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Can targeting preventive care reminders to primary care providers seeing their own patients improve response to clinical decision support?

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Can Targeting Preventive Care Reminders
To Primary Care Providers Seeing Their Own Patients
Improve Response to Clinical Decision Support?

By

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A Capstone Project

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CERTIFICATE OF APPROVAL

This is to certify that the Capstone Project of

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Can Targeting Preventive Care Reminders

To Primary Care Providers Seeing Their Own Patients

Improve Response to Clinical Decision Support?

has been approved

Paul Gorman, MD Capstone Advisor

Date

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DEDICATION

This work is dedicated to primary care providers – may improvements in decision support raise the quality of our preventive care and make our work lives better.

ACKNOWLEDGMENTS

I would like to thank the following people in their support of this work:

My capstone advisor, Paul Gorman, for his wisdom in providing the initial study design and guidance in improving and thinking through this project.

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And most importantly, my family: my children, Jason and Asha, for putting up with a graduate student father, and my wife, Nilam, without whose love and support this would not be possible.

Abstract

Purpose

Electronic health records (EHRs) have the potential to improve measurability and quality of care, but excess alerting may reduce alert response through alert fatigue. In order to understand if targeting of alerts to primary care providers (PCPs) may be of value in decreasing alert fatigue, we looked at the extent and accuracy of PCP identification within one organization's shared EHR and providers' clinical decision support (CDS) use. We hypothesized that PCP identification in the system would vary by site, would be accurate, and that a PCP's response to alerts would be highest during a provider's primary care visits with their own patients, and lower when seeing a colleague's patients.

Methods

All primary care visits to family medicine, internal medicine, and student health providers during a three-month period were identified. EHR visit, CDS, and PCP data were retrieved for these visits from an enterprise data warehouse. The PCP identified in the chart was compared to the PCP who saw the patient for a plurality of prior visits. For a subset of visits, we examined CDS use for three common visit types: when a patient saw their PCP (PCP visits), when the patient saw another provider (non-PCP visits), and when no PCP was identified at a visit (no-PCP visits).

Results

For 84,937 non-resident primary care visits, a PCP was identified in 80.9% of visits. Of these, 68.9% of visits were to the PCP, 12.1% of visits were not to the PCP, and for 19.1% no PCP was listed. Identification of the PCP at primary care sites varied from 0.9% to 100%. Continuity of care by site similarly varied from 0% to 99.4% of visits. For the subset of visits where both a PCP and a plurality provider could be identified, the agreement between the chart-listed PCP and the plurality PCP over one year of visits was high when compared to the PCP listed in the EHR (κ=0.758). Providers responded to an alert in 28.7% of visits when seeing their own patients, in 12.6% of visits when not seeing their own patients, and in 6.9% of visits where no PCP is listed ($p < 0.001$). CDS requesting and viewing showed a similar pattern and were highest in PCP visits, lower in non-PCP visits, and lowest in no-PCP visits ($p < 0.001$ for comparisons between the three groups).

Conclusion

Significant differences in EHR-identification of PCPs among sites were found that could impact quality measure attribution, care coordination, and CDS targeting. Provider use of CDS was highest when PCPs saw their own patients, supporting the hypothesis that continuity of care impacted CDS behavior. This may provide a basis for CDS targeting and a method to improve CDS response, but further work should be done to confirm this association.

I. Introduction

Most computer information systems with decision support present reminders and alerts to whoever is using the system. But in multi-specialty settings, many people may use the same chart, and presenting the same alerts to all providers may not result in optimal response. For example, alerts shown to a patient's primary care provider (PCP) may not be seen as relevant by specialists – and vice versa. Alerts for preventive care may not be seen as relevant when a patient is being seen for an acute problem, or when a patient is being seen by a provider who is not the patient's PCP (this often happens when a patient sees a PCP's partner for acute care). These situations may contribute to ignored or overridden alerts, so called "alert fatigue."[1] On the other hand, there may be an incremental benefit in showing an alert multiple times, regardless of who is seeing the patient, resulting in additional appropriate care.

In most system-wide outpatient electronic health record (EHR) systems, the name of the PCP is stored in a specific place in the EHR and prominently displayed in the user interface. However, not all patients with a PCP will have the doctor's name identified in the chart. Some providers recorded in the system are inaccurate or outdated. Inaccurate PCP identification may lead to problems with PCP-specialist communication or inability to attribute quality of care measures.

The purpose of this project is to understand if targeting the primary care provider in clinical decision support (CDS) could improve alert efficiency. The first part of the project will examine the extent of primary care provider identification within one organization's enterprise electronic health record (EHR) system. How many patients within the system have an identified PCP and how successful practices are in recording the PCP will be examined. The accuracy of the PCP identification will be compared to a standard measure. Given this information, the project will examine if primary care doctors seeing their own patients respond to preventive care alerts and reminders in a different way than primary care doctors who are not seeing their own patients. This will occur through a cross sectional study of visits where a valid PCP is and is not identified. The response to alerts and the related intermediate measures will be analyzed.

Literature review

Primary care is defined as "the provision of integrated, accessible health care services by clinicians who are accountable for addressing a large majority of personal health care needs, developing a sustained partnership with patients, and practicing in the context of family and community."[2] A review of research on primary care shows that it is associated with increased life span, fewer lower birth-weight babies, and lower all-cause mortality.[3] Primary care physicians expect to see the same panel of patients over time and identification of this panel is important for continuity of care, care coordination, quality measurement, and research. Care coordination is one of the Patient-Centered Medical Home Joint Principles.[4]

Identification of this panel makes it possible to identify the cost, quality, and patient experience that a single provider delivers.[5] However, Federal Meaningful Use quality measures attribute patients to the provider they last saw and not necessarily to the PCP.[6]

Clinical decision support is defined as "providing clinicians… with knowledge and person-specific… information, intelligently filtered or presented at appropriate times, to foster better health processes, better individual patient care, and better population health."[7] Reviews of CDS effectiveness show that it can improve practitioner performance.[8] Most of the literature describes decision support regarding drug alerts and ordering, and has been conducted in inpatient settings. However, Bryan and Boran reviewed studies of CDS interventions in primary care settings and found that most had positive or variable outcomes, with most studies reporting process outcome improvements.[9] Individual studies have looked at a range of interventions and also showed improvements in preventive care[10] and in quality of care for diabetes and heart disease.[11] The presence of CDS tends to improve process outcomes, and showed a median improvement of 4.2%.[21]

High CDS adoption and effective use is one the three pillars of "Enhanced Health and Health Care Through CDS" in the AMIA White paper, *A Roadmap for National Action on Clinical Decision Support.*[7] Yet, improving CDS effectiveness remains one of the "grand challenges" for CDS.[12] One problem for CDS effectiveness is that alert override rates for drugs are 49-96% because of low specificity, sensitivity, and workflow interruptions.[1] Ignoring of alerts has been ascribed to "alert fatigue," the "mental state" caused by frequent presentation of alerts such that providers override "both important and unimportant alerts… in a manner that compromises the desired safety...."[1] It is easy to see how PCPs are overwhelmed: one study found that PCPs were presented with an average of 56 asynchronous alerts per day – in addition to drug-related alerts – and spent 49 minutes on average per provider responding to them.[13]

In a multispecialty organization with a shared EHR, several physician specialties may access the same patient's chart. Much of the literature does not specify if alerts are presented to a particular person, and in some systems, alerts are provided to whoever is using the system. In the view of the IOM, the person carrying out the functions listed in the primary care definition *is* a primary care provider,[2] so alerting any person carrying out a primary care visit may be appropriate. One analysis of frequently overridden drug alerts found no clear consensus of which alerts could be eliminated, and the authors suggest targeting by specialty for future investigation.[14] Providers have indicated a desire for targeted alerting and the ability to indicate user preferences.[15] Enterprise information systems often attempt to target alerts by specialty, but the tools available within current EHRs limit the ease with which designers can do this.[16] Researchers have analyzed the roles of PCPs and specialists in the referral process,[17] and recommendations such as the need to clarify the PCP role and standardization of the process could equally be applied to alerting. However, to target the PCP, the PCP must be accurately identified in the EHR. While there is no standard way to do this, assigning patients to the PCP with a plurality of their visits will assign most patients to a PCP, although only 31% of visits are to that physician.[18]

Description of Research Questions

The central research question addressed was, "Do primary care physicians respond differently to alerts when seeing their own patients than when they see a colleague's patients?" However, before addressing this, it was necessary to understand the extent and accuracy of identification of PCPs in the electronic system. Therefore, the first part of the study answered the question, "How well are primary care physicians identified in the EHR?" A related question, "How accurate is the PCP listed in the chart for a visit?" was also an important to answer in order to carry out the research.

Primary Outcome

The primary outcome for the study was the rate of alert response when a patient is seen by the PCP as compared with the rate of alert response when the PCP does not see a patient.

Sub-problems

PCP Identification (Part 1a)

1. What percent of patients have a PCP identified overall in the organization?

2. For what percent of patients is a resident identified as the PCP?
3. Does the percent of patients with a PCP identified vary with the location of care?

Accuracy of PCP Identification (Part 1b)

Does the PCP as identified in the EHR agree with the PCP as determined by the PCP plurality method?

Provider response to alerts (Part 2)

Does the rate of alert requesting, viewing, responding, or taking action differ when a patient sees their PCP, a provider who is not their PCP, or if no PCP is identified during the visit?

II. Methods

Setting

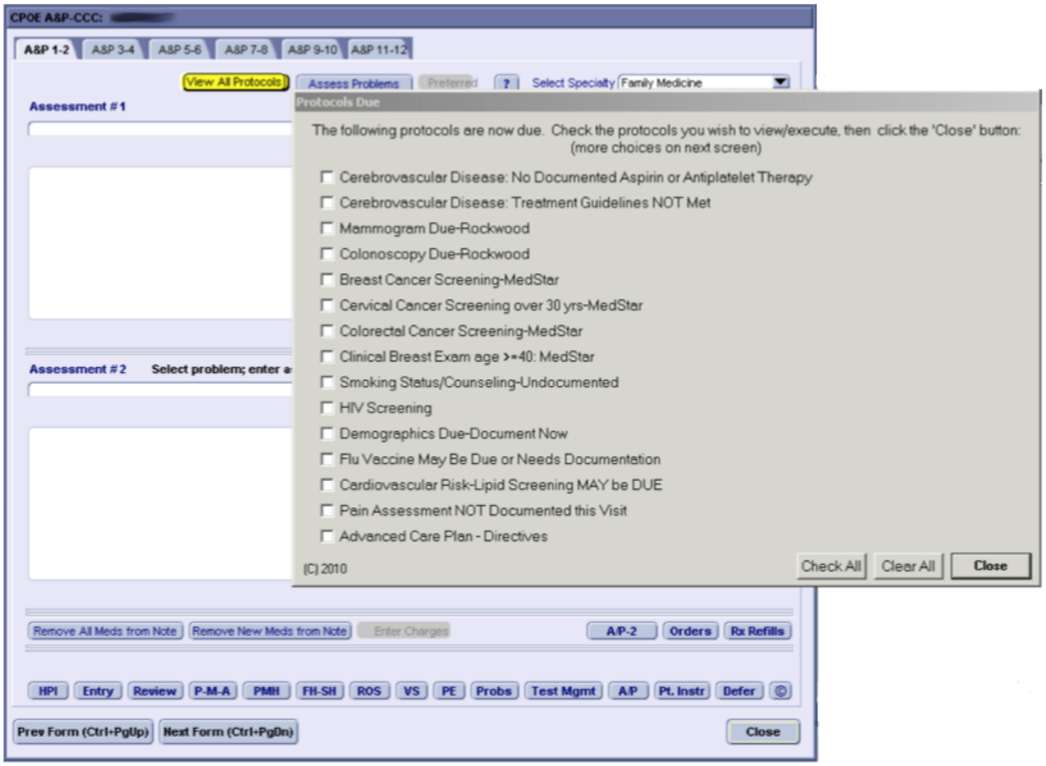
The study was conducted in outpatient primary care practices that are owned or operated by MedStar Health, a not-for profit health system in the metropolitan Baltimore, MD and Washington, DC area with 10 affiliated hospitals, 5600 physicians, with over 2 million outpatient visits yearly.[19] The organization shared a common EHR instance (GE Centricity EMR 9.5) at outpatient sites during the time of the study.

This system additionally utilized a customized CDS system from a third party vendor (Clinical Content Consultant, Concord, NH). Alerts were triggered during a visit based on information in the EHR database about the patient (e.g., demographics, problem list, medication list, results, etc.) and the logged in user (e.g., specialty and role). Where protocols were determined to be appropriate and relevant ("due"), they were presented to the provider by making a specific indicator button glow yellow (labeled "View all Protocols" see Figure 1a). A provider must request or bring up the alerts by pressing this button, which then pops up a window of alerts due in a modal display. The provider may choose to respond to one of the due alerts by clicking on the alert in the window. For each chosen alert, a subsequent window is sequentially shown. Each subsequent window typically gives a list of possible options such as done, order, not indicated. There is no method of displaying non-modal alerts as the system is currently installed. The alerts were designed to follow these design and workflow principles:

- Only protocols that are due and relevant for the current user's specialty are presented. Internal medicine and family medicine physicians are shown the same alerts when caring for adult patients.
- The button to display CDS is present throughout the visit forms and providers are instructed to review alerts at the beginning of a visit, during the course of a visit, and prior to concluding a visit.
- Alerts initially display a list of topics, and allow the user to select which alerts (or alerts) will be reviewed at that time.
- Alerts are designed to display the rule, relevant data in the system or missing from the system, and to allow for most appropriate actions, typically with a single click (e.g., order, document a decline, document done elsewhere).

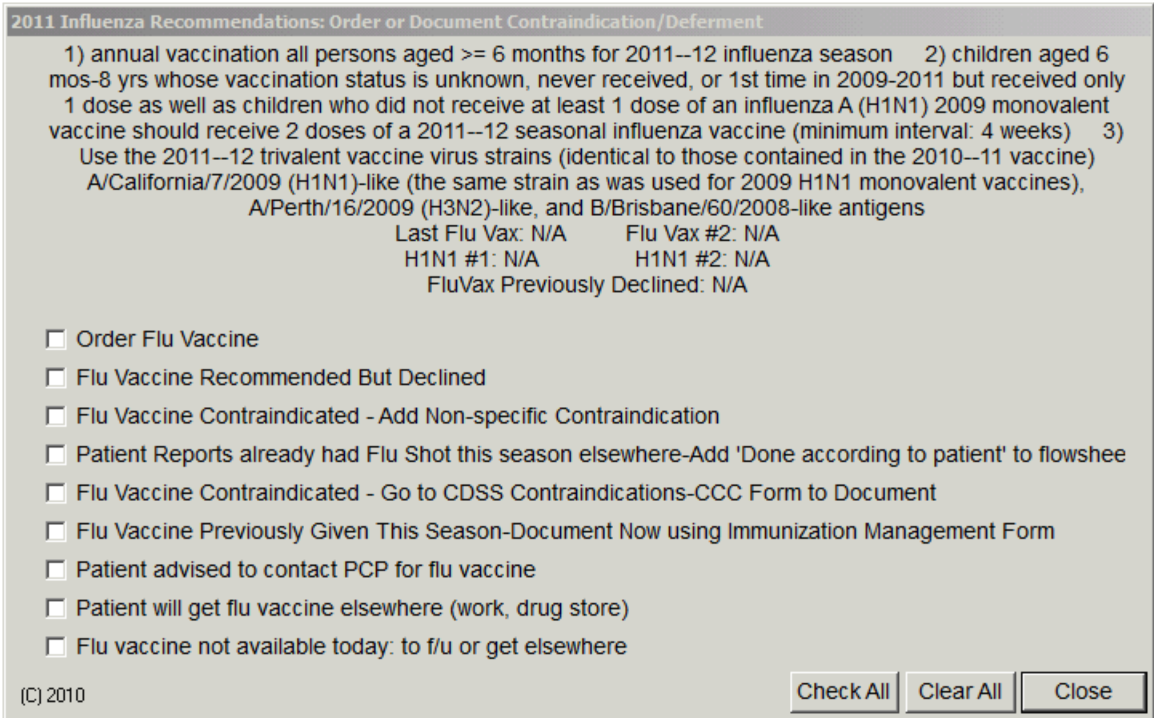
Examples of alerts firing during the study period include those for vaccines (influenza and pneumococcal), preventive care (pap smears, mammography, HIV screening), cardiovascular prevention (Million Hearts Initiative[20] which included aspirin, blood pressure control, lipid management, and smoking), vital signs, and demographics (note that this is not an exhaustive list of possible alerts). Drug-drug, drug-allergy, drug-condition, dose, and formulary alerts are triggered via a built-in Centricity medication module and were not examined in the present study.

Figure 1a. View all Protocols Button and Initial Decision Support Pop-Up Window with Alerts Due



A yellow “View All Protocols” button is available in several places throughout office visit forms (top left of the screen above). Clicking the yellow button brings up a list of decision support protocols in a grey pop up window shown above. The list of protocols that are due (have not yet been completed) is shown to the user. Completed alerts are not shown to the user until they are due again. The user checks the protocol or protocols that they would like to address. After clicking “Close,” in the lower right corner of the grey box, the grey list window goes away and a subsequent window opens for each checked protocol (see Figure 1b below for an example). (Screenshot shown from 2010. Current workflow and versions are substantially similar. Reprinted with permission from Clinical Content Consultant and GE Healthcare.)

Figure 1b. Influenza Decision Support Pop-up Window



The above is an example of a secondary window shown in the decision support process with options to respond to an influenza alert. The top part of the alert contains information regarding the recommendation and existing EHR data, such as the last Influenza vaccine. The user chooses one or more options to satisfy the alert. After clicking "Close," additional actions may also be triggered (eg order for flu vaccine or in other cases order for laboratory, medication, or radiology orders, not shown). The user completes those orders in additional windows (not shown). On completing the relevant order, the grey popup window for the next protocol checked appears (not shown). This continues for each additional protocol that was selected in the first list (Figure 1a) of due protocols. (Screenshot shown from 2010. Current workflow and versions are substantially similar. Reprinted with permission from Clinical Content Consultant and GE Healthcare.)

Data Extraction

EHR data was extracted using a vendor data extraction tool (Centricity Business Informatics 5.1, General Electric Company). This was accomplished by querying an internal data warehouse, which received regular data extracts from the EHR. Research data was then loaded into SPSS 21 (IBM Software) for analysis. Data was extracted for the October to December 2013 time period and queries were run between January and March 2014.

Definitions

Database field names within the EHR are listed in all caps.

- The PCP was listed in the EHR in the RESPONSIBLE PROVIDER field. Since this field was continuously updated and the data warehouse did not retain historical values for this field, the PCP identified in a query is the PCP at the time of the query and not necessarily the PCP that was listed in the system at the time of the visit.
- Alternate method for PCP determination. The PCP designated by the plurality PCP method was established using the method described by Pham et al.[18] This algorithm "excludes specialist visits and … assigns the beneficiary to the primary care physician billing for the most evaluation and management visits."[18] Since the article used a look-back period of one year, we used a one calendar-year look-back and compared this to the PCPs for those patients. For patients with only one visit, that provider was designated the plurality provider. If there was no provider who saw a patient for a plurality of visits

(in other words two or more providers saw the patient the same number of times), no plurality provider was designated.

- The provider seeing the patient for the current visit was assumed to be the provider responsible for the corresponding office visit note (DOCUMENT REPONSIBLE PROVIDER), which may or may not have been the same provider who signed the note.
- Primary care sites within MedStar were identified by the PI and validated by the outpatient CMIO and other administrative staff. Sites were identified in the EHR through the office visit note's location of care field (DOCUMENT LOCATION OF CARE).
- Primary care providers were defined for this study as Internal Medicine, Family Medicine, Internal Medicine-Pediatrics or student health (largely Family Medicine) providers who practiced at MedStar primary care locations.
- If a resident was the provider for a visit was determined by the document provider JOB TITLE field.

Alert Response

Provider response to alerts as studied in Part 2 was tracked at several levels by the EHR:

- **Alert Button clicked**: since the EHR system requires active user intervention to view alerts, if the View all Protocols button was clicked, the system displays protocols/rules that are due (meaning the decision support rule has not yet been satisfied) and these are then listed in the STUDY NAME#2 field.

- **A specific alert was viewed**: if an alert or alerts due were checked in the first window to be acted upon, a second pop-up with a set of responses is brought up. For each secondary alert box viewed, alerts that were viewed were tracked in the STUDY NAME#1 field.
- **Alert response**: for a subset of those alerts, if the provider responds to the alert by checking a response box (eg "give now," "already done"), this is tracked in the STUDY NAME field. While for some alerts an order would be made or a medication started, these additional responses were not tracked in the present study.

Study Design – PCP Identification (Part 1a)

Design. Cross sectional study of primary care visits to understand at which sites the responsible provider field (PCP) was used.

Inclusion Criteria. For part 1a of the study, inclusion criteria were as follows:

1. Age of pt ≥ 18 years
2. At least one visit to family medicine, internal medicine, or internal medicine-pediatrics provider
3. The EHR was used for the visit and visit note is signed
4. Visit to a primary care site, including family medicine, internal medicine, internal medicine-pediatrics, or student health.

Exclusion Criteria. For initial analysis of sites, all providers were included. Subsequently and for the remainder of the study, all visits to a resident physician (where a resident was the document responsible provider) were excluded. Note that this does not necessarily exclude visits when a resident was listed as the PCP for the patient.

Data Collection. All visits meeting the inclusion criteria and occurring during the last three months of 2013 (October – December 2013) were selected. Percentage of visits at various sites was calculated through the query function of the data extraction tool. The document provider job title was used to identify resident providers for visits.

PCP identification. The provider recorded in the RESPONSIBLE PROVIDER field for the patient at the time of the query was identified as the PCP for the visit. All queries were performed within approximately 3 months of the end of the study time frame.

Data and Statistical Analysis. The following metrics were calculated from the data set:

1. Percent of visits during the period where a PCP is identified for the visit (overall, in the organization)
2. Percent of visits with a PCP by location of care
3. Percent of visits with a PCP where a resident is identified as the PCP
4. Percent of visits where the patient sees their PCP, a partner, or where no PCP ("PCP none") is identified (three study groups)

5. The number of physicians that are represented by the visits in each of the three categories.

Study Design – Accuracy of PCP identification (Part 1b)

Design. The PCP field, as designated during visits meeting the inclusion criteria above, was analyzed to establish the accuracy of the PCP designation in the EHR. PCP as listed in the EHR was identified just before or during visits per the current workflow. The PCP by the usual workflow was compared with the plurality primary care physician algorithm[18] using National Provider Identifier (NPI) numbers to match providers.

Inclusion Criteria and Exclusion criteria. Inclusion and exclusion criteria were as listed in part 1a except that visits were collected over all of 2013. In addition, since kappa requires that both compared fields be present, visits without a NPI for the visit PCP or plurality provider were excluded.

Data Collection. Visits from 2013 meeting inclusion criteria were selected, the PCP listed for the patient at the time of the query (February 2014) was identified, and a list of patients seen over the 2013 calendar year with the number of patient visits to each provider was created.

Plurality PCP identification. To establish the plurality PCP, the provider seeing the patient the largest number of times (as identified in the query above) was designated the plurality PCP. If no single provider saw the patient the largest number of times (ie two or more providers tied for most visits), no plurality PCP was designated (see definitions section). Patients were identified and matched by using the internal database ID joining the two queries. The PCP listed for the patient was compared with the plurality provider as established from the dataset using NPI.

Data and Statistical Analysis. The following metrics were calculated from the data set.

1. Non-adjusted agreement (percent) between PCP and plurality PCP.
2. The agreement by kappa for the PCP as identified in the chart and by the PCP plurality method.

Study Design – Provider Response to Alerts (Part 2)

Design. All visits meeting criteria above from the 3-month period above.

Inclusion Criteria and Exclusion criteria. Inclusion and exclusion criteria were as listed in part 1a with the additional criterion that the document provider had a NPI number.

Definition of Groups – See Figure 2.

The three groups were defined as follows:

1. PCP visits – Visits where provider is seeing his or her own patient. These visits were included when the PCP for the patient matched the provider responsible for the note for a given visit.
2. Non-PCP visits – Visits where the patient does not see his or her own primary care provider were identified when the PCP did not match the provider responsible for the note for a given visit.
3. No-PCP visits – Visits where the PCP field was blank (no PCP was designated for a patient).

Sample size Calculation. An *a priori* sample size calculation was performed as follows for the primary outcome, the alert response rate for PCP compared to non-PCP visits. Note that this ignores groupings of providers in study groups and does not include the no-PCP group.

1. Alpha =0.05, Beta 0.8, equal groups
2. Effect size: 5 percent difference in alert response based on prior research[21,22] (PCP visits 0.2 vs. non-PCP visits 0.25)
3. Equal sample sizes
4. Sample size = 1094 visits in each group based on Chi Squared for two groups (PCP vs. non-PCP visits)[23]

Data Collection. Data from visits regarding CDS use and response were extracted from the EHR data warehouse and classified according to group as outlined above.

Data and Statistical Analysis. Descriptive statistics for this section included (overall and in each of the three groups):

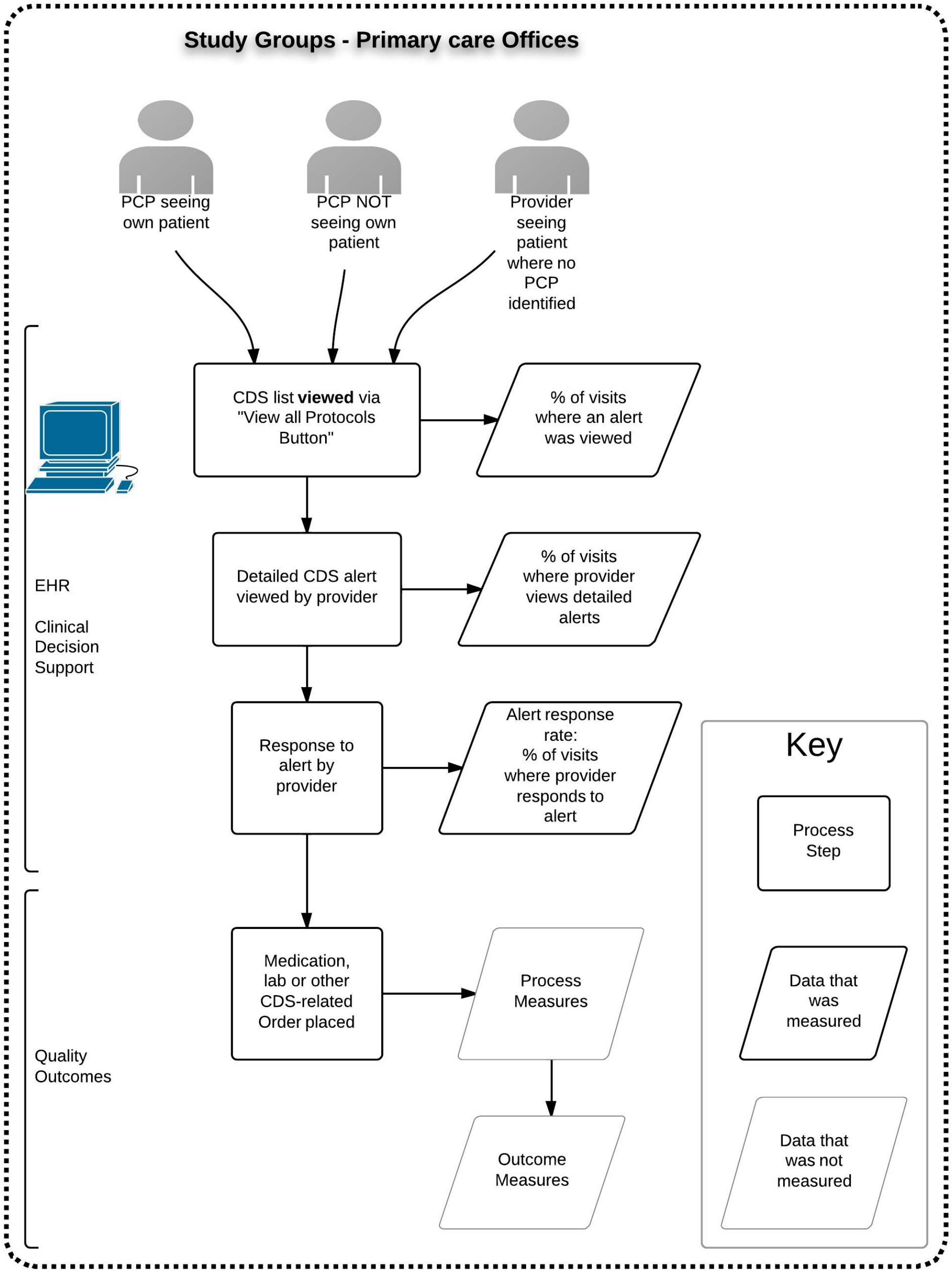
- Percent of visits with CDS accessed (alerts requested)
- Percent of visits where alerts were viewed (secondary screen with alert detail and possible responses)
- Percent of visits with alert response (Percent of alerts that have some response).

Primary Outcome: Percent of visits in the PCP group vs. non-PCP group where the physician responded to alerts was analyzed using a Chi-Squared test.

Secondary Outcomes: The proportion of alerts requested, viewed, and responded to in each of the three groups was analyzed using a Chi Squared test for a 3x2 contingency table.

IRB Approval. The research protocol was approved by the MedStar Health Research Institute Institutional Review Board (IRB) (Protocol 2013-140), the Oregon Health & Sciences University IRB, and the Georgetown University Medical Center IRB. The Oregon Health & Sciences and the Georgetown University Medical Center IRBs each agreed to have MedStar act as the IRB of record.

Figure 2. Schema of the three study groups, intermediate and downstream outcomes



Groups are (left to right): PCP visits, non-PCP visits, no-PCP identified visits.

III. Results

PCP Identification (Part 1a)

In an initial review of primary care sites for adult providers, 90,133 visits were identified for 71,375 patients. For 7,527 of those visits, a resident was the provider of record (8.4% of visits). In subsequent analyses, visits to resident providers were excluded.

In non-resident visits, 84,937 visits to primary care sites occurred during the three-month time frame (Table 1). For 80.9% of the visits, a PCP was identified, and for 19.1%, no PCP was identified. Of all the visits, 68.9% were with the patient's PCP as identified in the chart and 12.1% were not with the PCP.

Table 1. Primary care Visits and PCPs with Group Identification

Characteristics	Visits (n = 84,937)	Percent
Visits where a PCP is identified for the visit	68,741	80.932
Visits where no PCP is identified (no-PCP visits)	16,196	19.068
Visits to PCP (PCP visits)	58,482	68.853
Visits not to PCP (non-PCP visits)	10,259	12.078

In looking at the providers who conducted these visits (Table 2), almost all were physicians (89.4%). The specialty for most of the providers was Internal Medicine (77.6%) followed by Family Medicine (17.4%); 4.1% were classified as "Student Health" even though this is not a recognized ABMS medical specialty.

Table 2. Provider Degree and Specialty for Visits

Characteristics	Visits (n = 84,937)	Percent
Provider degree		
Physician	75,920	89.384
Nurse	14	0.017
Nurse Practitioner	6,328	7.450
Physician Assistant	2,659	3.131
Other	16	0.019
Provider specialty		
Family Medicine	7,839	17.34
Internal Medicine	65,879	77.56
Medicine-Pediatrics	899	1.06
Student Health	3,435	4.04

During the three months of visits, 67,805 patients were seen (Table 3). The median age of patients was 56, with a second smaller peak at 28 years. There were 505 unique PCPs identified during these visits of which 90.9% were physicians. Internal Medicine was the most common specialty for PCPs (80.1%) followed by Family Medicine (18.7%).

Table 3. Patient and PCP Characteristics for Visits

Characteristics	Patients (n = 67,805)	Percent
Median age (yrs)	56	
Range (yrs)	94 (18-113)	
Mode (yrs)	59 2nd peak at 28	
Primary care providers	505	
PCP types designated for a visit		
Physician	62,432	90.858
Nurse Practitioner	3,513	5.113
Physician Assistant	1,567	2.280
Resident	1,179	1.716
Other	19	0.028
Nurse Midwife	4	0.006
PCP specialties designated at a visit		
Internal Medicine	55,020	80.062
Family Medicine	12,834	18.675
Medicine-Pediatrics	618	0.899
Other	250	0.364

Overall a PCP was identified for 80.9% of visits, but this varied widely among the 62 patient care sites. For each site, the percent of visits where a PCP was identified and the percent where the PCP conducted the visit is shown in the Appendix. Table 4 summarizes data on PCP presence during the visit and the continuity of care by site. The median value for percent of visits with PCP present was 95.1% of visits, however the range was very large. A few sites rarely identified PCPs, but most sites typically identified one. The continuity of care as measured by the percent of visits where a PCP sees their own patient also varied widely. Again, there was a large range, but the median value among sites was 80.3%. Both of these distributions are negatively skewed with a tail at the lower percentages.

Table 4. Percent of PCP identification and continuity of care, by site

		Visits where PCP present (Percent by site)	Visits where PCP is seeing own patient (Percent by site)
Mean		76.665	62.387
Median		95.103	80.334
Mode		1.0000	0
Std. Deviation		33.536	34.885
Range		99.17	99.36
Minimum		00.83	0
Maximum		1.0000	99.36
Percentiles	25	67.713	35.665
	50	95.103	80.334
	75	99.050	90.948

Accuracy of PCP identification (Part 1b)

The PCPs listed for the patients in the EHR on the query date were matched with the plurality provider for the same patients during the prior year of visits. For the 135,680 unique patients that were included, the kappa for agreement between PCP and PCP plurality provider was 0.758. Raw agreement for between plurality PCP and PCP in the chart was 76.0%.

Provider Response to Alerts (Part 2)

For analysis of provider response to alerts, visits were limited to those where the provider responsible for the document was a provider with a NPI number; this includes PAs, NPs, and physicians. With this added constraint, 84,907 visits were eligible and 68.9% of these visits were to the PCP and 11.9% were non-PCP visits (Table 5).

Table 5. Provider CDS behavior when conducting PCP visits, non-PCP visits, and no-PCP visits

Characteristics	Visits (n = 84,907)	PCP visits (n = 58,482)	Non-PCP visits (n = 10,094)	No-PCP visits (n = 16,331)
Visits (%)	100	68.878	11.888	19.234
Providers	nc	188	215	212
Visits with CDS Requested (%)	25.211	30.859	22.86	6.442
Visits with CDS viewed (%)	24.271	29.700	20.73	7.023
Visits with CDS response (%)	23.493	28.669	12.55	6.932

nc = not calculated, since a provider may have conducted visits in more than one of the three groups.

Providers requested CDS in 25.2 % of the 84,907 visits (pressing the "View All Protocols" and viewing the resultant list of due protocols). CDS detail was viewed in 24.3% of visits, and providers responded to an alert in 23.5% of visits. In 30.9% of PCP visits, CDS was requested, as compared with 22.9% of non-PCP visits, and 6.4% of no-PCP visits ($p < 0.001$). For the primary outcome of alert response rate, providers responded to an alert in 28.7% of PCP visits compared with 12.6% of non-PCP visits ($p < 0.001$). For secondary outcomes comparing all three groups, providers responded to alerts in 28.7% of PCP visits, in 12.6% of non-PCP visits, and 6.9% of no-PCP visits (all comparisons significant $p < 0.001$).

IV. Discussion

The study sought to assess PCP identification and accuracy in the EHR, and providers' CDS behavior based on the apparent relationship with the patient. PCP identification in the EHR system was mostly complete, but a PCP was not listed for approximately 20% of visits. While most sites fully identified PCPs, there was wide variation in how often a PCP was identified for a visit. PCP identification was found to be accurate, and providers seeing their own patients requested, viewed, and responded to CDS in more visits.

Implications for Practice

These findings present several challenges for practices. As we proceed with more widespread quality measurement, practices will need to identify the PCP or other provider who is responsible for each quality measure. Clear identification of the provider responsible for each patient will make measure attribution more realistic and valid, rather than attributing measures to the last provider who saw the patient. An enterprise policy and recommended workflow for PCP identification in the EHR may be helpful.

When listed in the EHR, the PCP provided was shown to be accurate when compared to an external standard. This agreement would suggest that the traditional medical practice workflow of identifying a PCP during an office visit in discussion with a patient (when followed) is sufficient. It is important to note that our methodology does not compare the chart PCP to a gold standard (such as asking the patient to identify their PCP), but instead to a standard method of identifying a PCP. In the absence of a listed PCP, the plurality PCP method could be used to suggest one.

The study found rates of alert requesting, viewing of alert detail, and responding that were very different if the patient was seeing their PCP, another provider, or if no provider was listed as the PCP. In some ways, this may reflect the attitude and sense of responsibility the provider feels for their own panel of patients. Receiving primary care at a usual location of care has been shown to increase preventive service delivery.[24, 3] When a patient does not see their own provider, they are likely to be seeing their PCP's partner unless the visit is taking place outside of their usual location of care. For non-PCP visits, the present study could not distinguish between these two possibilities.

The study included primarily family physicians and internists, and assumes they behave similarly in their response to alerts for their primary care patients and their colleagues' patients. The reason for patients to visit a PCP and a non-PCP may not be the same, and CDS use may not be equally likely during those visits. We have not examined the reason for visits included in the study (eg a preventive visit versus a sick visit), and this could be a potential confounder accounting for some of the observed differences.

The study allows us to gauge the effects of potential changes in PCP identification and continuity. If a PCP were to be identified for a patient before a no-PCP visit, effectively switching the visit groups, we might expect that the provider CDS response rate would improve to those seen in the PCP group. Given results seen in Table 5, the absolute benefit increase in CDS response rate for the scenario of adding a PCP for each no-PCP visit would be 21.7%. We can then calculate a "number needed to treat" for this data. The number of PCPs that would need to be identified for no-PCP visits to gain one additional alert response is 4.6 for the three-month period. By improving continuity of care, and scheduling non-PCP visits with the PCP, the absolute benefit increase would be 16.1%. The number of patients that would need to be scheduled with the PCP instead of a non-PCP for each alert response is 6.2.

Interpretation in the context of published literature

There are very few studies that link primary care and CDS. The present study seems consistent with what has been found previously. Ferrante et al showed receipt of preventive services were associated with both a personal physician and with the use of CDS tools, but did not connect primary care directly with CDS.[25] On the other hand, Shires found that use of the EHR in the exam room was associated with lower recommendation rates for preventive services.[26] The 4.2% median improvement in process improvements found in a systematic review of CDS[21] is consistent with the magnitude in improvement between the groups in our study.

Reviews of primary care show that primary care improves health outcomes and increases the provision of preventive services,[3] but these reviews were done before the EHR era. Today, preventive services may be provided because of provider or patient initiative, because providers realize they are due, or because of CDS reminders. CDS use by the PCP may be one mechanism by which PCPs improve patient outcomes. Studies have found that once health information technology including CDS is adopted, that not every physician makes use of the features, and that primary care, patient-centeredness, and larger practice size were factors predicting use.[27] In a similar manner as PCP status may effect CDS use, groups have discovered other factors, such as physicians' uncertainty beliefs, which also impact EHR use.[28]

Implications for Organizations

Organizations may interpret these findings in several ways. They may conclude that PCPs seeing their own patients are the primary providers of preventive services and that increased targeting of CDS to the PCP during PCP visits is warranted in order to reduce alert fatigue for no- and non-PCP visits. On the other hand, organizations may feel that given the increased teamwork required for the medical home model, the additional amount of prevention that is provided by non-PCPs visits may be beneficial and should be encouraged. We did not look at delivery of preventive services outside of the visit, so delivery by clinic staff and nursing were not captured by this study.

Implications for Research

The process of carrying out the research was more challenging than would be expected. It was difficult to identify which doctors were actually primary care doctors, and which sites were primary care sites. Extraction of data from the system was difficult, and required learning of specialized software tools and non-SQL query methods. For quality measurement and improvement to become ubiquitous, extraction must be trivial for someone without IT skills, and provider and site characteristics transparent. There seems to be a gap between the promise of quality reporting and what is possible given current systems and workflows.

In creating data warehouses for research and quality, we strongly suggest that the database curator label primary care providers and sites to increase the accuracy of identification. PCP identity at the time of the visit should be maintained.

Limitations

There are several important limitations of this study. First, the work was done in one organization, and set in adult primary care specialties. The alerts examined in this study were for preventive and ongoing care, and had to be requested by the treating provider. These issues limit the external validity of the study. Since there was scant previous research on targeting of alerts in primary care settings, an observational design was used. As a result, the association of provider continuity with improved alert behavior cannot be assumed to be causal.

The fact that the PCP for a given visit could only be determined at the time of the query limits the accuracy of the study. It is possible that the PCP was changed between the time of the visit and the query. Given the timing of the visits and the queries, at most 6 months could have passed since the first visit, and at a minimum 3 months. A change in PCP after a PCP visit, but before the query, would likely have reduced the continuity of care and moved the patient into the non-PCP visit group. However, a PCP could also have been removed after a visit – making the visit look like a no-PCP visit (this might happen if a provider leaves a practice) – or even changed to the provider who saw the patient, making the visit look like a PCP visit. It is not clear that these switching scenarios bias the study results in a particular direction.

Additionally, there are likely clustering effects within our data for which we have not adjusted. For example, a given physician or site may use CDS more or less frequently and some doctors may also have greater or lower continuity of care. Sites had varying continuity of care and used the PCP listing more or less frequently. Given the straightforward outcome measures, we have not adjusted for this in calculating response rates. Our challenge in identifying PCPs and primary care sites may have meant that some PCPs or primary care sites were left out, or that some specialty providers or sites were inadvertently included.

Future work and recommendations

It will be important to understand if these associations can be explained by confounding factors such as visit purpose (sick vs. preventive). A future observational study could better account for clustering, explore factors that inhibit or increase CDS use, and account for confounding variables.

Ultimately, it is critical to understand if the provider's relationship with the patient leads to improved CDS behavior. An interventional design could examine if targeting PCPs with CDS leads to more alert response with less alert fatigue then alerting all providers, and establish if it is a causal factor in CDS use. A qualitative or mixed-methods design would also be helpful to understand why PCPs do or do not use CDS during a given visit.

V. Summary and Conclusions

The present study examined PCP identification in a non-profit health system during primary care visits. We found that PCPs were identified for 80.9% of visits, but not 100% as would be ideal. There was variation in PCP identification by site, with the median identification of PCP 95.1% of visits, but with a large tail. This may point to variations in workflow or policy that could be improved. The challenge and high degree of work to carry out the present study point to a need to enhance identification of primary care providers and sites, so that quality measurement and attribution can occur with limited extra work.

The accuracy of PCP identification in the EHR was high. We conclude that typical workflows are sufficient to identify a PCP, and that if a PCP is present, that more complicated methods of PCP identification are not necessary for research or operational purposes. However, if the PCP is not listed, the accuracy and feasibility of the plurality PCP method makes it a good method for proposing a candidate PCP.

Finally, there were differences found in how providers responded to decision support depending on their apparent relationship with the patient. Primary care physicians seeing their own patients requested more alerts, viewed more alerts, and responded to alerts more frequently than PCPs not seeing their patients, or when no PCP was identified. This may reflect the special relationship between primary care physicians and their patients, and point to one mechanism by which primary care improves health. Providers and administrators may choose to use this information to improve primary care, and CDS implementers could use it to target alerts more effectively.

VI. Appendix.

Percent identification of PCP and Percent Continuity visits by site of care

	Visits (n= 84937)	% of all visits at site	Patients at site (n=67805)	Visits with PCP identified, by site (n=68741)	% Visits with PCP identified, by site	Visits with PCP Seeing Own pt, by site (n=58482)	% Visits with PCP Seeing Own pt, by site
Site 1	5735	6.752	4778	5604	97.716	4933	86.016
Site 2	5145	6.057	4142	5119	99.495	4158	80.816
Site 3	3418	4.024	2703	3330	97.425	2737	80.076
Site 4	3395	3.997	2607	3374	99.381	3346	98.557
Site 5	3375	3.974	2770	2379	70.489	1780	52.741
Site 6	3308	3.895	2666	3163	95.617	3028	91.536
Site 7	3205	3.773	2538	3188	99.470	2583	80.593
Site 8	3072	3.617	2209	32	1.042	0	0.000
Site 9	2878	3.388	2361	2876	99.931	2628	91.313
Site 10	2448	2.882	2034	2127	86.887	1458	59.559
Site 11	2328	2.741	1734	2259	97.036	1809	77.706
Site 12	2273	2.676	1830	2135	93.929	1983	87.242
Site 13	2260	2.661	1581	82	3.628	6	0.265
Site 14	2254	2.654	1842	2237	99.246	1992	88.376
Site 15	2200	2.590	1890	1508	68.545	1342	61.000
Site 16	2118	2.494	1621	2014	95.090	1076	50.803
Site 17	1895	2.231	1496	1868	98.575	1763	93.034
Site 18	1774	2.089	1375	1495	84.273	1359	76.607
Site 19	1750	2.060	1274	1730	98.857	1696	96.914
Site 20	1692	1.992	1380	1512	89.362	998	58.983
Site 21	1627	1.916	1320	1624	99.816	1439	88.445
Site 22	1538	1.811	1207	632	41.092	429	27.893
Site 23	1401	1.649	1164	34	2.427	10	0.714
Site 24	1387	1.633	1099	1044	75.270	946	68.205
Site 25	1374	1.618	1132	1367	99.491	1131	82.314
Site 26	1285	1.513	1115	1228	95.564	1171	91.128
Site 27	1284	1.512	936	1244	96.885	1135	88.396
Site 28	1221	1.438	1034	1121	91.810	1064	87.142
Site 29	1148	1.352	987	1070	93.206	1044	90.941
Site 30	1145	1.348	990	1140	99.563	1108	96.769
Site 31	1084	1.276	785	63	5.812	25	2.306
Site 32	1028	1.210	728	1020	99.222	959	93.288
Site 33	984	1.159	757	56	5.691	2	0.203
Site 34	964	1.135	808	952	98.755	664	68.880
Site 35	859	1.011	703	58	6.752	31	3.609
Site 36	799	0.941	667	790	98.874	696	87.109
Site 37	782	0.921	656	773	98.849	727	92.967
Site 38	740	0.871	606	673	90.946	660	89.189
Site 39	696	0.819	596	692	99.425	645	92.672
Site 40	690	0.812	570	654	94.783	649	94.058
Site 41	670	0.789	521	469	70.000	46	6.866
Site 42	596	0.702	491	590	98.993	401	67.282
Site 43	573	0.675	431	50	8.726	7	1.222
Site 44	494	0.582	404	472	95.547	420	85.020
Site 45	474	0.558	415	265	55.907	191	40.295
Site 46	443	0.522	220	443	100.000	425	95.937
Site 47	430	0.506	391	409	95.116	154	35.814
Site 48	410	0.483	330	399	97.317	395	96.341

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Site 49	390	0.459	352	337	86.410	334	85.641
Site 50	363	0.427	283	3	0.826	0	0.000
Site 51	301	0.354	248	124	41.196	106	35.216
Site 52	299	0.352	231	285	95.318	272	90.970
Site 53	237	0.279	164	213	89.873	202	85.232
Site 54	192	0.226	169	8	4.167	5	2.604
Site 55	157	0.185	148	156	99.363	156	99.363
Site 56	130	0.153	124	94	72.308	78	60.000
Site 57	124	0.146	102	76	61.290	24	19.355
Site 58	57	0.067	57	57	100.000	51	89.474
Site 59	23	0.027	18	15	65.217	3	13.043
Site 60	11	0.013	11	5	45.455	0	0.000
Site 61	2	0.002	2	2	100.000	1	50.000
Site 62	2	0.002	2	2	100.000	1	50.000

Ordered by number of visits, pt=patient; site names have been suppressed.

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