entered a diagnosis that would exclude the patient from receiving the alert such as history of prostate cancer, the justification note would not appear.

A similar alert also displayed when clinicians ordered a urinalysis or urine culture when there was no acceptable diagnosis present in the encounter (Supplement).[3] It likewise called attention to potential downstream harms and required the clinician enter a justification or else a "No justification given…," note was added to the chart. If the clinician subsequently entered a diagnosis that would exclude the patient from receiving the alert such as dysuria, the justification note would not appear.

A non-interruptive diabetes alert indicating potential harms of diabetes overtreatment appeared in encounters for patients ages 75 years or older if the most recent HbA1C was <7.0, and insulin or an oral hypoglycemic—a sulfonylurea, or meglitinide—was present on the active medication list. An interruptive version of the alert appeared when one of these medications was ordered or refilled. The alert called attention to potential harms and indicated the current clinical consensus. Clinicians had to acknowledge that they were either: 1) reducing treatment now, 2) treatment had already been reduced or 3) they did not plan to reduce treatment. The display of the alert is provided in the supplementary material.

Importantly, these alerts did not restrict clinician decision making in any way. Clinicians could respond to study interventions by canceling the order or decreasing medications or they could ignore advice presented to them and proceed with original intended order or treatment. They were not intended to substitute for clinical judgement in individual clinical circumstances.

Subjects

We approached 14 primary care physicians from three practices from a large academic health center in downtown Chicago. All provided informed consent and were given a brief document describing the interventions and their clinical rationale. They were also given study team contact information in the event they had concerns or questions about the intervention. We activated the

alerts and diabetes alert within the EHR for enrolled physicians on January 17, 2019. A comparison group of 105 physicians was concurrently measured.

Measures

We produced measures of overuse using the Choosing Wisely campaign endorsed by the American Geriatrics Society. The measures of overuse included: (1) the proportion of men aged 76 years and older without prior prostate cancer who had prostate specific antigen (PSA) screening performed; (2) the proportion urinalysis or urine culture (UA/UC) tests ordered for non-specific reasons to identify bacteriuria in women ages 65 years and older; and (3) the proportion of adults ages 75 years and older with diabetes who were treated with insulin or oral hypoglycemic drug (sulfonylurea or meglitinide) whose most recent HbA1C was <7.0. Details of these measures have been previously reported.[3] We measured care delivered to both patients of the primary care physicians who received the intervention and a comparison group of non-intervention physicians within the same practice. Patients were attributed to the primary care clinician with whom they had the greatest number of visits during the measurement period.

We collected outcome data directly from EHR data documented as part of routine care delivery. Data collected included physicians' diagnoses, orders, prescriptions and free text entries to alerts. We also collected diagnoses, order and prescription data to establish measures of overuse in a manner similar to how we have reported previously.[3] We manually reviewed the charts of diabetes patients to determine if there was a reduction or discontinuation of diabetes medication between the time of the alert and the end of the pilot.

Physician survey

We sent clinicians in the pilot an online survey during the sixth month of the intervention. The online survey was administered through REDCap and took 10-15 minutes to complete.[13,14] The survey included items about perceived frequency of the alerts, their accuracy, actions taken in response to them, and recommendations for whether or not the these interventions should be

disseminated to others. Clinicians received up to three reminders to complete the survey. Clinicians who completed the survey received a payment of $150.

Safety Measures

To assess for a potential harms of the intervention, we developed and tested safety measures. Two measures were related to the urinalysis/urine culture intervention and two were related to the diabetes intervention. Meaningful outcomes associated with prostate cancer screening occur after many years, and thus were not available during the study period.[15] Urine testing safety data included reviewing patient charts who required hospitalization for UTI following CDS exposure and evaluating the rate of UTI requiring hospital care among women aged 65 years and over following an office visit with a physician in the pilot. For diabetes, we evaluated patients with hyperglycemia requiring hospital care following intervention exposure and the rate of hyperglycemia requiring hospital care rate among patients with previously tightly controlled diabetes cared for by pilot physicians.

Analysis plan

We calculated the rates of the three overuse measures in the 6 months before and 6 months during the pilot for both pilot physicians and the physicians in the same three practices who did not participate in the pilot. We calculated the difference in differences between these groups and estimated 95% confidence intervals. For the survey we present descriptive statistics.

RESULTS

The six-month pilot took place between January 17, 2019 and July 17, 2019. Of the 14 participating physicians, 11 (79%) were women and 3 (21%) were men. Three (21%) were non-white. All were internists and one was also a geriatrician.

CDS Nudges and Overuse Outcomes

A description of the encounters during which these physicians received these alerts is provided in Table 1. The PSA alert fired 19 times for 8 (57%) pilot physicians. For the 19 encounters where the PSA alert fired, the physician did not order a PSA test on four (21%) occasions, and the physician entered an appropriate diagnosis after the alert (e.g., a diagnosis of prostate cancer) three (16%) times. PSA ordering was lower (4%) among physicians in the pilot group both before and during the pilot period compared to non-pilot physicians from the same three practices (Table 2). Overall, PSA ordering for screening in men aged 76 years and older did not significantly change from before the pilot to the pilot period in either the intervention or comparison group.

The UA/UC alerts fired 48 times for 13 (93%) pilot physicians (Table 1). The test was not performed in 29 (60%) of encounters where the UA/UC alert activated, and in 10 (21%) cases the test was ordered and the physician entered a diagnosis that was an exclusion (e.g., dysuria). Compared to the 6 months preceding the pilot, during the 6-month pilot the proportion of urinalysis or urine cultures ordered for non-specific reasons decreased (14% to 11%) though the difference-of-differences was not statistically significantly different compared to the non-pilot physicians (Table 2).

The diabetes alert fired 128 times and fired for all 14 (100%) clinicians. Among the 62 patients for whom the DM alert appeared, physicians reduced the intensity of diabetes treatment in 21 (34%) based on manual chart review.

Physician Survey

Results from the survey of the 14 pilot primary care physicians indicated that 3 (43%) recalled the PSA alert, 8 (73%) recalled the UA/UC alert, and 8 (62 %) of clinicians recalled the diabetes alert after six months (Table 3). Of the three physicians recalling the PSA alert, two (67%) reported that the alert was clinically accurate and consistent with current guidelines for

use of PSA testing for prostate cancer screening in older adults, one (33%) physician reported usually not ordering a PSA test in response to the alert, and one (33%) reported sometimes not ordering a PSA test in response to the alert. Of physicians recalling the UA/UC alert, 7 (88%) reported that the message was clinically accurate and consistent with their understanding of urinary tract infection in older women, 4 (50%) reported that the alert sometimes stopped them from ordering a UA or UC for that patient. Of the physicians recalling the diabetes alert, all 8 (100%) reported that it was clinically accurate and consistent with current guidelines for treatment of DM in older adults. Four (50%) reported that they decreased or stopped an oral hypoglycemic and/or insulin in response to the alert and 5 (63%) reported that the alert led them to change patients' clinical management.

Safety Measures

There were zero patients with UTI requiring hospital care following decision support exposure. Among the 2,861 women ages 65 and older with an office visit to a pilot physician during the study, four had UTI requiring emergency department or hospital care and none of these cases appeared to be study-related on chart review by study physicians. Zero previously tightly controlled diabetes patients of pilot physicians had hyperglycemia requiring hospital care.

DISCUSSION

We successfully implemented three behavioral nudges into the electronic health record. These were designed to reduce unnecessary testing and treatment in older adults and were pilot tested with 14 primary care physicians in three practices. While this pilot study was not powered to detect statistically significant differences between intervention and comparison group, our results demonstrate the interventions functioned properly, were generally well received, and may have led to changes in the predicted direction in clinical behaviors including reducing UA/UC testing for nonspecific reasons in older adult women, PSA screening in older adult men, and de-intensification of diabetes medication in older patients at risk for hypoglycemia.

Additionally, clinicians in the study usually agreed that the alerts and alerts were accurate and easy to accommodate in clinical practice.

Decision support to reduce asymptomatic bacteriuria has been shown to reduce urine culture testing, but not urinalysis testing in hospitalized patients.[16] Similar to what we present in here, in the study by Keller et al. educational material was provided to clinicians and the decision support imbedded into the electronic health record. Although clinician acknowledgment of the CDS was required to proceed with ordering in that study, clinicians did not need to provide a justification for why they were continuing a UA/UC order.[16] A prior study from our group has shown that accountable justification can significantly reduce unnecessary antibiotic treatment.[4,17] We expect that the additional step of requiring a justification to proceed with UA/UC ordering will likewise promote a greater reduction in UA/UC than a more passive approach, and are currently testing this in a large pragmatic study.

To our knowledge, there have not been prior studies evaluating the implementation of CDS for reducing PSA testing in older adult men. In this pilot, almost a quarter (21%) of PSAs were not ordered after the alert fired, but the total number of PSA orders were low and the enrolled physicians in this pilot were already using PSA screening in older men less frequently than their practice peers who were not in the pilot study. A recent qualitative study showed that clinicians may make decisions about cancer screening in patients with limited life expectancy in a non-deliberative fashion.[18] Thus, an alert designed to remind clinicians that patients in this age group may no longer benefit from cancer screening and to make salient the potential harms of screening may be a particularly useful way to reduce unnecessary cancer screening.

Regarding diabetes care of older adults, recently Belli et al. designed and implemented a collection of six behavioral-economics-informed nudges designed to improve adherence to diabetes recommendations from the American Geriatrics Society's Choosing Wisely

statement.[19] They found a 5.1% increase in guideline compliance. As with our planned intervention, they reported that they will test their nudges in a large randomized controlled trial.

There are significant advantages to using CDS as a strategy to reduce unnecessary testing and treatment in older adults. Decision support rules are easy to implement for large numbers of clinicians, they can be designed to address knowledge deficits as well as underlying motivations for why clinicians overuse some services such as clinical inertia, overestimation of benefits compared to risks, and can prompt clinicians to discuss reasons for testing or not testing. Additionally, they have the potential to improve documentation by nudging clinicians to record appropriate clinical signs, symptoms and diagnostic codes associated with testing and treatment. However, there are few disadvantages as well. Clinicians can find multiple alerts and "pop-ups" to be bothersome, though if alerts like these yield changes in behavior they will no longer appear. Additionally, clinicians can develop "alert fatigue" from multiple interruptions during a patient encounter.[20] However, in our study, clinicians overall did not report that the alerts negatively impacted their workflow or patient care. Lastly, there is the potential that alerts could potentially reduce appropriate care, especially if the clinician does not understand why the CDS fired. However, we retrospectively evaluated patients sent to the ED or were hospitalized after the UA/UC and diabetes CDS fired and did not find any preliminary evidence of safety problems.

We highlight several limitations in this study. First, this was a pilot study so we did not intend nor were we powered to determine if the CDS alerts led to meaningful differences in unnecessary testing or treatment. We recruited a convenience sample of primary care physicians who appear to have been relatively more adherent to the Choosing Wisely recommendations. It is unclear if these results are generalizable to a larger group of primary care physicians or to other primary care clinicians (physician assistants or advance practice

nurses). Worse performing clinicians would have greater room for improvement, but might react to the CDS nudges more negatively.

CONCLUSION

This pilot demonstrated the successful implementation within a health systems' EHR and initial real-world testing of three CDS nudges informed by social psychology insights to reduce overuse in older adults obtaining primary care. These preliminary findings suggest the potential for favorable effects on clinical outcomes, and acceptability to physicians. A large ongoing cluster randomized trial is assessing the effectiveness of the nudges within the electronic health record in 60 primary care practices.

Table 1. Description of Clinical Encounters with Pilot Physicians Receiving Clinical Decision Support during 6-Month Pilot

	Clinical decision support		
	PSA screening men age ≥ 76	**Urinalysis or culture for non-specific reasons women age ≥ 65**	**Diabetes overtreatment, age ≥ 75**
Clinical encounters with decision support alerts, N	19	48	128
Pilot physicians who received at least one alert, N (out of 14)	8	13	14
Median No. alerts per physician	2.5	3	11.5
Action taken at encounter with alert			
Test not done, N (%)	4 (21)	29 (60)	*
Test done, exclusion diagnoses added, N (%)	3 (16)	10 (21)	*
Test done, no exclusion entered, N (%)	12 (63)	9 (19)	*
Acknowledgement entered, N (%)	19 (100%)	36 (75%)	28
Type of acknowledgement, N (%)	• Order 17 (89%) • Exit and Cancel Order: 2 (11%)	• Order: 33 (69%) • Exit and Cancel Order:3 (6%)	• I am reducing treatment now: 8 (6%) • Treatment already reduced: 5 (4%) • I do not plan to reduce treatment now: 15 (12%)
No acknowledgment entered, N, (%)	0	12 (25%)	100 (78%)
Diabetes therapy reduced on chart review, N patients (%)	*	*	21 / 62 (34%)

Table 2. Measures of Overuse Before and During Pilot Period

	Patients attributed to clinician group in six months prior to the pilot		Patients attributed to clinician group during six-month pilot		
Overuse Measure	Patients of 14 pilot physicians n / N (%)	Patients of 105 comparison physicians n / N (%)	Patients of 14 pilot physicians n / N (%)	Patients of 105 comparison physicians pilot n / N (%)	**Difference in differences (95% CI)**
PSA screening men age ≥ 76	12 / 305 (4)	202 / 1486 (14)	13 / 308 (4)	209 / 1510 (14)	0.03 (-5.6, 5.7)
Urinalysis or culture for non-specific reasons in women age ≥ 65	38 / 270 (14)	283 / 1393 (20)	25 / 230 (11)	235 / 1221 (19)	1.8 (-5.4, 9.0)
Diabetes overtreatment, age ≥ 75	42 / 136 (31)	162 / 483 (34)	50 / 126 (40)	178 / 465 (38)	4.2 (-4.3, 12.6)

Table 3. Survey Responses of Pilot Physicians (N = 14)

	PSA screening men age ≥ 76	Urinalysis or culture for non-specific reasons women age ≥ 65	Diabetes overtreatment, age ≥ 75
Number of eligible physicians for topic, N *	7	11	13
Recalled seeing the alert, N (%)	3 / 7 (43)	8 / 11 (73)	8 / 13 (62)
Of pilot physicians who recalled seeing the alert			
Did the alert fire appropriately (yes), N (%)	3 / 3 (100)	5 / 11 (63)	7 / 13 (88)
Was the alert clinically accurate (yes), N (%)	2 / 3 (67)	7 / 11 (88)	8 / 13 (100)
The alert led me to change the clinical management of my patients (strongly agree or agree), N (%)	1 / 3 (33)	3 / 11 (38)	5 / 13 (63)
I was able to easily incorporate the alert into my clinical practice (strongly agree or agree), N (%)	2 / 3 (67)	4 / 11 (50)	7 / 13 (88)
Interacting with the alert was time consuming (disagree or strongly disagree), N (%)	2 / 3 (67)	1 / 11 (13)	6 / 13 (75)
I would recommend the alert be used by other clinicians (Strongly agree or agree), N (%)	2 / 3 (67)	3 / 11 (38)	7 / 13 (88)

*A smaller number of physicians were eligible for each topic than the number who received each alert because some pilot physicians received alerts only after the survey was performed.

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Author Contributions: TR, TB, JL, DM, JD, NG, CF, SP had a role in study design, execution, analysis and drafting of the manuscript. JL had a role in data analysis and drafting of the manuscript.

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