## Linking the Pieces Together: The Impact of Electronic Health Records and Team Cohesion on Coordination of Care Across Delivery Sites

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**Abstract**

**Objective.** To examine the impact of an integrated outpatient-inpatient electronic health record (EHR) and primary care team cohesion on clinician ratings of care coordination.

**Study Design/Data Collection.** Self-administered surveys of all primary care clinicians in a large integrated delivery system, collected in 2005, 2006, and 2008 during the staggered implementation of an integrated EHR (2005-10). Using multivariate regression, we examined the combined effect of EHR and team cohesion on clinician ratings of the level of coordination for care spanning delivery sites.

**Principal Findings.** For clinicians working in cohesive teams, the EHR was associated with significant improvements in all care coordination measures (OR=2.53, [95%CI: 1.63-3.93] for access to timely and complete information; OR=2.43 [1.50-3.95] for agreement on treatment goals; and OR=1.74 [1.09-2.77] for agreement on responsibilities). We found no significant association between the EHR and care coordination in non-cohesive teams.

**Conclusion.** The impact of EHR use on care coordination depends on the strength of primary care team members’ working relationships. Cohesive teams more successfully leveraged the EHR to achieve greater improvements in care coordination than did non-cohesive teams.

**Key words.** Electronic Health Records, care coordination, primary care, teams, medical home

**Introduction**

A growing number of Americans are living with chronic conditions and often require medical care that bridges multiple delivery sites, such as the transition from the hospital back to primary care ([Anderson 2010](#_ENREF_3); [Bodenheimer, Chen, and Bennett 2009](#_ENREF_8); [Partnership for and Johns Hopkins 2004](#_ENREF_25); [Schoen et al. 2009](#_ENREF_33); [Thorpe, Ogden, and Galactionova 2010](#_ENREF_38)). Not surprising, effective coordination of this care for individual patients may be necessary to ensure high quality care ([Institute of 2001](#_ENREF_18); [Whittle and Bosworth 2007](#_ENREF_39)). The American Recovery and Reinvestment Act of 2009 allocated $27 billion to encourage adoption and meaningful use of electronic health records (EHRs) in the United States by 2014 ([2010a](#_ENREF_1); [2010b](#_ENREF_2); [Blumenthal 2010b](#_ENREF_5); [Blumenthal and Tavenner 2010](#_ENREF_6)). Communication of clinical information for coordination of care across delivery sites is listed explicitly as a requirement for "meaningful use" of EHR under ARRA ([Blumenthal 2010a](#_ENREF_4)). Other ongoing health care innovations such as bundled payments, accountable care organizations (ACO), and the patient centered medical home (PCMH) aim to improve care quality in part through facilitating better care coordination ([Blumenthal and Tavenner 2010](#_ENREF_6); [Rittenhouse and Shortell 2009](#_ENREF_29); [Shortell, Casalino, and Fisher 2010](#_ENREF_34)).

The shared use of an EHR across hospitals, specialist and primary care practices, and other provider organizations, offers great potential to improve care coordination by enabling use of comprehensive, current patient information at the point of care each time a patient is seen by a caregiver and providing an array of tools to monitor a patient’s health status and intervene promptly when necessary. However, effective use of the information and tools made available by an EHR requires on-going communication and teamwork among the doctors, nurses, therapists, pharmacists and others providing patient-care services. Even in an integrated delivery system with a completely integrated outpatient-inpatient EHR system, care team members’ working relationships could impact any potential benefits of the EHR.

The transfer of patients across delivery sites, such as from a hospital to a primary care practice, has been shown to increase the risk of medical errors ([Kripalani et al. 2007](#_ENREF_19); [Smith, Allwright, and O'Dowd 2007](#_ENREF_37)). Poorly executed care transitions can lead to greater use of hospital, emergency, and ambulatory services ([Bodenheimer 2008](#_ENREF_7); [Cummins, Smith, and Inui 1980](#_ENREF_11); [Kripalani et al. 2007](#_ENREF_19); [Moore et al. 2003](#_ENREF_22); [Smith et al. 2005](#_ENREF_36)). Efforts to coordinate care delivery when patients are transferred across sites have been shown to improve patient safety ([Kripalani et al. 2007](#_ENREF_19); [Smith et al. 2007](#_ENREF_37)). In particular, the use of an EHR may enable the timely transfer of information and facilitate communication among clinicians across care delivery sites. However, the potential of EHRs to improve the coordination of patient care is largely speculative. There is still limited research evidence on the effects of EHR on care coordination ([Graetz et al. 2009](#_ENREF_15); [O'Malley et al. 2009](#_ENREF_23)) and no evidence on how organizational factors may modify this effect.

We examined the combined effect of an integrated outpatient-inpatient certified EHR and team cohesion on clinician ratings of care coordination across delivery sites in a prepaid, integrated delivery system (IDS). We used survey data from primary care clinicians collected in three different years (2005, 2006, and 2008), during the staggered implementation of a commercially available, integrated EHR system (2005-10). Even in this prepaid, integrated delivery system with existing primary care teams and a complete integrated outpatient-inpatient EHR system, we expected to find variations in whether teams were cohesive and in the effects of the new information system. We hypothesized that the use of the integrated EHR would result in improvements in all reported measures of care coordination and that this association would be stronger for cohesive teams than for non-cohesive teams.

**METHODS**

**Study Setting**

This study was conducted at Kaiser Permanente Northern California (KPNC), a large, prepaid Integrated Delivery System (IDS) providing comprehensive medical care for over three million members. The system receives a bundled prospective payment for all medical care. Adult primary care clinicians work in the Internal Medicine and Family Medicine departments and are grouped in 110 primary care teams, across 18 Medical Centers. Adult primary care teams were created in 1998 as part of an ambitious effort to redesign primary care using multidisciplinary teams, where by there would be extensive use of Nurse Practitioners, Behavioral Medicine Specialists, Physical Therapists, Clinical Health Educations, and substantially fewer physicians.

**Health Information Technology**

In February 2005, the IDS began a five-year staggered implementation of a commercially available, integrated outpatient-inpatient certified-EHR system. The system was rolled out in two phases: staggered deployment of the system across outpatient clinics (2005-2008) and across inpatient hospitals (2007-2010). The hospitals typically implemented the inpatient EHR system about one to two years following the outpatient clinic implementation. Once implemented, use of the EHR system was mandatory, i.e. the paper-based medical record, coding, and ordering systems all ceased to exist.

The EHR is an EpicCare®-based integrated Health IT system that increases the amount of information available at the point-of-care, presenting integrated clinical information in an electronic medical record, with comprehensive computer-based provider order entry, sophisticated decision-support tools for lab testing and treatment-intensification, and secure messaging between providers and/or patients. This system has been certified by the Certification Commission for Health Information Technology as a complete EHR, thereby providing its users with the capabilities necessary to meet the goals of the “Meaningful Use” criteria for federal incentive payments.

**Survey Collection**

In 2005, 2006, and 2008, we mailed a self-administered questionnaire to all adult primary care clinicians working in the IDS, including physicians (MD or DO), nurse practitioners, and physician’s assistants. We excluded clinicians who did not have an active panel of patients at the time of the survey. Each clinician received a letter introducing the study, a copy of the survey, and a pre-paid return envelope. Respondents who completed the survey received a small gift card. Non-respondents were re-sent reminder letters and surveys; up to four follow-up mailings were sent during each year of survey collection.

The study population included 1,175 clinicians in 2005; 1,103 clinicians in 2006; and 1,030 clinicians in 2008. Overall, 565 primary care clinicians responded in 2005 (48% response rate), 678 in 2006 (62% response rate), and 626 in 2008 (61% response rate).

Care Coordination

In self-administered questionnaires, primary care clinicians rated three aspects of coordination, i.e., information transfer, treatment objectives, and clinician responsibilities across the care episode. Our questionnaire further broke out the information transfer to assess both the completeness of the relevant clinical information and the timeliness of this information transfer; we later collapsed these two dimensions of information transfer to simplify the presentation.

On the survey using a five-point Likert scale, we asked clinicians about coordination when care is transferred across delivery sites (e.g., from the hospital to the outpatient team): “How often does each of the following occur when care is transferred across delivery sites?”

* “All relevant medical information is available.”
* “The information transfer is timely, i.e. available when it is needed.”
* “All clinicians agree on the treatment goals and plans.”
* “All clinicians agree on roles and responsibilities of each party.”

The response categories were: never, rarely, sometimes, usually, and always. Questions on care coordination were developed by an expert panel of scientific advisors specifically for this study. After we developed these questions, the Stanford-UCSF Evidence-based Practice Center (EPC) published a comprehensive report care coordination, which supported the these same key elements: access to information, agreement on goals and responsibilities, and agreement on a purpose or goal ([McDonald et al. 2007](#_ENREF_21)).

As noted earlier, we combined responses to the survey questions asking if “all relevant medical information is available” and if “information transfer is timely”. We reasoned that in order for information to be useful when coordinating care, it must be both complete and timely. In addition, responses to the two original survey questions were highly correlated (0.8). We created a dichotomous outcome measure, “Access to complete and timely information”. This variable was coded as one if the respondent reported “always” or “usually” to both questions; otherwise it was coded as zero.

For the other two coordination measures, we created two separate dichotomous variables called “agreement on treatment goals and plans” and “agreement on roles and responsibilities”; each was coded as one if the clinician responded that the relevant agreement “always” or “usually” occurs; otherwise it was coded as a zero. The number of missing values was small (<5%) and not correlated with EHR status; therefore missing responses were dropped from the analyses.

Team cohesion

Using a five-point Likert response scale, we asked the following four questions on team cohesion and communication. These questions were developed using published validated instruments ([Ohman-Strickland et al. 2007](#_ENREF_24)):

* “When there is conflict on this team, the people involved usually talk it out and resolve the problem successfully.”
* “Our team members have constructive work relationships.”
* “There is often tension among people on this team.” (reverse scored)
* “The team members operate as a real team.”

We calculated the average response over the four team cohesion items and aggregated them across all members from the same primary care team. The overall measure demonstrated high internal consistency reliability with a Cronbach Alpha coefficient of reliability of 0.83. For simplicity in presentation, we categorized team cohesion scores into quartiles and created a binary indicator variable classifying each team as cohesive or not, with the lowest quartile of scores as representing non-cohesive teams. Sensitivity analyses using other thresholds and constructions of team cohesion yielded comparable findings.

Covariates

Our survey collected several respondent characteristics, including race/ethnicity, gender, and job title. We supplemented survey responses with information attained from the IDS’ automated database on certain PCP characteristics, including age, gender, job title, and race/ethnicity.

Interaction between EHR and Team Cohesion

The main variable of interest is the interaction term corresponding to the product of the terms for use of the integrated outpatient-inpatient EHR and for primary care team cohesion. We defined each primary care clinician’s integrated EHR status at the date they completed the survey based on their team and hospital’s EHR status. Clinicians needed to work in facilities where both the inpatient and outpatient EHR components were implemented to qualify as having an integrated EHR.

Analytic Approach

To analyze the interaction effect of using an integrated EHR system and team cohesion on our three measures of care coordination, we used a generalized linear latent and mixed models (GLLAMM) logistic regression with random intercepts for clinician and hospital([Rabe-Hesketh, Skrondal, and Pickles 2004](#_ENREF_27)). We included the following clinician characteristics as covariates: age, gender, race/ethnicity, and job title. We also included a year indicator variable to control for time trends that may have affected the dependent variables but were unrelated to the implementation of EHR. Models included interaction between the indicator for team cohesion and integrated EHR status.

To calculate the estimated EHR effect for clinicians working in cohesive vs. non-cohesive teams, we multiplied the interaction coefficient by the non-cohesion team and EHR coefficients. We used results from our logistic regression models to compute the marginal adjusted percent of respondents who reported each outcome by fitting each model as if all respondents worked in teams with: (1) no EHR and a non-cohesive team, (2) no EHR and a cohesive team, (3) EHR and a non-cohesive team, and (4) EHR and a cohesive team.

Team cohesion was created to be a team level variable, including responses of three or more clinicians per team; whereas coordination was designed as an individual clinician level variable. As a sensitivity analysis to test the stability of our team cohesion measure, we ran all models excluding teams with fewer than four respondents (N=51) and models where the response of the individual clinician was excluded from their primary care team cohesion score and attained comparable results. All analyses were implemented using Stata 10 (StataCorp LP, College Station, TX).

**Results**

Table 1 shows the characteristics of respondents who completed the survey in each year of administration. In 2005, none of the respondents had access to the integrated EHR; by 2006, 6.3% of respondents were using the EHR, and in 2008, 52% of respondents were using the integrated EHR. We compared respondents and non-respondents on several characteristics, and in 2005 and 2006, we found that female clinicians and nurse practitioners and physician assistants were more likely to respond than male clinicians or physicians, and in 2006 and 2008, younger clinicians were more likely to respond than older clinicians.

Table 2 shows characteristics of the primary care teams. In 2005, teams had an average of about eleven primary care clinicians working per team, and that number decreased slightly to ten primary care clinicians per team in 2008 (range 3-25). On average, respondents reported working in the same primary care team for over five years.

Table 3 displays the results from the logistic regression analyses for the three coordination measures for care transferred across delivery sites. For clinicians working in cohesive teams, those using the integrated outpatient-inpatient EHR were significantly more likely to report access to timely and complete information (OR=2.53, 95% CI: 1.63-3.93), clinician agreement on the patient’s treatment goals and plans (OR=2.43, 95% CI: 1.50-3.95), and agreement on each other’s roles and responsibilities (OR=1.74, 95%CI: 1.09-2.77) compared with clinicians without the integrated EHR. For clinicians working in non-cohesive teams, we did not find a statistically significant association between use of the integrated EHR and reports of care coordination. We found a statistically significant interaction effect of EHR use and non-cohesive teams for reported access to timely and complete information (OR=0.37, 95%CI: 0.16-0.90) and clinician agreement on treatment goals and plans respectively (OR=0.36, 95%CI: 0.14-0.92). The interaction variable was not statistically significant for agreement on roles and responsibilities. For clinicians without the integrated EHR, those working in cohesive teams were significantly more likely to report agreement on each other’s roles and responsibilities than those working in non-cohesive teams (OR=0.59, 95%CI:0.42-0.84).

Figure 2 shows the adjusted percent of respondents who reported each care coordination outcome by EHR status and team cohesion level. After adjustments, for the three coordination measures, we observed a similar pattern, where clinicians working for non-cohesive teams reported lower levels of coordination across all measures, with almost no change before and after the EHR. The increase in reported coordination was significantly greater with EHR use for cohesive teams compared with non-cohesive teams. Reported access to complete and timely clinical information was substantially greater with EHR use for cohesive teams (54% vs. 38% pre-EHR) compared with non-cohesive teams (32% vs. 33% pre-EHR); likewise, for reported clinician agreement on treatment goals and plans for cohesive teams (64.3% vs. 50.6% pre-EHR) compared with non-cohesive ones (44.0% vs.45.9% pre-EHR) and agreement on roles and responsibilities for cohesive teams (63.9% vs. 46.7% pre-EHR) compared with clinicians working in non-cohesive teams (48.7% vs.46.7% pre-EHR).

**Discussion**

EHR has the potential to improve clinical care delivery, however the literature documenting achievement of this potential has been sparse and mixed ([Cebul et al. 2011](#_ENREF_10); [Friedberg et al. 2009](#_ENREF_14); [Holroyd-Leduc et al. 2011](#_ENREF_17); [Linder et al. 2007](#_ENREF_20); [Reed et al. 2012](#_ENREF_28); [Romano and Stafford 2011](#_ENREF_32)). Given the complexity of the implementation process for individual and groups of clinicians, there is surprisingly little known about how the organization of clinicians might influence the effect of EHR use on care coordination. We examined the impact of implementing a commercially available, integrated outpatient-inpatient EHR system on primary care clinicians’ reports of three important elements of care coordination across delivery site, and how team working relationships may modify this effect. We found that EHR use was associated with significantly higher levels of coordination for clinicians working in cohesive primary care teams but not for those working in non-cohesive teams.

Current efforts to reform how health care delivery is organized, including the PCMH, promote greater reliance on team-based primary care ([Rittenhouse and Shortell 2009](#_ENREF_29)). ACO models attempt to align incentives and goals across the continuum of care in order to encourage greater coordination across multiple sites with the primary care team ([Rittenhouse, Shortell, and Fisher 2009](#_ENREF_30)). Given these efforts to reform the way in which health care delivery is organized and financed, and concurrent multibillion dollar federal investment in promoting the widespread use of EHRs, it is important to understand how the organizational environment influences the EHR effect on various outcomes, including care coordination.

We found that whether clinicians are working in cohesive teams versus non-cohesive teams appears to influence EHR effect on coordination. There are good reasons to believe that the working relationship among a patient’s caregivers is related to the quality of care they receive. Evidence suggests that high quality care for patients with chronic diseases is best achieved when provided by highly functioning multidisciplinary care teams ([Bodenheimer 2008](#_ENREF_7); [Bodenheimer et al. 2009](#_ENREF_8); [Shortell et al. 2004](#_ENREF_35)). The implementation of new technology that directly affects clinical workflow, such as EHR, could affect how well teams function; the relationship also could bi-directional. Most likely, primary care teams, as do individual physicians, need to adjust to routines and workflows brought on by the EHR. This learning process could be achieved through both formal and informal channels. While formal learning is critical for instilling the basics of EHR use, informal learning, which is reinforced through ongoing communication and strong working relationships, may be critical to maximize the effectiveness of the EHR ([Robey, Boudreau, and Rose 2000](#_ENREF_31)). Clinicians working in teams with strong working relationships may be more comfortable experimenting with the new technology through trial and error and sharing best-practices learned with each other. This may speed the collective learning and ensure that clinicians leverage all of the functions of the EHR in order to maximize any potential gains in care quality and limit unintended adverse consequences.

While we expected that clinicians working in teams with higher cohesion scores would experience greater improvements in care coordination from use of the integrated EHR than those in primary care teams with lower cohesion, we hypothesized that all clinicians would report higher levels of care coordination with the use of an integrated EHR. One of the principle functions of an EHR system is to provide all clinicians and medical staff involved in a patient’s care with current and comprehensive patient health information at the point of care. Therefore, we were surprised to find that clinicians working in non-cohesive teams did not experience any improvements in the three measures of care coordination with use of the integrated EHR.

While the EHR clearly provides clinicians with more information than what was previously available when clinicians were using paper medical charts and patient care was transferred across delivery sites, such increase in information can create its own access and processing challenges. More information and more "places" within the EHR to store the information engender additional transaction costs to learn how to obtain this information and creates potential information overload. A recent paper outlined several ways in which the social environment can interact with EHR implementation resulting in many unintended and undesirable consequences ([Harrison, Koppel, and Bar-Lev 2007](#_ENREF_16)). By their account, examples of these unintended consequences include, busy clinicians entering critical data in miscellaneous sections of the EHR, making it difficult for others to retrieve, and the EHR eliminating the need for frequent informal interactions, which previously provided redundant checks that helped prevent errors.

In our survey, we collected responses to several open-ended questions that provide useful context and additional depth to our main finding. Clinician responses to these questions support the concept of these unintended consequence of the EHR cited in the literature ([Bostrom and Heinen 1977](#_ENREF_9); [Harrison et al. 2007](#_ENREF_16)). Although there appeared to be general agreement among clinicians that there was certainly more information available with the EHR, the EHR was cited as creating a new problem: too much information, some of it redundant and not helpful, possibly rendering the relevant parts easier to miss. For example, one clinician wrote:

*“Sometimes there is too much information from the patient’s hospital stay, you can see all notes including nursing, discharge planner, etc. Health Connect [EHR] should be able to limit the notes only from MDs and let us expand it if we like. But right now, we see everything- and have to filter it ourselves to get only MD notes. Very time consuming and most of the time we only want to see MD notes anyway.”*

Although the patient’s information may be complete and available after the integrated EHR is implemented, clinicians reported having a difficult time locating the relevant information in a timely manner. For example, another clinician reported:

*“The question is not if the information is available but if we have time to access it or can find it."*

In addition taking more time to find the relevant information, the increase in the quantity of information could cause clinicians to miss critical information from a patient’s medical record.

*“There is so much information and repetition in the system. It's easy to miss the important points.”*

So while the EHR provided more information and theoretically, easier access to this information, the sheer volume of available data created its own challenges. For example, users of the system need to know in which sections of the EHR to record the relevant information and also where to look when retrieving information from others. The flexibility of the EHR and corresponding limited use of highly structured fields possibly contributed to this challenge as clinicians could enter the same information in many different sections of the EHR and in divergent formats. It is possible that clinicians working in less cohesive, more stressful primary care team environments may have had less ability to navigate the record or have less systematic approaches to document and retrieve information from the record. In addition, the extensive reporting requirements on the EHR, combined with limited time, could contribute to potentially counterproductive strategies, such as cutting and pasting sections of the patient’s record.

Another potential explanation for our findings is that cohesive teams could be better at informal learning, which is reinforced through ongoing communication and the strength of working relationships ([Robey et al. 2000](#_ENREF_31)). All primary care clinicians in our setting received the equivalent formal classroom-style training on how to use the EHR; however, informal learning likely varied significantly across primary care teams. Members working in teams with strong working relationships may have been more comfortable experimenting with the new technology through trial and error and be more willing to share learned best-practices with each other. This may speed the collective learning of this new tool and ensure that clinicians maximize the potential benefits of the EHR while avoiding unintended consequences.

In response to open-ended questions on how they learned to use the EHR, most clinicians reported learning more from colleagues than from the formal training provided:

*“I learned the most from colleagues; it’s helpful when we all meet to share knowledge”*

*“[I learned to use EHRs] mostly by practicing, trying to solve problems, talking to other people, and a lot of trial and error.”*

Clinician responses are consistent with the literature on organizational learning which states that the team environment is critical for the adoption and learning of new technology ([Edmondson, Bohmer, and Pisano 2001](#_ENREF_12); [Edmondson et al. 2003](#_ENREF_13)). The implementation of an EHR can certainly disrupt a team’s clinical workflow and routines. How quickly and efficiently primary care teams can adjust to these new routines likely depends on the strength of their working relationships. Although all clinicians in our study undoubtedly had access to more information with the integrated EHR, how quickly and efficiently they were able to access the relevant information depended on their team environment.

It is important to note that this study was conducted among primary care providers from a single IDS, using a single EHR system. In other settings, the effect of the EHR system on care coordination may differ. Still, the EHR studied is an EpicCare®-based system, commercially available and estimated to be used by one in four ambulatory care physicians in the US. Furthermore, our care coordination and team cohesion measures were based on self-reported data, not on an audit of actual information available. These clinician-reported coordination measures provide a unique opportunity to examine the effect of EHR on coordination of care since audit trails do not provide measures of care coordination. Likewise, measures of team working relationships can only be captured through self-reported data. We had a high level of response and multiple respondents per each team. In addition, we ran models limiting data from teams with five or more respondents and the results were comparable. Lastly, we collected ratings of team cohesion and of care coordination at the same point in time for each respondent, which could raise two related concerns: 1) response bias (e.g., some respondents tend to give uniformly high or low ratings); and 2) the direction of the relationship. In the analysis, however, the cohesion measure is a team level variable consisting of the mean of at least three clinicians on a team. We ran sensitivity analysis where we excluded the individual clinician’s rating of team cohesion from their primary care team’s cohesion score and attained comparable results.

There is documented variability on how successful clinical practices are at implementing EHR systems, where some were met with worker resistance and few resulted in noted failures ([Poon et al. 2006](#_ENREF_26)). While EHR systems vary in their degree of usability, users also differ in their level of computer skills. There are likely many factors that contribute to the successful implementation of an EHR system. Not all EHR systems and organizational structures will result in the same level of improvements in care quality from the EHR, and some may even lead to in greater inefficiencies and adverse outcomes. In our study, we found the benefits of an integrated EHR on care coordination depended on the strength of working relationships among primary care team members.

It may be that higher team cohesion promotes faster learning of the EHR, allowing clinicians to achieve better outcomes more quickly, but that eventually all teams achieve the same level of quality improvements from the use of EHR. Conversely, it is also possible that the EHR allows higher functioning teams to perform better as a team, magnifying the differences between lower and higher functioning teams. Future studies should examine possible pathways in which team cohesion modifies the impact of EHR on care coordination and how changes in care coordination measures affect patient outcomes.

The introduction of an integrated outpatient-inpatient EHR was associated with significant improvements in several clinician-relevant aspects of coordination for care transferred across delivery sites; importantly, this improvement occurred only for clinicians working in cohesive teams and not for clinician working in non-cohesive teams. Organizational attributes of the work environment, such as team working relationships, impact the effectiveness of this new technology. Health Information Technology, and specifically EHR, offer new opportunities for improving overall quality of care, preventing medical errors, and reducing health care costs. Still, EHR systems are not silver bullets and their impact on care quality and efficiency will be limited if any deficiencies of the work environment and team relationships are not mutually addressed.

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Table 1: Respondent characteristics by survey year

|  |  |  |  |
| --- | --- | --- | --- |
|  | 2005 | 2006 | 2008 |
| **%** | (N=565) | (N=678) | (N=626) |
| Response Rate | 48.1 | 61.5 | 60.8 |
| Gender: Male | 45.3 | 46.0 | 48.3 |
| Female | 54.7\* | 54.0\* | 51.7 |
| Race/Ethnicity: Non-white | 51.0 | 56.9 | 60.8 |
| White | 49.0 | 43.1 | 39.2 |
| Job Title: N.P/P.A. | 15.8\* | 11.7\* | 5.6 |
| M.D./D.O. | 84.3 | 88.4 | 94.4 |
| Age: 25-39 | 36.0 | 38.1\* | 39.5\* |
| 40-54 | 47.5 | 45.1 | 44.8 |
| 55+ | 16.5 | 16.8 | 15.7 |
| EHR Status: No EHR | 100.0 | 93.7 | 52.2 |
| Integrated EHR | 0.0 | 6.3 | 47.8 |

Note: 262 clinicians completed the survey in all three waves of data collection (2005, 2006, and 2008), 609 completed at least 2 surveys, and 1,207 completed at least one survey.

\*p<0.05 comparing respondent and non-respondent characteristics each year, represents groups that were more likely to respond.

Table 2: Team Characteristics (mean, standard deviation)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | 2005 | |  | | 2006 | | | 2008 | | |
| N = | 105 | | | | 106 | | | 104 | | |
| Primary care clinicians per team | 11.14 | | (3.78) | | 10.4 | | (3.86) | 9.86 | | (5.92) |
| Respondents per team | 5.39 | | (2.32) | | 6.40 | | (2.71) | 6.01 | | (4.24) |
| Reported team tenure (years) | 5.62 | | (4.53) | | 5.54 | | (4.79) | 6.39 | | (4.75) |
| Team Cohesive Scores: |  | |  | |  | |  |  | |  |
| Cohesive teams | 3.30 | | (0.35) | | 3.23 | | (0.35) | 3.18 | | (0.42) |
| Non-cohesive teams | 3.87 | | (0.27) | | 3.87 | | (0.23) | 3.83 | | (0.19) |

Note: We calculated team cohesion scores by averaging responses over the four team cohesion survey items and aggregating them across members from the same primary care team. We categorized team cohesion scores into quartiles and created a non-cohesive team indicator variable for teams in the lowest quartile. Team cohesion scores ranged from 1 to 5, with 5 representing the highest level of cohesion.

Table 3. Logistic regression of clinician reported coordination measures for care transferred across delivery sites

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Access to complete and timely information | | Agreement on treatment goals & plans | | Agreement on roles & responsibilities | |
|  | OR | 95% CI | OR | 95% CI | OR | 95% CI |
| No EHR & cohesive teams | Ref. | | Ref. | | Ref. | |
| No EHR & non-cohesive team | 0.73 | 0.52,1.03 | 0.74 | 0.52,1.06 | 0.59\*\* | 0.42,0.84 |
| EHR & cohesive teams | 2.53\*\*\* | 1.63,3.93 | 2.43\*\*\* | 1.50,3.95 | 1.74\* | 1.09,2.77 |
| EHR & non-cohesive team1 | 0.69 | 0.31,1.52 | 0.65 | 0.29,1.49 | 0.67 | 0.30,1.48 |
| N | 1794 |  | 1772 |  | 1763 |  |

\* *p* < 0.05, \*\* *p* < 0.01, \*\* *p* < 0.001

1The OR for EHR & non-cohesive team was calculated by multiplying the OR for No EHR & non-cohesive team, EHR & cohesive team, and EHR\*non-cohesive team interaction.

Note: Generalized linear latent and mixed models (GLLAMM) logistic regression with random intercepts for clinician and medical center and also adjusted for year and clinician characteristics (age, gender, race, and job title).

Figure 1: Adjusted clinician reported care coordination by EHR and team cohesion

Note: We computed the marginal adjusted percent of respondents who reported each outcome by fitting the logistic regression models as if all respondents had (1) no EHR and non-cohesive team, (2) no EHR and cohesive team, (3) EHR and non-cohesive team, and (4) EHR and cohesive team.

\* *p* < 0.05, \*\* *p* < 0.01, \*\* *p* < 0.001. P-value compares integrated EHR to no integrated EHR by team cohesion.

Appendix

Table A1. Logistic regression of clinician reported coordination measures for care transferred across delivery sites with random intercepts for clinician and medical center (full model results)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Access to complete and timely information | | Agreement on treatment goals & plans | | Agreement on roles & responsibilities | |
|  | OR | 95% CI | OR | 95% CI | OR | 95% CI |
| No integrated EHR | Ref. | | Ref. | | Ref. | |
| Non-cohesive team | 0.73 | 0.52,1.03 | 0.74 | 0.52,1.06 | 0.59\*\* | 0.42,0.84 |
| Integrated EHR | 2.53\*\*\* | 1.63,3.93 | 2.43\*\*\* | 1.50,3.95 | 1.74\* | 1.09,2.77 |
| Interaction: EHR\*non-cohesive | 0.37\* | 0.16,0.90 | 0.36\* | 0.14,0.92 | 0.65 | 0.27,1.58 |
| Year: 2006 vs. 2005 | 0.83 | 0.61,1.12 | 0.75 | 0.55,1.04 | 0.77 | 0.57,1.05 |
| 2008 vs 2005 | 1.14 | 0.79,1.64 | 0.87 | 0.59,1.29 | 0.94 | 0.65,1.38 |
| Female vs. male | 0.85 | 0.61,1.18 | 0.88 | 0.61,1.26 | 1.07 | 0.75,1.52 |
| White vs. non-white | 0.73 | 0.52,1.02 | 0.76 | 0.53,1.10 | 0.87 | 0.61,1.25 |
| MD vs. NP/PA | 1.88\* | 1.05,3.37 | 1.89\* | 1.01,3.54 | 2.46\*\* | 1.35,4.48 |
| Age: 40-54 vs. 25-39 | 1.13 | 0.81,1.58 | 0.69\* | 0.48,1.00 | 0.73 | 0.51,1.04 |
| 55+ vs. 25-39 | 1.73\* | 1.07,2.82 | 0.75 | 0.44,1.28 | 0.79 | 0.47,1.33 |
| N | 1794 |  | 1772 |  | 1763 |  |

\* *p* < 0.05, \*\* *p* < 0.01, \*\* *p* < 0.001

Model includes random intercepts for clinician and medical center.

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