

Identifying barriers to the effective use of clinical reminders: Bootstrapping multiple methods

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Abstract

Advances in electronic medical record capabilities enable clinical reminders to inform providers when recommended actions are “due” for a patient. Despite evidence that they improve adherence to guidelines, the Veteran’s Health Administration (VHA) has experienced challenges in having providers consistently use clinical reminders as intended. In this paper, we describe how multiple methods were used to opportunistically triangulate, or “bootstrap,” an understanding of barriers to the effective use of clinical reminders in the VHA. In an initial study using ethnographic observations and semi-structured interviews of HIV clinical reminders, we identified six barriers to effective use: workload, time to remove inapplicable reminders, false alarms, training, reduced eye contact, and the use of paper forms rather than software. In a second study, we collected open-ended and closed-ended data regarding barriers and facilitators to the use of clinical reminders in general in the VHA through a survey of 261 participants at a national informatics meeting, where 104 of 142 VHA health care facilities were represented. The findings from the second study extended our understanding of the previously identified barriers. In addition, four new barriers were identified: ease of use issues, accessibility of workstations, resident physicians and trainees, and administration benefiting more than providers from clinical reminder use. We discuss potential implications regarding the similarities and differences in study findings for factors to consider in planning interventions to improve clinical reminder use.

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1. Introduction

The potential for computerization to improve clinical care has been appreciated for some time [1]. Recent advances in health information systems, in particular electronic medical records [2,3], provide the opportunity for

more sophisticated uses of machine processing to aid human cognition. One such attempt is to display via “clinical reminders” tasks that computerized processing infers are “due” based on automated recognition of patient data, including age, gender, vital signs, laboratory results, medications, and dates of prior activities. For example, “diabetic eye exam DUE NOW” is displayed annually in a diabetic patient’s electronic medical record to remind the provider to schedule an eye exam with an optometrist to reduce the risk of loss of eyesight. In general, clinical reminders are intended to improve clinical

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care by reminding physicians or nurses real-time during patient exams to take a set of recommended actions.

In the majority of published randomized controlled studies, computerized clinical reminders have been effective at improving adherence with established clinical guidelines [4,5]. Despite this potential, a challenge in the use of clinical reminders is convincing practitioners to consistently use the system as intended, not unlike experiences with other health information technology such as computerized provider order entry [6] and bar coding to identify patients and treatments [7]. Rather than mandate adoption of what might be poorly designed technology, the Veteran's Health Administration (VHA) was interested in identifying design and organizational barriers to effective use of clinical reminders.

The VHA is an excellent natural laboratory for the use of computerized clinical reminders. Clinical reminders have been in continuous use for several years in the hundreds of outpatient primary care clinics throughout VHA. Computerized clinical reminders display prominently as a list on the primary screen of the patient's electronic medical record in the Computerized Patient Record System (CPRS). A desire to perform well on organizational quality metrics, the so-called External Peer Review Program (EPRP) indicators, likely encourages the use of many of the clinical reminders.

The most extensive trial of clinical reminders to date was conducted with 275 resident physicians at 12 Veterans Health Affairs (VHA) medical centers randomly assigned to a reminder or control group [8]. Similar to findings from other studies, the clinical reminders significantly impacted rates of compliance with standards of care. A unique finding was that the effect declined throughout the 17 months of the study. This finding suggests that there are likely barriers to the effective use of clinical reminders that go beyond the initial costs of change and learning to use the system.

In this paper, we describe how multiple methods within and across two studies were used to somewhat opportunistically triangulate, or "bootstrap," an understanding of barriers to the effective use of clinical reminders in the VHA. We first describe the clinical reminder software and the "bootstrapping" strategy for gleaning insight from multiple methods. Next, we overview the first study, which used ethnographic observations and semi-structured interviews to identify six barriers to 10 HIV reminders used by specialist physicians. Then we describe the methods used in the second study, where we collected open-ended and closed-ended data through a survey of 261 participants at a national informatics meeting about barriers and facilitators to the use of all clinical reminders in VHA outpatient clinics. The findings from the second study extended our understanding of the originally identified barriers by providing new insights. In addition, four new barriers were identified. Finally, we discuss how similarities

and differences across the study findings are suggestive regarding how well the findings may generalize to different settings and how they might be addressed.

2. Computerized clinical reminders

Computerized clinical reminders in the Veteran's Health Administration (VHA) run on top of a complex electronic infrastructure that has been continuously modified and extended since the 1970s. In 1996, Computerized Patient Record System (CPRS) software that incorporates order entry and other functionality in a Graphical User Interface (GUI) format was initially released. Clinical reminders display on the primary screen of the CPRS software, which was mandated nationally in the VHA in 1999.

The Computerized Patient Record System (CPRS) has extensive functionality, including ordering and reviewing of laboratories, pharmaceuticals, and diagnostic tests, and documentation of progress and procedures. Clinical reminders that are "due" for a patient, based on the available data, appear on the primary "coversheet" screen of the Computerized Patient Record System (CPRS) software (Fig. 1). This screen includes allergies, medications, laboratories, vital sign data, appointments/admissions, crisis notes, adverse reactions, warnings, and clinical reminders in a condensed single-window view. By clicking on the alarm clock icon in the upper right hand corner, further information about the clinical reminders, including potentially applicable reminders that are not currently due, can be accessed.

Reminders are removed from the "due" list through three different mechanisms. First, they may be satisfied by actions apart from the reminder itself, but nonetheless observable to the computer system (e.g., ordering a laboratory test through CPRS). Second, the user may follow recommended links via the reminder (e.g., ordering a laboratory test through a reminder's dialog box). In the first two cases, documentation is a by-product of following the reminder advice. Third, in cases where the reminders are judged not to be clinically relevant or an action that is taken cannot be automatically detected by the software, the provider can remove the reminder manually. In this case, the provider opens a progress note for the patient session and signs in. After a note has been opened, a reminders "drawer" is available. The user clicks on an individual reminder that is contained in a folder in the drawer (folders are labeled due, applicable not applicable, all evaluated, and other). At this time, a dialog box (Fig. 2) can be used to document the reason for inapplicability of the reminder, which is automatically entered into the progress note. Upon refresh, the status of the reminder will change so that it is no longer "due." The amount of time before the clinical reminder again becomes "due" depends upon which option has been selected.

Active Problems	Allergies / Adverse Reactions	Postings
Htn Diabetic Retinopathy (ICD-9-CM 250.02) Bipolar Disorder, Mixed (ICD-9-CM 296.2) Hypertthyroidism Dependent Personality Tetanus Nephrotic Syndrome	Penicillins Milk Penicillin Ibuprofen	Wishes To Be Organ Donor (w) Legal Guardianship (w) Jun 05, 2003 Legal Guardianship (w) Jun 05, 2003 Advance Directive/Non-Cincinnati Va Va Living Will/Va Advance Directive

Active Medications	Clinical Reminders	Due Date
No Active Medications Found	* Diabetic Lipid Control	DUE NOW
	* Diabetic Serum Creatinine	Jul 20,02
	* CHF Ejection Fraction Status	DUE NOW
	COPD Inhaler Use	DUE NOW
	COPD Spirometry (PFT)	DUE NOW
	* Alcohol Use Screen	Oct 08,04
	Hypertension Screen/BP Check	Sep 16,04
	Hypertension Lifestyle Counseling	Oct 20,04
	Nutrition/Obesity Screen	Oct 08,04
	Exercise Screen	Oct 20,04
	* Diabetic Hemoglobin A1C	May 17,01
	* CHF Diet/Weight/Meds Counseling	DUE NOW
	Pain Assess/Reassess (Brief)	DUE NOW

Recent Lab Results	Vitals	Appointments/Visits/Admissions
Pt Only Blood Plasma Sp Lb #574721 Nov 26,04	T 96.8 F Sep 09,2004 09:28 (36.0 C) P 111 Sep 09,2004 09:28 R 60 Sep 09,2004 09:28 BP 117/77 Sep 09,2004 09:28 HT 66.5 in Sep 09,2004 09:28 (168.9 cm) WT 206.5 lb Sep 09,2004 09:28 (93.9 kg) PN 5 Oct 01,2004 08:01	Nov 30,2004 09:32 Zzoutpatient(location Only) No

Fig. 1. CPRS coversheet where due clinical reminders are displayed for a fictional patient.

Exercise Screening should be done yearly to all patients.

PATIENT HAD EXERCISE SCREENING DONE
Level of Understanding: (None selected)
Comment:

PATIENT HAD EXERCISE SCREENING DONE PREVIOUSLY
 PATIENT HAS POOR LEVEL OF UNDERSTANDING FOR EXERCISE SCREENING
 PATIENT DECLINED EXERCISE SCREENING
 PATIENT HAS LIFE EXPECTANCY LESS THAN 6 MONTHS

Clear Clinical Maint Visit Info < Back Next > Finish Cancel

CLINICAL REMINDER ACTIVITY
Exercise Screen:
Patient had Exercise Screening at this encounter.

Patient Educations: Exercise Screening

* Indicates a Required Field

Fig. 2. Dialog box used to manually remove the exercise screen clinical reminder.

3. Methods: bootstrapping multiple methods

The traditional methodological combination of ethnographic observations followed by a survey uses observations to identify variables of interest and the survey to determine the frequency of the variables in a representative sample. In contrast, this paper explains how multiple methods were used for a single purpose: to shed light on barriers to practitioners (providers) in a complex setting (outpatient clinics) using a clinical reminder portion

of a software package that is designed to improve task performance. As the VHA is one of few pioneers of electronic medical records in general, and clinical reminders in particular, little research has been conducted on this topic. Therefore, we took advantage of extant opportunities to collect data about the topic, where method and participant selection was primarily driven by pragmatic constraints and access. This is sometimes referred to as a “bootstrapping” strategy in the conduct of a cognitive task analysis. Early in the process of learning about the cognitive demands of a domain, knowledge and cognitive strategies of domain practitioners, and aspects of computerized support tools [9], a range of methods are often utilized. More generally, the use of multiple methods, combining data sources from several types of data collection to combine methods and datasets to generate generalizable information, is usually referred to as triangulation.

4. Study 1: observation of barriers to HIV clinical reminder use

4.1. HIV reminders

Ten guideline-based reminders were developed as part of a larger project to improve quality of HIV care. Each one used electronic record data to identify patients

potentially receiving suboptimal care, such as single drug antiretroviral therapy or no prescription for antiretroviral drugs despite immune deterioration and high viral load. The purpose of the HIV clinical reminders was to reduce the likelihood that physicians would forget to screen a patient for related diseases (5/10 reminders), miss that patient data has crossed a threshold for an intervention (3/10), or forget to perform a periodic action in a treatment plan (2/10). Specifically, the HIV clinical reminders cued specialist physician providers to:

- screen for related diseases (hepatitis A, B, C, toxoplasmosis, and syphilis),
- initiate medication regimens when immune function (CD4⁺ count) falls below recommended thresholds, and
- monitor immune function, viral load, and lipids at recommended intervals.

4.2. Methods

As described in [10], Patterson and colleagues observed HIV providers at two pilot and six sites after the clinical reminders were implemented, from October 2001 to October 2002. The two pilot sites were selected based on ease of accessibility and the six study sites were selected based on IRB approval and participation in a larger, randomized 16-site study [11]. This larger study evaluated the independent effects of these computerized clinical reminders and a group-based quality improvement intervention. Five sites implemented the clinical reminders as the sole intervention. Three sites received the quality improvement intervention as well as implemented the clinical reminders. This intervention included training on the HIV clinical reminders as well as three face-to-face learning sessions and weekly interactive conference calls surrounding quality improvement techniques. All clinic sites were dedicated to infectious disease (ID) patients and all care providers had been using the Computerized Patient Record System (CPRS) on which the clinical reminders display for over a year, but the size and work organization varied.

Two observers, trained in ethnographic field observations in complex settings [12], conducted observations for 1 day each at the two pilot and six study sites, for a total of 28 providers and 32 patients. Semi-structured interviews were conducted opportunistically with all accessible clinic personnel, including the host attending physician. All interviewees were asked to describe their role in providing patient care, what they perceived to be barriers to the use of clinical reminders in general and the 10 clinical reminders being evaluated, and what training they had received. As issues were raised by the interviewees, questions to clarify trade-offs and assess the tractability of the barriers were asked.

Notes from both the observations and interviews were translated into electronic format by the investigator within two days of data collection to minimize loss of additional data in memory and introducing inaccurate information during translation. The observational data were transformed into a standard activity protocol format that details observed verbalizations and behavior separately from less reliable inferences about internal cognitive processing [13]. The protocols were analyzed for usefulness and usability problems, normally indicated by a reaction of surprise to how the clinical reminders responded to a user action.

The verbal response data from the semi-structured interviews were organized for each site into a template that was designed to target specific questions as well as support the discovery of unanticipated insights. Finally, data from the observations and interviews were collectively analyzed. The specific analytic technique employed was process tracing analysis [14], which iteratively uses a conceptual framework to generate top-down questions as well as abstracts data bottom-up into emerging themes. Barriers were classified as “present” if they were observed or self-reported during the interviews and “unable to tell if present” if they were not.

4.3. Findings

Six barriers to the effective use of the HIV clinical reminders were found at a minimum of two of the eight outpatient clinics:

1. *Workload.* This was the primary barrier, based on the relative frequency of times that it was self-reported during the interviews and provided as an explanation for not using the clinical reminders during the observations. At all sites, at least one provider reported that (s)he did not use the clinical reminders when (s)he was busy. At some sites, physicians reported using the clinical reminders only when they had additional time during the clinic day.
2. *Time to document why the clinical reminder did not apply.* All sites reported that a significant barrier was the lack of time to document why the reminder’s advice was not followed. At all sites, at least one provider never documented why reminders did not apply. At least one provider at all sites conducted documentation after the patient had left the room. At two sites, case managers documented clinical reminders that were not clinically relevant when the physicians did not.
3. *Inapplicability to the situation.* Excluding sites where the clinical reminders were never used, nine of 26 patients had HIV clinical reminders that the observed providers believed were inappropriate for the situation.

4. *Training.* At five sites, limited knowledge of how to use the clinical reminder software in general was a barrier to effective use. During interviews, we were informed by several physicians that their facility's basic formal training class on the Computerized Patient Record System (CPRS) did not include how to remove inapplicable clinical reminders.
5. *Quality of provider–patient interaction.* Three of the 23 permanent staff did not use clinical reminders because they did not want to reduce eye contact with their patients.
6. *Use of paper forms.* Only three of the eight sites used resident physicians to provide care. At two of these sites, the residents filled out paper forms which were reviewed prior to computerized order entry by others.

5. Study 2: survey of barriers to use of VHA clinical reminders

5.1. Methods

A survey instrument with closed-ended and open-ended questions was distributed to participants at a national meeting that took place in Georgia in May 2003. The questionnaire is available from Dr. Doebbeling and a detailed description of the methods has been published elsewhere [15]. This meeting focused on the VHA's electronic health record and included representatives from 136 VHA medical facilities. Facility representatives, who were nominated by their facilities, were clinical staff (e.g., physician, nurses), administrative personnel (e.g., chief of staff), or informatics experts. Many attendees were opinion leaders at their facility and had extensive experience with local CPRS capabilities, either as users or developers of clinical applications for the electronic medical record and its decision support tools.

The survey instrument elicited whether 15 computerized clinical reminders were implemented at the respondent's facility, representing a broad range of conditions clinicians might encounter in outpatient clinic settings. The remainder of the 73 closed-ended items in the survey instrument focused on institutional factors that might be barriers or facilitators to effective use of the clinical reminders, including different forms of computer use (provider education, performance feedback, and clinical support such as ability to retrieve radiological images), perceived utility and ease of use, adequacy of training, organizational support, hospital culture/climate, and availability of feedback mechanisms for modifying reminders. Responses for this portion of the survey instrument were either dichotomous (yes or no) or measured on a 5-point Likert-type scale. The open-ended questions at the end of the survey were:

1. What has helped you learn and incorporate automated clinical reminders in patient care?
2. What makes use of automated clinical reminders difficult in patient care?
3. Has an automated clinical reminder ever helped you deliver care more effectively? If yes, please give an example.
4. Have you ever been surprised by the actions of any computerized clinical reminder in CPRS? If yes, please give an example.

For the closed-ended question analysis, outcome measures were obtained from questionnaire responses. For these measures, we aggregated individual responses at the facility level. The first outcome measure represents which of the computerized clinical reminders were available at the facility. The second outcome measure, a "facility clinical reminder score" (minimum possible score = 0, maximum possible score = 15), was created by summing "yes" responses to questions surveying whether a facility had at least one clinical reminder for a particular health condition. Aggregate scales were used, combining multiple responses, including:

- computer training and personnel support (8 items; $\alpha = 0.842$)
- Electronic Health Record functionality (12 items; $\alpha = 0.86$)
- clinical reminders utility and ease of use (6 items; $\alpha = 0.75$)
- availability of graphical display of individual and clinic performance (2 items; $\alpha = 0.95$).

For each scale, higher scores indicated greater perceived support, ease of use/utility, functionality, or availability.

For the open-ended question analysis, one investigator initially analyzed questions 1 and 3 and another analyzed 2 and 4. The analysis was iteratively conducted in Excel spreadsheets by the original analyst, influenced by discussions during a series of teleconferences with other investigators. The 174 responses to question 1 were singly categorized. Responses from "non-users" of the clinical reminders were removed from analysis for question 2, because several responses indicated lack of personal experience with use during patient visits, which was not judged to be as important for responses to the other questions. One hundred and ninety-five respondents were classified as users, for which only 151 answered question 2. These respondents were 67 physicians, 58 nurses, 18 nurse practitioners, and 8 physician's assistants. The responses were multiply and iteratively classified during the analysis, which is the only question for which multiple codes were deemed necessary. Question 3 ($N = 136$) was iteratively coded several times by two investigators because there was the least consensus during discussions regarding how to best categorize the

data. Question 4 had the fewest responses and the most responses that were judged not to respond to the question. Of the 54 responses, 28 were judged to answer the question, and were singly coded.

5.2. Findings regarding barriers to clinical reminder use

In this paper, we only report findings from the survey that relate to barriers to the effective use of clinical reminders. See [15] for a complete description of the methods and findings for the closed-ended responses and [16] for a complete description of the methods and findings for the open-ended responses.

Responses were received from 261 participants representing 104 of 142 (73%) major VHA facilities. Seventy-one percentage of the respondents were providers (physicians, nurses), 4% were information technologists, and 15% were clinical application coordinators. Clinical application coordinators, who are liaisons between informatics and clinical services, provide services such as implementing and customizing software packages.

For the six barriers to effective use of the HIV clinical reminders identified in the initial study, the following evidence was generated from analyses of the survey data:

1. *Workload.* 134/288 (47%) of the responses from 111 clinical reminder users to “What makes the use of automated clinical reminders difficult in patient care?” were related to workload. Subcategories were:
 - Time constraints $N = 66$ (44%)
 - Slow computers $N = 25$ (17%). In addition, a survey question asked about this directly. In response to “In your facility, to what extent does the speed of the computer speed impede the use of reminders?”, 31% responded great or very great.
 - Too many reminders $N = 24$ (16%)
 - Some reminders are too long $N = 7$ (5%)
 - Having physicians do clerical data entry tasks $N = 2$ (1%)
 - Assembly line medicine $N = 2$ (1%)
 - Not core work $N = 2$ (1%)
 - Workflow $N = 2$ (1%)
 - Lack of nursing support $N = 2$ (1%)
 - Duplication of work $N = 1$ (1%)
2. *Time to document why the clinical reminder did not apply.* 46/288 (16%) of the responses to “What makes the use of automated clinical reminders difficult in patient care?” indicated that the time required to justify deviating from the advice of the clinical reminder when it was not clinically relevant was a burden. No closed-ended questions related directly to this barrier.
3. *Inapplicability to the situation.* 19/288 (7%) of the responses to “What makes the use of automated clinical reminders difficult in patient care?” indicated that reminders did not always apply to a given situation.
 - In response to “In your facility, to what extent are reminder formats tailored to specific populations?”, 55% responded not at all or very little.
4. *Training.* 21/288 (7%) of the responses to “What makes the use of automated clinical reminders difficult in patient care?” indicated that insufficient training contributed to difficulty in using clinical reminders. Specifically, responses were that training was needed on: clinical reminder use in general ($N = 8$; 38%); removing inapplicable reminders ($N = 6$; 29%), general computer skills ($N = 3$; 14%), creating clinical reminders ($N = 2$; 10%), generating reports ($N = 1$; 5%), and viewing active reminders ($N = 1$; 5%). Of 174 responses generated to the open-ended question “What has helped you learn and incorporate clinical reminders in patient care?”, only 38 (22%) described formal training. The other response categories were informal internal support from organizational members ($N = 56$; 32%), self-teaching ($N = 52$; 30%), pressure from management or performance measures without adequate support to learn to use the reminders ($N = 19$; 11%), and other ($N = 9$; 5%). Several of the closed-ended survey questions asked about training as well ($N = 1$; 5%). In response to “In your facility, to what extent have you been trained in using clinical reminders?”, 46% responded not at all or very little. In response to “In your facility, to what extent does the lack of staff computer skills impede the use of reminders?”, 25% responded great or very great. Several questions from the survey regarding training and personnel support for computer use were combined into a composite variable. No significant association was found between the number of reminders implemented at the facility and this composite variable.
5. *Quality of provider–patient interaction.* One response from a registered nurse to “What makes the use of automated clinical reminders difficult in patient care?” was “placement of computer in room—have to turn back to pt to use computer.” Note that registered nurses do not typically use clinical reminders unless they are helping out intake nurses or doing clinical reminders related to the reason for a walk-in appointment. This was the only response that directly related to the barrier reported from the HIV study. New, related issues raised were not wanting the computer to dominate the agenda of the visit in relation to patient concerns (8 responses) and wanting to take patient individuality into account (2 responses). No closed-ended questions related directly to this barrier.
6. *Use of paper forms.* No open-ended responses to “What makes the use of automated clinical reminders difficult in patient care?” or closed-ended questions related to the use of paper forms rather than the CPRS software. Using paper forms does not

eliminate the opportunity to use clinical reminders, but makes it significantly harder because the providers are not viewing the screen that contains reminders when they write orders (although note that one case manager at one of the infectious disease clinics in the HIV reminder study routinely placed reminder information on paper forms for physicians).

In addition to the six barriers identified in the prior study of HIV reminders, four new barriers emerged from the analysis of the survey data:

1. *Ease of use issues.* 26/288 (9%) of the responses to “What makes the use of automated clinical reminders difficult in patient care?” indicated that ease of use issues contributed to difficulty in using clinical reminders. In addition, there were 28 responses to the open-ended question “Have you ever been surprised by the actions of any computerized clinical reminders in CPRS? If yes, please give an example.” Several responses indicated that users were surprised by the system’s actions following selecting a reason for inapplicability of a reminder (14%) and following the advice of the reminder (7%), which suggest disconnects between users’ mental models and designers’ models. Also, the data suggest ways to reduce false alarm rates. Reminders were described as inapplicable due to inaccurate diagnostic code, particularly for diabetes (43%), mitigating patient factors (11%), and automated processing failing to recognize relevant patient data (7%). In response to “In your facility, to what extent are reminder formats easy to use?”, 46% responded not at all or very little. In response to “In your facility, to what extent have reminder formats been modified based on comments by users?”, 63% responded not at all or very little. Finally, multivariable regression found that a “perceived utility and ease of use” scale compiled from composite variables was positively associated with the number of implemented reminders. Each five-point increase on the scale was associated with a one-unit increase in the number of the 15 surveyed clinical reminders at the facility (F statistic 5.78; p value 0.005).
2. *Accessibility.* None of the open-ended responses reported that the number of available workstations made the use of clinical reminders difficult in patient care. Nevertheless, in response to “In your facility, to what extent are enough workstations available in each provider (MD, PA, NP) exam room?”, 82% responded not at all or very little. In response to “In your facility, to what extent are enough workstations available for other staff (nurses, etc) in patient interview rooms?”, 68% responded not at all or very little.
3. *Resident physician and trainees.* An increase in the number of residents and trainees was associated with a decrease in the number of clinical reminders imple-

mented (parameter estimate 0.21; $p = 0.01$). Note that this decrease related only to the 15 clinical reminders included in the survey.

4. *Administration benefits more than providers.* 31/288 (11%) of the responses to “What makes the use of automated clinical reminders difficult in patient care?” indicated that the administration rather than providers were the primary beneficiaries of the clinical reminder use. For example, a Registered Nurse responded that “reminder is written to fulfill regulatory issues, i.e., administrative directive, versus vets clinical need.” Similarly, a physician responded: “sometimes it comes down to: do I give care today or fill out forms—cannot always do both so patient always comes first.” No closed-ended questions related directly to this barrier.

6. Integration of findings across multiple methods

6.1. Differences in the domains

Although the two domains, HIV care and primary care, in the two studies clearly have similarities, we gained insight into some key differences that may impact the use of clinical reminders. Explicitly exploring these differences may suggest potential “leverage points” for reducing the barriers that do not require extensive software revision as well as limitations to the effectiveness of redesign for addressing barriers in other domains. Domain differences are explored below for cognitive demands, knowledge and cognitive strategies, and aspects of computerized support tools.

6.1.1. Domain differences in cognitive demands

The cognitive demands appear to differ between the domains. In the first study, several of the specialist physicians did not use clinical reminders at all or during the first visit because they were concerned about reducing eye contact with the patient. This finding was not well-supported by the survey data. Several explanations for this difference have been hypothesized. First, there might not actually be a greater need for eye contact in HIV care. It is possible that specialist physicians have more freedom to decide whether or not to use clinical reminders than primary care physicians and intake nurses, who might also be concerned about maintaining eye contact with patients. Currently, VHA specialist physicians are not monitored for “completion rates” on reminders, unlike primary care physicians who are individually monitored and intake nurses who are monitored as a team.

If there is a greater need for eye contact in HIV care, one reason might be the difference in roles. No intake nurses had access to the HIV reminders in the first

study. In the second study, many of the clinical reminders were done by intake nursing personnel. The intake nursing role is generally to collect vital sign data and ask patients for the primary reason for their visit. This role tends to have fewer cognitive demands, less variability across patients, and is several minutes long. Specialist physicians, in contrast, spend more time reviewing a patient's medical history, diagnosing, and treating the patient, which takes more time. One observed difference between patient interaction with intake nurses and physicians is that intake nurses generally do not shut the door, whereas most of the physicians, both specialist and primary care physicians, did. This suggests that the interaction between patient and physician is a more intimate one than with intake nurses, which might necessitate more eye contact.

However, there might also be differences in demands between infectious disease specialist and primary care physicians that require more eye contact. The first visit to a specialist in infectious diseases is often soon after hearing a new diagnosis, such as being HIV positive, that is emotionally charged. Even after the first visit, it has been hypothesized that deviation from physician recommendations have greater consequences in general for HIV patients than for primary care patients. For example, it is more important for patients to adhere to strict medication regimens for antiretroviral medications than for other medications. Also, additional precautions need to be taken to prevent infecting others.

6.1.2. Domain differences in knowledge and cognitive strategies

Differences in the role of resident physicians in the two domains suggest that there are different knowledge requirements for the domains. In the HIV study, a barrier was the use of paper forms by resident physicians to write orders to enable oversight prior to order entry. This barrier was not reported in the survey of primary care providers. In considering this finding, it is important to note that five of the eight infectious disease clinics did not use resident physicians, whereas the elimination of resident providers is known to be highly unusual in primary care clinics. The relatively infrequent use of resident physicians and additional supervision of them when they are used in infectious disease clinics suggests that the care requires more specialized knowledge and expertise. It may be that the redundant paper forms were used as a failsafe to insure that resident performance was carefully monitored and appropriate mentoring would take place in the HIV clinic.

6.1.3. Domain differences in aspects of computerized support tools

Even though both studies involved the same infrastructure and software, there were several differences between the design of the HIV reminders and clinical

reminders in general. Most notably, none of the HIV reminders were associated with the EPRP quality metrics, unlike many of the extensively used clinical reminders [14]. Likely resulting from this difference, none of the studied specialist physicians received individual feedback regarding their "completion rate" for clinical reminder use, which is standard practice for primary care physicians in many VHA hospitals. Second, the number of clinical reminders for physicians and intake nurses at each VHA facility varies, but is generally more than 10, the number of HIV reminders in the first study.

6.2. New insights on previously identified barriers

In addition to supporting many of the barriers identified in the HIV study, the primary care survey also provided additional insight into how these barriers play out across a range of settings. The larger survey sample provided data from both large and small VA hospitals across the country. The qualitative responses, in particular, provided a rich set of examples of barriers.

The first barrier from the HIV study, workload, was well supported by the survey data. A critique of the workload barrier finding from the HIV study was that physicians may be reporting high workload as a defense mechanism to avoid adding tasks rather than reporting a true barrier to the effective use of clinical reminders. A related issue was that it was unclear how to address this barrier as it was viewed unlikely that patient visit times could be expanded. The insights gained from the second study suggest additional possible interventions to reduce workload, such as increasing computer speed, decreasing the overall number of reminders, decreasing the length of particular reminders, providing physicians support for data entry, and eliminating duplication of work.

The second barrier, time to document why the clinical reminder did not apply, was well supported by the survey data. It might be possible to streamline the current method for doing this. In addition, alternative strategies for the use of clinical reminders could be investigated whereby data are not collected regarding why a provider feels that a particular reminder is not relevant. Note that the clinical reminder system at Brigham and Women's hospital takes this approach [18].

The third barrier, inapplicability to the situation, was well supported by the survey data. This finding is particularly important as few providers and patients were observed in the HIV study, and so it was unclear how the finding would generalize to a larger sample of facilities and providers. Also, it was possible that the HIV reminders had a higher false alarm rate than other clinical reminders due to their recent development and potentially more complicated logic. The survey findings provide additional insight into addressing this barrier as high false alarm rates were reported to be particularly problematic for diabetes.

The fourth barrier, training, was well supported by the survey data. The additional insights from the survey data are that there are other mechanisms besides formal training that might be pursued: providing internal support, emphasizing the importance of learning how to use clinical reminders to increase provider motivation. The survey responses also illuminate the content of the training that might be helpful, such as how to remove inapplicable reminders, create new reminders, generate reports, and view active reminders.

The fifth barrier, quality of provider–patient interaction as defined by the need to maintain eye contact between the provider and patient during the exam, was not well-supported by the survey data, although related issues emerged about not wanting the computer to dominate the agenda of the visit and wanting to take patient individuality more into account. It is unclear why this barrier was not found. It is possible that primary care providers also perceive that the quality of provider–patient interaction is reduced, but do not feel that they have the option to avoid using them for this reason, and so did not report this as a difficulty. Unlike primary care providers, specialist providers have not been historically expected to use clinical reminders, and they have also never been individually monitored for completion rates of clinical reminders, although this is possibly on the horizon for several specialties in the VHA, including HIV care. It is also possible that primary care providers use strategies to engage patients while using clinical reminders, such as by tilting the screen so that the patient can view them simultaneously, that specialist physicians have not yet adopted.

The sixth barrier, the use of paper forms by resident physicians to write orders, was not supported by the survey findings. Although it is possible that paper forms are used but were not reported on the survey, we believe a more likely explanation is that resident physicians in specialist clinics are more closely supervised than in primary care clinics. Therefore, the previous recommendation of an addition of an “oversight” function in CPRS prior to acting upon resident orders might not be necessary for primary care physicians.

6.3. New barriers identified in the second study

Four new barriers were identified in the second study. The first new barrier identified from the survey data was poor ease of use. Convergently, note that clinicians surveyed in a different study [19] reported that poor ease of use was a possible explanation for the underuse of automated health maintenance reminders they observed. Nevertheless, ease of use issues were not sufficiently reported or observed during the semi-structured interviews at at least two sites in the first study to merit inclusion as a barrier. It is unclear why this barrier was not found, but it is unlikely to be due to an actual

difference as the same underlying architecture and software package was used in both studies. It is interesting to note that the investigators made 18 recommendations to improve ease of use of the clinical reminders following the first study. The 10 HIV reminders were redesigned based on these recommendations. For the recommendations that required more fundamental changes than could be done by the HIV reminder designers, they will be recommended for the current transition from a MUMPS to JAVA architecture for the provider order entry software within which the clinical reminders run.

The second barrier, accessibility to workstations, was a barrier at only one of the infectious disease clinics in that workstations were not available in patient exam rooms. Nevertheless, it was possible at that clinic to use the clinical reminders by viewing a patient’s record prior to entering the exam room and physicians were not observed to wait to use the available workstations. It is difficult to determine how widespread this barrier is from the HIV study data, given the limited sample size. Overall, there is little evidence for this barrier from the HIV study data. The fact that this barrier was not found in responses to the open-ended survey question addressing difficulties with clinical reminder, suggests that participants in the survey had not personally encountered this barrier in their own patient care. Conversely, responses to close-ended survey questions suggests that survey participants are aware that lack of access to workstations is a problem for some VA hospitals. Despite this somewhat contradictory data, increasing accessibility to workstations is unlikely to have negative, unintended consequences. Investment in additional workstations may well be justified.

The third barrier, the use of resident physicians and trainees, was likely also a barrier to the use of the HIV reminders based on the interview data, but not enough observational data were collected to verify that inference. Only three of the eight sites used resident physicians. At two of these sites, no physicians used the clinical reminders, including the resident physicians. At the third site, 7/7 resident physicians were unable to remove inapplicable clinical reminders while being observed because they did not know that they first needed to open a new note. These findings indicate that improving the ease of learning to use CPRS, in particular for removing inapplicable reminders, might be required for resident physicians and trainees to be expected to routinely use clinical reminders.

The fourth barrier, a perception that the administration benefits more from clinical reminder use than the provider, was not strongly supported in the study of the HIV reminders. Interestingly, the HIV reminder designers explicitly chose not to recommend organizational monitoring of clinical reminder use and targeted physicians rather than nurses as users. The evidence

regarding the perception of the primary beneficiary of the HIV reminders was mixed. One attending physician said: “I have not felt organizational pressure to do them and don’t expect that I will.” One site explicitly decided to do a toxo titer test that they had not previously done despite their belief that it was an unnecessary expenditure of resources. The explanation was that the site wished to “look good” on the reports generated for the research study to evaluate the effectiveness of the clinical reminders on performance for the participating sites. One attending physician, who used clinical reminders but did not remove them when they did not apply, said that he was concerned about mandating the use of the clinical reminders because of the implication that this would be an adequate indicator of physicians’ ability to provide care. At three of the infectious disease clinics, case managers or physician assistants “cleaned up” after the physicians met with patients to improve documentation and how they were perceived by the organization, including by removing inapplicable reminders. Overall, providers appeared concerned about the potential for use of the HIV clinical reminders to monitor their performance, but did not believe that was happening at that time.

7. Conclusions

The findings from the multiple methods employed within and across the two studies extend our understanding of barriers to the effective use of computerized clinical reminders. Four of the barriers to the effective use of the HIV clinical reminders by specialist physicians generalized to the use of all VHA clinical reminders by primary care providers. The second study extended our understanding of the barriers found in the original HIV study and identify four additional barriers. No disconfirming evidence was found for the barriers, with the exception of administration benefiting more than providers from the use of the HIV clinical reminders.

Because most triangulation, or “bootstrapping,” endeavors, such as the one described in this paper, are normally driven by pragmatics and opportunistic data collection, these studies were not explicitly designed to compare results. As a result, it was not possible to definitively determine whether differences in findings regarding barriers were due to differences in the setting (specialty vs primary care clinics), user groups (specialist physicians vs primary care physicians and intake nurses), methods, reminder design (HIV reminders vs other reminders), sampling differences (size, facility, role, experience with clinical reminder use, and level of training), data collection strategies (ethnographic observation vs survey), or other factors. The classification of the barriers in both studies is not necessarily orthogonal. For example, ease of use, workload, and time are likely

related concepts although they are reported separately as barriers. In addition, both the analysis of the observational data and the analysis of the open-ended survey data were iterative, exploratory analyses that have the potential to be heavily influenced by investigator bias. Standard techniques to reduce investigator bias were employed, including interactive investigator debate regarding classification, iterative analysis as new themes were identified, and search for disconfirming as well as confirming evidence. The chief limitation of the survey was that a convenience sample was relied upon, and thus, the responses may not adequately represent typical clinical reminder users. Note, however, that facilities included in the survey analysis did not differ in terms of hospital size and teaching status from those VHA facilities that were not represented in the survey sample. Finally, stepwise variable selection was used for multivariate analysis instead of including all possible variables in the model due to the limited sample size and proportionally large number of possible predictor variables.

Overall, the strategy of “bootstrapping” multiple methods provided useful insight and a sense of how the barriers differed in the two settings. This type of approach is expected to be widely applicable to identifying barriers to the effective use of new information technology in any domain, including healthcare. Triangulation was employed in multiple senses [20] across the two studies: (1) different data were collected, (2) there were a number of different investigators leading data collection, tool creation, and analysis, and (3) method triangulation both within and across the studies. The methods in the HIV study, ethnographic observations and semi-structured interviews, are generally believed to be useful early in the process of modeling factors that impact the usefulness and usability of a system [17]. Nevertheless, the survey data also proved to be useful in generating new insights and revealing new barriers, particularly from the relatively large sample of open-ended survey response data. The observational data gave a sense of which questions might be most impacted by the commonly acknowledged limitations with self-report data from the surveys and interviews. For example, the answers to the second and fourth open-ended questions were judged to be better suited to self-report than the first and third when the results were compared across the studies. The closed-ended questions on the survey were able to provide a percentage estimate of respondents who agreed that an item was a barrier to use and how they coped with the barriers. Although the survey respondents were a convenience sample, these estimates were not possible from the small samples in the first study, and could be viewed as providing “ceiling” and “floor” estimates since the respondents are likely some of the best-trained and informed VHA personnel. The open-ended survey questions allowed a sense of which issues were most prominent to the sampled popu-

lation, or at least most worthy of mention, and enabled subcategories within a concept to emerge, such as variations on how workload is defined. The multivariable regression from the composite survey variables enabled preliminary investigation of which barriers to use affected the number of implemented clinical reminders at a facility, which is one potential measure of the “impact” of the barriers on willingness to adopt clinical reminders.

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