FINAL PROGRESS REPORT

TITLE:	IT Implementation by Cognitive Engineering of Organizational Routines R18 HS18170
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ABSTRACT: (Maximum 200 words)

Purpose: Apply Cognitive Task Analysis (CTA) to understand the overt and hidden features of organizational routines and the macrocognitive skills of safety-net practices. Apply the findings to help them implement a chronic disease registry, quality improvement, and clinical reminder system.

Scope: Three rural Federally-Qualified Health Centers in Michigan.

Methods: Sequential mixed-methods multiple case comparison, each intervention building upon previous. Task Diagram and Team Audit CTA methods. Delivery of CTA consultation report to each practice.

Results: CTA readily identified key features of organizational routines, including tacit features, and strengths and deficits in team skills. Practice A's planning and coordination had significant deficiencies, the recommendations for addressing them were not adopted, and the implementation failed. Practice B's administrators had well-developed planning, replanning, and management of uncertainty skills. These allowed them to make use of their CTA report and progress toward implementation despite major technical hurdles and personnel turnover disruptions, including the ultimate financial collapse and closure of the FQHC. Practice C had good coordination, but limited planning, monitoring, and replanning skills. However, they made use of the CTA consultation to build those skills, and successfully implemented the HIT after an earlier (pre-CTA) failed attempt and despite difficult technical barriers.

Key Words: Primary Health Care, Health Information Technologies, Safety-net Providers, Rural Health Services, Point of Care Systems, Organizational Culture

PURPOSE

The study's purpose was to determine if a clinical quality management system could be successfully implemented using a cognitive engineering approach to alter organizational routines. The following specific research questions were intended:

1. What barriers and facilitators are encountered in implementing clinical quality management systems in safety-net ambulatory care settings and what is the impact of using cognitive engineering tools during implementation?
2. Does the implemented clinical system increase adherence to evidence-based practices in ambulatory care settings serving an underserved population?
3. Are cognitive task analysis (CTA) based interventions on organizational routines acceptable, maintainable, and transferable in ambulatory care settings serving an underserved population?

SCOPE

Implementing health information technology (HIT) in primary care is an ongoing challenge. Several theoretical frameworks have been applied in recent years to implementation research in primary care, including to HIT implementation. In general these frameworks have their roots in the health behavior or sociology literatures. They identify the components of the adoption process, and the technical challenges, changing workflows, and changing relationships that must be addressed, but do not in general consider the specific skills needed to address them.

In this project we adopted a different approach: the macrocognition framework,[1,2] which draws on a variety of literatures that explain and measure the thinking and deciding that people do to accomplish complex, real-world tasks alone, in teams, and with technology. The macrocognition framework focuses on the cognitive components of, and skills needed to accomplish, knowledge work (Table 1). It also explicitly recognizes that the knowledge of experts and teams that allows them to function at superior levels is often neither observable nor readily accessible to introspection.

Table 1: Macrocognition Functions

Key Functions	Definition
Decision Making	Making decisions based on using either recognition-based strategies or by comparing options analytically.
Sensemaking and Learning	Deliberate attempts to generate coherent, conceptual situational understanding and/or shared mental models.
Planning and Replanning	Mentally simulating options, based on experience and/or mental models, to shape or reshape routines or processes.
Problem Detection and Monitoring	Tracking progress of plans, active seeking of deviations from anticipated outcomes or findings that question mental models.
Managing the Unknown and Unexpected	Incorporating uncertainty or partial information into mental models, plans; evaluating risks; planned processes for nonroutine or disruptive events.
Coordinating	Synchronizing roles and activities of multiple people across one or more routines; developing and maintaining common ground in planning, sensemaking.

The primary toolset for applying the macrocognition framework is cognitive task analysis (CTA). CTA is a set of highly structured and complementary qualitative methods designed to elicit the often invisible or highly automatized thought processes of expert (individual and team) decision making in real world environments.[2,3] CTA can help understand and improve teams' performance on clinical and organizational tasks, by identifying the critical cognitive aspects of those tasks that would otherwise remain hidden. Properly understanding these macrocognitive functions allows for more comprehensive, accurate, and effective formative evaluations, implementation planning and troubleshooting, and knowledge transfer.

The macrocognition framework with its CTA toolset offers the advantage of its decades-long track record of successfully understanding and guiding the improvement of individual and team performance in a range of knowledge work settings where failures would be both very visible and costly, e.g., fireground command, nuclear powerplant operation, civil and military aviation, naval ship command, intensive care units, and operating rooms.[2,4–8] Our team pioneered the use of CTA in primary care, [9] using it to understand how physicians structure visits. In this project we apply CTA to understanding and facilitating HIT implementation in primary care.

Implementing HIT, like implementing any substantial change in how practices' work is done, requires that practices adapt their organizational routines.[10] At a minimum, it requires that practices adapt their clinical workflow routines; often it requires adapting existing or creating new organizational routines as well. CTA is well suited to help teams

understand their routines—especially the less visible cognitive aspects of those routines—more accurately than they could by unaided introspection and observation. The findings of CTA can make teams aware in advance of potential failure points in their planned new or modified routines, as well as assess and help them improve the change management skills they will need in order to implement HIT successfully.

Practices that are part of integrated delivery systems, large group practices, or physician-hospital organizations commonly have access to sophisticated technology support, leadership and change-management expertise, and financial resources that can help HIT implementation succeed even where the practices' own skills are limited. Rural underserved practices typically do not have access to these resources, putting them at a distinct disadvantage when implementing HIT. Consequently, they may both need and benefit more visibly from HIT implementation assistance.[11,12] Hence, we chose to work with rural Federally-Qualified Health Centers (FQHCs) for our exploration of the effectiveness of this novel application of CTA.

METHODS

This was a sequential comparative case study. Using Peters et al.'s typology[13] of implementation research, this was a dual project: a *plausibility*-level *influence* study of the use of CTA reports to aid HIT implementation (questions 2 and 3), and a study of the use of the macrocognition framework to *explain* important factors in implementation (questions 1 and 3). Implementation outcomes targeted were *acceptability*, *appropriateness*, and *feasibility* for CTA as an implementation aid, and *adoption* and *sustainability* for the HIT itself. Influence studies test whether an intervention produces an outcome. The plausibility level allows a modest, usually non-numerical, level of confidence that the outcome is due to the intervention, as opposed to the probability level, which assigns a high and usually explicitly calculated probability that the outcome is due to the intervention. Explanatory studies seek to answer some of the how and why the intervention has the effects observed. Acceptability is defined by stakeholders' agreement with the intervention. Appropriateness is the perceived relevance or fit of the intervention in the setting studied. Feasibility is the extent to which the intervention can be carried out in the studied setting. Adoption in Peters et al.'s typology includes either the decision or action to deploy the intervention. Sustainability is defined by action only, however: the degree to which the intervention is maintained in practice.

The HIT was Cielo Clinic (later purchased by The Advisory Board Corporation and renamed Crimson Care Registry[14]). It is a clinical quality management system (CQMS) comprising a disease registry, point-of-care clinical reminder system for both preventive and chronic disease management services, call lists and automatically-generated letters to patients, and detailed report generation for administrative and quality improvement purposes. Implementing the CQMS is a substantial change in workflow but requires less workflow change than, for example, implementing an electronic medical record (EMR). The CQMS was actually developed using CTA tools, to minimize disruption of clinical workflows. However, implementing it successfully has non-trivial implications for organizational culture. Practices must agree upon and implement reminders for specific clinical services, decide whether to empower non-physician staff to address some of them, and determine how they will act upon quality reports produced by the system.

The sites were three rural FQHCs in Michigan. They were selected because they comprised substantial variation in geographic location and structure. Site details are presented in Table 2. The Michigan Primary Care Association (MPCA) - the statewide organization of FQHCs - was aware of several of its members that wished to implement a CQMS, and facilitated the connection between our research team and those FQHCs.

We used the Task Diagram and Team Knowledge Audit CTA methods.[3] The Task Diagram method involves mapping a workflow, but differs from simple workflow mapping in two important ways. First, the focus is on capturing the important aspects of macrocognition in the work, such as where key decisions are made, what information is needed for those decisions, and how the team evaluates and acts on the outcomes. Second, it employs a set of pre-defined (but open-ended) probe questions designed using psychological and organizational theory to elicit that information, particularly the portions of it that undirected questioning or introspection would not. The Team Audit (TKA) method uses similarly designed probe questions to delve deeply into the knowledge work tasks identified as particularly important in the Task Diagram. TKA relies primarily on semi-structured interviews, but commonly includes observations of team interactions and analyses of forms, logs, patient charts, and other artifacts.

The research staff tasked with conducting the CTA data collection was trained in the methods by nationally-known expert practitioners of the method,[2] and then underwent further training and practice specific to primary care

application by the investigators. CTA data collection is typically done in teams of two, a lead and a second interviewer; the newly-trained staff seconded the investigators in early interviews and led after gaining experience.

Table 2: Site Characteristics

	Location	# of Locations	Physician FTE	Dental Provider FTE	Behavioral Health Services?	Annual Visits	Health IT System
FQHC A	Small town/rural mixed economy	3	3.60	0.00	Yes	28,301	Registration and billing only
FQHC B	Rural/remote, forestry and tourism, high unemployment	6	2.40	3.20	Yes	8,265	Obsolete version of registration and billing
FQHC C	Rural agricultural and recreational	3	4.17	2.00	Yes	13,050	Registration and billing only

The interview guides and probe questions were developed through multiple iterations over a period of several months by the full team. They were informed by the literature on organizational routines[10,15] as well as the investigators' previous experience with CTA in primary care, their own experience as primary care physicians or organizational psychologists, trial runs with non-study practices, and discussions with colleagues expert in IT and sociotechnical systems at the University of Michigan.

Each site's participation began with an organizational meeting. The project team visited the site, presented a detailed discussion of the project, and worked out a launch plan and timetable with the site. The Cielo Clinic sales team then provided their standard commercial demonstration and introductory training presentation to the site.

The research team was then sent to gather the data upon which the clinic's CTA report was developed by visiting the site again. They conducted semi-structured interviews with multiple informants covering all roles in the clinic, using the Task Diagram and Team Audit guides. Interviews were conducted in the typical CTA process, by a pair of interviewers (lead and second). Detailed Task Diagrams and Team Audits were conducted with each interviewee independently, then integrated in subsequent analysis, in order to identify dispersed vs. distributed knowledge and understand the degree of commonality of mental models among team members. Extensive notes were taken during each interview, and the interviews were also recorded and transcribed for later analysis. The team also collected extensive field notes on the physical environment, observations of interactions, impressions of the organizational climate and culture, and work activities observed.

In our first round of analysis, we studied our data to understand each practice's clinical and organizational routines and produce a CTA consultation report as a guide to implement the HIT. The analysis was conducted in the standard fashion for CTA.[2] Briefly, the members of the project team performed an initial round of immersion crystallization and individual proposals for emergent themes, then met as a team weekly to refine the coding, code the transcripts, and reconcile coding. Further weekly meetings were devoted to generating a set of specific action recommendations and information points, and preparing a detailed custom report (approximately 20 pages) for each practice. Each report highlighted tacit and dispersed knowledge crucial to their work routines, areas that the HIT would impact, decision points, likely failure points, current information handling, and workarounds. It summarized similar features in their organizational routines. The report's recommendations for work routines covered recommended changes in workflow and information handling, knowledge sharing, mitigation of failure points, and obviating workarounds. For organizational routines, recommendations focused on specific risks to, or changes needed to support, implementing the workflow changes recommended.

After conducting the first analysis and preparing the CTA report, we then returned to the site to present the report and discuss our recommendations. This was done with the entire staff of the FQHC present, and discussion emphasized.

Further detailed discussions about the recommendations were held subsequently with leaders responsible for the implementation. At that point the Cielo Clinic representatives conducted their standard commercial software installation, hands-on training, and launch.

We followed up by telephone conference with the FQHC leadership after launch, and at the second and third sites made follow-up site visits on several occasions up to 18 months later. Detailed field notes were kept on the teleconferences and at the site visits, and additional CTA interviews and direct observations were conducted at the site visits. These data were analyzed in the same fashion as the first round, again in weekly team meetings. This second round analysis focused on applying the macrocognition framework to understand the impact of the CTA consultation report, the outcome of the implementation, and FQHC's management of change at the clinical and organizational levels.

Quantitative data on rates of mammography, childhood lead screening, Pap smears, immunizations, blood pressure control (<140/<90), and hemoglobin A1c control (<9%) were obtained from the FQHC's Uniform Data System (UDS)[16] reports. Rates of responses to clinical reminders issued by the CQMS were collected. These data were used for the plausibility-level influence analysis.

RESULTS

CTA methods were readily applied for both understanding the teams' workflow routines and evaluating their change routines. The process was very well accepted by all 3 sites, with many comments about just going through the interviews being helpful to the practice, even before results were received. Table 3 displays the key CTA findings from each FQHC at the clinical (workflow) and organizational levels.

Table 3a: CTA Findings – Clinical Routines Level

FQHC	Function	Findings
A	Decision Making	Clinical decision making very provider-centric.
	Sensemaking and Learning	Providers, MAs, clerks, nurses each have very limited mental models of how other groups function. Leadership has inaccurate mental model of office workflows.
	Planning and Replanning	Planning and Replanning processes are limited. Non-leadership staff are not significantly involved. Limited planning in relation to electronic workflow results in staff continuing to rely on paper charts or hand-written notes for patient reminders and other missing information.
	Problem Detection and Monitoring	No organized problem detection, dependent upon staff noticing things awry. Missing sticky notes or misplaced charts (see Coordinating) lead to undetected errors.
	Managing the Unknown and Unexpected	Limited formal processes and high reliance on tacit knowledge results in ad hoc methods of managing disruptions to patient flow and charting.
	Coordinating	Workflow informally structured, highly non-standard across MA/provider teams. Each team responsible for its own coordination within, high reliance on tacit knowledge by MAs and nurses about how to work with their provider. Little coordination between teams, tacit knowledge is dispersed, creating problems when cross-coverage needed. Workflows dependent upon fragile physical artifacts, e.g., which corner of a desk a chart is placed upon, sticky notes in paper charts about urgent or important tasks to be done for patients.
B	Decision Making	Decision making for patient treatment is mostly provider specific and loosely based on an online source for basic guidelines. Internal guidelines do exist but location is not widely known. Provider turnover and use of locum tenens contribute to variation.
	Sensemaking and Learning	Geographically separated clinics limits the ability of staff to engage in Sensemaking to develop shared mental models.

		Communication and consistency among clinics is a known issue with various solutions put in place over time. Clinic staff is encouraged to share thoughts and those suggestions are supported by administrative leadership. However, changes often are unsuccessful because many at the clinic level are unaware of process changes.
	Planning and Replanning	A desire among physicians and staff to streamline processes, train more efficiently across offices and communicate better internally. Leadership is willing to make necessary investments for planning and communication, e.g., closing clinics for all staff meetings. They understand the issues and staff often suggest changes, though implementation success is variable.
	Problem Detection and Monitoring	The problems with consistency among clinics are known so each clinic sticks to doing their own processes. Charts are often different, duplicative and/or chronically ill patients aren't up-to-date on needed labs or procedures and it's on the staff or patients to fill in the gaps of 'unknowns.'
	Managing the Unknown and Unexpected	With staff turnover and various "owners" of change management, staff is uncertain of who is in charge of rolling out new procedures at the association-level and some staff is unaware of changes. Clinics then end up going back to the same system.
	Coordinating	No formal meetings are set-up for physicians and their staff members or for any leadership group. Some coordination meetings, e.g. a diabetes quality improvement committee, have been facilitated by outside contractors, but when this support is removed the meetings cease. Coordination between medical and dental providers is limited, dental providers report insufficient information in patient charts to understand patients' conditions that could affect dental treatment.
C	Decision Making	Staff have some empowerment to make scheduling decisions but clinical decision making is provider-centric, relying heavily on providers' past experiences. Decision making around clinical guidelines involves a process of group consensus through provider meetings.
	Sensemaking and Learning	There is limited understanding of how other groups function across the office.
	Planning and Replanning	A performance improvement committee responsible for clinical planning and replanning demonstrating some limited use of PDSA and Lean principles to enact clinical workflow changes.
	Problem Detection and Monitoring	No organized problem detection. Reliant on staff and providers detecting issues and communicating informally with members of the performance improvement committee. Time constraints often prevent staff from correcting information identified as missing. Due to lack of formalized process, problems are often discovered after patient has left, necessitating follow-up.
	Managing the Unknown and Unexpected	Cross-trained front desk staff and documented patient flow workflows limits the need for staff to manage unknown or unexpected situations.
	Coordinating	Formally documented workflows results in relatively standardized clinical and patient flow processes. There is some variation in documentation practices across providers. Administrative staff cross-trained in all front desk positions and rotate depending on day.

Table 3b: CTA Findings – Organizational Routines Level

FQHC	Feature	Findings
A	Decision Making	Overt and tacit decision making differ sharply. Decisions of any consequence are made informally by one dominant physician in the practice, even when those decisions overtly are the province of the practice administrator.
	Sensemaking and Learning	The practice does not have an organized approach for sensemaking or learning about organizational processes. The practice administrator wanted to introduce one.
	Planning and Replanning	Limited in extent and informal in nature. Practice administrator has some planning skills but rest of practice largely reactive. Looked for external direction.
	Problem Detection and Monitoring	Unstructured. Routine reports reviewed by practice administrator, but not by practice as a whole.
	Managing the Unknown and Unexpected	Little contingency planning. Staff look to physician leader to deal with unexpected events or changes in conditions.
	Coordinating	Primarily informal, heavily dependent upon tacit understandings. Limited formal coordination, e.g., written policies for work, which are so little used that most staff do not know where they are kept. Memoranda on operational matters issued by practice administrator appear to have little impact.
B	Decision Making	Decisions about organization-level matters are made largely by the central leaders, with input actively solicited from site leaders. Little physician involvement due to turnover, but when a medical director is on board s/he is fully included. The decision processes appear to be a mix of consensus and authoritarian-with-input.
	Sensemaking and Learning	Significant effort goes into sensemaking, consistent with their unstable environment. The effort is largely by leadership, does not involve physicians but does somewhat involve NPs. Partly done by central leadership, partly by conference among central and site leaders. Largely but not entirely shared mental models between the sites result.
	Planning and Replanning	A near-continuous process, of necessity due to their unstable staffing and finances. Focused on operational planning rather than strategic. Primarily done by executive director and site leads.
	Problem Detection and Monitoring	Mix of formal and informal processes, both extensive. Clinic and central leaders review UDS and internal reports (the most extensive in our sample) quarterly. Personal contacts and sharing of narrative at meetings is also a major mechanism of detection and monitoring.
	Managing the Unknown and Unexpected	Highly skilled at reactive management, through long practice. Formal contingency planning is very limited, but frequent provider turnover has created a de facto organizational routine for dealing with it.
	Coordinating	Monthly conference calls for site and central leadership. Quarterly QI meetings association-wide, often by conference call. Geographic dispersal strains coordination.
C	Decision Making	Non-clinical decision making is largely made by a group of three leaders including the medical director, a RN in the role of Clinical Quality Improvement Coordinator and the CEO. Decisions are often influenced by recommendations or suggestions from outside entities (i.e. Cielo, Lean, PDSA). Staff

		clearly understands where decision making authority lies.
	Sensemaking and Learning	Somewhat limited skills, and tend to look outside for assistance (consultants, QI workshops). Sensemaking tends to be a group process among the 3 leaders (MD, RN, CEO).
	Planning and Replanning	Leadership lacked a clear vision and direction for planning. Planning process immature, lack of planning and vision on the front end creates the need for a lot of problem solving and re-planning after changes are implemented.
	Problem Detection and Monitoring	No formal detection and monitoring process, some inconsistent use of PDSA cycles with varying success.
	Managing the Unknown and Unexpected	Limited contingency planning at the organizational level, in contrast to extensive at the clinical level. Not often needed, as setting is stable and turnover low.
	Coordinating	Meetings are a main avenue for communication and coordination. Regular meetings include provider meetings, staff meetings, all hands meetings and a performance improvement committee.

Appendix 1 presents an anonymized example of a CTA consultation report delivered by our team. We next present brief narratives of how the report was received and used, and the outcomes of adoption and sustainability as defined in the Peters et al. typology under Methods above.

FQHC A: Leadership at FQHC A initially indicated that their interest in participating in our CTA intervention stemmed from a desire to use implementation of the CQMS system as a stepping stone towards eventual adoption of a full EMR. They had engaged in very little planning for HIT adoption in advance of participation in our project and multiple individuals indicated in their CTA interviews that they were looking for significant direction and consultation to support their process.

We returned to the clinic in person to deliver and review their detailed custom CTA consultation report. Despite our encouragement to include all clinic staff, and particularly providers, in the meeting, clinical staff participation in the report delivery meeting was limited as patient visits were ongoing. Later follow-up and debrief interviews with clinic management and the senior clinician on staff indicated that while they had positively received our report and agreed that our advice/suggestions were valuable they failed to follow the majority of them in the implementation process. For example, we suggested adjusting the patient visit schedule to accommodate the extra time needed for data entry and workflow adjustment during the roll out period, but the clinic chose to attempt to continue operations at full capacity. Given the macrocognitive skills issues we detected, we strongly advised activating one small subset of clinical reminders at a time, with specific attention to problem detection and replanning, before adding another set. However, the clinic activated the entire set (over 50) at once, and implemented no problem detection, monitoring, or replanning. They did launch the CQMS on schedule, and ran it for over 3 months. The senior clinician indicated in debriefing that it did help them catch many missing screening, prevention, and chronic disease management needs for patients. However, the impact on their work routines from launching without any of the mitigation recommendations from our report was as disruptive as we predicted. Ultimately the clinic discontinued their use of the CQMS, and further canceled their planned EMR launch. That only changed when their affiliated hospital stepped in and completely managed (full time on site) the EMR adoption and implementation process on behalf of the clinic.

FQHC B: Our second FQHC was already holding regular quarterly quality improvement (QI) meetings, and sought the CQMS to further their QI efforts. This site faced three unique and ongoing challenges: 1) a high burden of uncompensated care in a region of longstanding high unemployment, 2) widely dispersed sites (spanning over 100 miles) in an area of low population density, and 3) high physician turnover with substantial reliance on locum tenens physicians. The FQHC leadership maintained the work routines, many in explicit form as manuals, tried to keep them uniform across sites, and was actively interested in incorporating the CQMS into them. They introduced our team and project to their staff and providers at an all-hands meeting of personnel convened from all their sites. Later, when we presented our report, they convened site leaders and staff from across their dispersed sites to receive our report and discuss it. They invited our project staff to join in their regular QI teleconferences. They were still using an obsolete

version of their practice management software, from which it was difficult to retrieve data on immunizations and other service provision, and worked with our programmers to develop utilities to support data extraction for import into the CQMS. However, they were beset by provider turnover and financial difficulties. Their first effort to launch was disrupted prior to go-live by the forced resignation of the medical director for patient care improprieties, and it took more than a year to find a replacement. The major hospital in the area was bought out by a national for-profit chain, which instituted a policy of refusing to make appointments in their outpatient clinics for patients with outstanding bills. That combined with the recession and sharp cuts in Medicaid eligibility by state government more than doubled FQHC B's uncompensated care burden. Despite these challenges, they regrouped and resumed organized efforts to launch the CQMS, again convening their leaders together with us, updating their launch plan, and progressing on the plan up until the last month before they had to close their doors for financial reasons.

FQHC C: The third FQHC in our study had experienced a previous failed attempt at implementing the same CQMS product that we were working with in our CTA intervention. Clinic leadership, upon learning of our project through the state Primary Care Association, asked to participate hoping that the CTA could support a successful relaunch. Initial CTA interviews revealed a basic quality improvement skill set (see Table 3) that could be leveraged for change management to improve their existing but limited planning, replanning and monitoring skills. Clinic leadership was very receptive to our research team's involvement with their committees responsible for quality improvement and CQMS implementation. They closed the clinic and had all staff present when we delivered our CTA report. Staff at all levels participated actively, asking questions and discussing action plans. They included us in their planning, communications, and meetings, and actively sought our consultation and support. In followup interviews they reported executing a number of the strategies presented in our CTA consultation report, in particular those that involved more formal problem detection and monitoring, replanning, and coordination. They invested the staff time, meetings, and resources recommended. Their initial implementation had failed due to burdensome multiple redundant workarounds for technical problems in the CQMS and in their Internet connectivity, and lack of confidence in the data resulting from both the technical problems and the patchwork fixes. Over the course of our involvement with them they substantially improved their problem detection and monitoring, replanning, and sensemaking processes, becoming steadily less dependent upon our support.

Figure 1 presents chart review data from FQHC C's UDS reports. Our CTA consultation was delivered in August of 2011. Prior to that time they were recording only rates of eligible patients receiving cervical cancer screening (Pap) and hypertension patients at goal BP (HTN-C). With the initiation of the CQMS they immediately used its reminder function to support their QI efforts on asthma action plans (AAP), a high-priority condition for their site due to the high frequency of emergency visits for asthma exacerbations. In 2012 they implemented CQMS reminders for several other conditions. They achieved high rates of performance of lipid lowering therapy (Lipid) and aspirin (ASA) for coronary heart disease patients, and relatively high rates of colorectal cancer screening (CRC) as well.

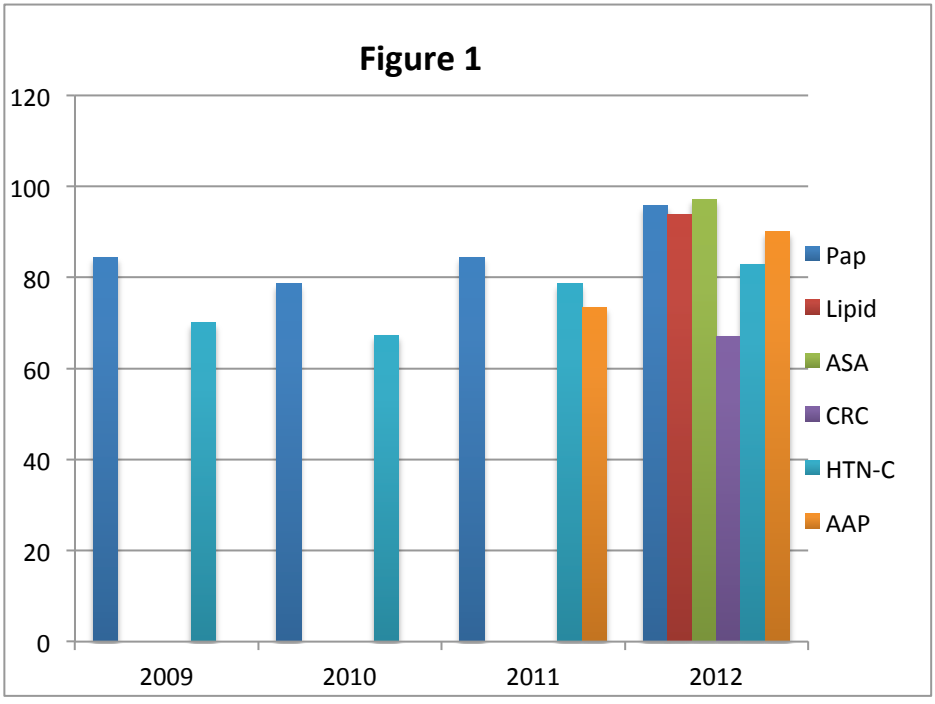
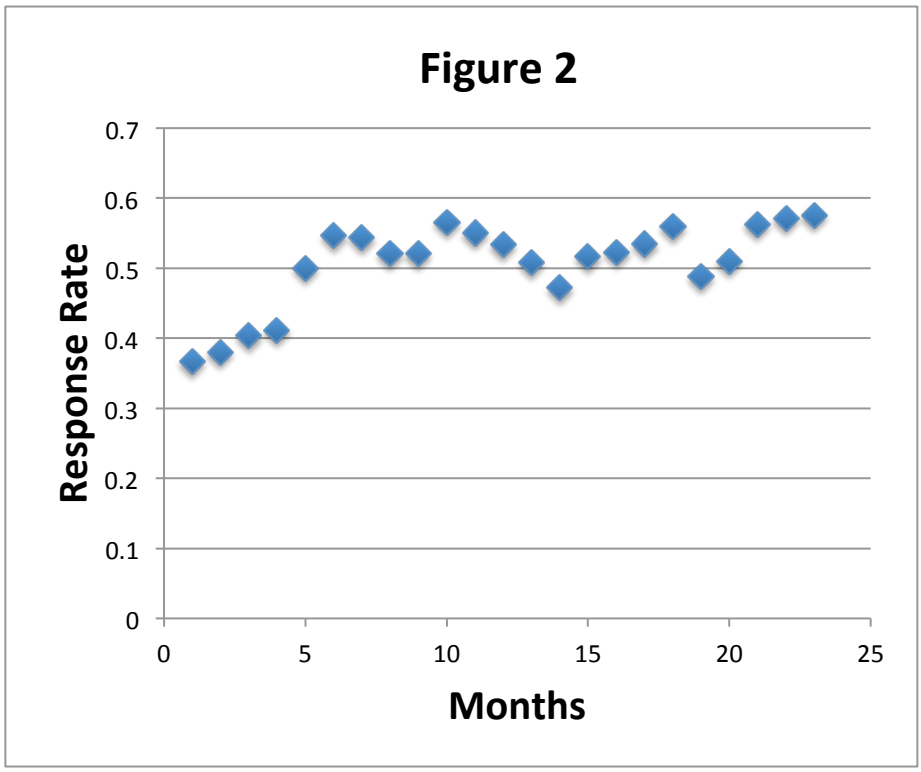


Figure 2 presents the providers' response rates, that is, per reminder issued by the CQMS what fraction of the clinical actions were taken in response. The response rate rose quickly after launch and remained at a sustained high rate throughout the project.

There was a clear trend across time between the FQHCs as we used the sequential case design to "titrate" our level of involvement to success in implementation. FQHC A had major macrocognitive function deficiencies. We identified them and provided a consultation report with explicit recommendations for mitigating them. That was clearly not sufficient. There were cultural barriers in that FQHC that impeded use of the consultation report as well, so it is not clear that anything short of effectively taking over the practice (as the hospital ultimately did) could have been effective. However, our experience suggested to us that more direct assistance targeted at identified macrocognitive function deficits was called for. Accordingly, we worked more intensively with FQHC B. FQHC B had overall relatively good macrocognitive function, and with modestly more involvement on our part than with A, failed to launch only due to events beyond our or their control. FQHC C had significant macrocognitive function deficits but a culture that was open to (even eager for) coaching in remedying them. Our team assumed the role of macrocognition coach for them, and was able to help them learn those macrocognitive skills. They were then able to function independently.



Our conclusion is that CTA and the macrocognition framework apply in health IT implementation in a manner similar to other high-stakes, time-pressured expert team environments. The impetus for the genesis of CTA was in large part the recognition that attempts to improve the performance of teams by using information from interviews and observations of the best teams was having limited success.[17–19] CTA was developed in part to capture the "active ingredients" that were being missed, and has a long track record of success in doing so. In other settings that has been shown to result in more effective intervention than less structured approaches.

In the present setting, we did not have a comparison against other approaches; as pointed out in the first paragraph of Methods, this is a plausibility-level not probability-level design. Within that constraint the macrocognition approach appeared to provide a useful level of detail, specificity, and focus on a very specific set of skills and functions (Table 1) that have been shown to be crucial determinants of teams' effectiveness. It might be considered as a more rigorous formulation of the concept of capacity for change–one that is actionable, in that a set of time-tested intervention tools is available. It enabled us to focus our coaching efforts on building teams' function in specific well-defined skills areas, to good effect.

Returning to our research questions, we identified barriers and facilitators and discussed the impact of CTA tools on understanding and addressing them. The CQMS was associated with a high level of performance on indicators that were targeted with its reminders, though we cannot prove causality in this project. Finally, CTA was readily applied and sustained, acceptable to practices (the process was acceptable even where its results were not applied), and plausibly effective in the safety net primary care setting.

More broadly, the macrocognitive functions that CTA evaluates are of great importance for practices, in this period of rapid transformational change in primary care. This project demonstrated that CTA can identify specific deficits in those functions, and CTA-guided intervention can improve a team's skills at those functions, in primary care as it has in other areas of knowledge work. That suggests that the large body of literature on CTA does generalize to primary care, and could add significant value to practice facilitation or change management efforts.

LIST OF PUBICATIONS AND PRODUCTS

Peer-Reviewed Publications

Potworowski,G, Green, LA. *Cognitive Task Analysis: Methods to Improve Patient-Centered Medical Home Models by Understanding and Leveraging its Knowledge Work.* Rockville, MD: Agency for Healthcare Research and Quality. February 2013. Publication No. 13-0023-EF.

Green LA, Potworowski G, Day A, May-Gentile R, Vibbert D, Maki B, Kiesel L. Sustaining "meaningful use" of health information technology in low-resource practices. *Ann Fam Med*, in press.

Publications in Preparation

Green LA, Potworowski G, Day A, May-Gentile R, Vibbert D, Maki B, Kiesel L. Macrocognitive skills and health IT implementation: a mixed-methods comparative case study. Anticipated submission November 2014.

Peer-Reviewed Presentations

Green LA, Potworowski G, Day A, Vibbert D. Increasing HIT implementation success by applying cognitive task analysis to improve change management skills. 41st North American Primary Care Research Group (NAPCRG) Annual Meeting, Ottawa, Ontario. November 2013.

Potworowski G, Green LA. Using cognitive task analysis to facilitate HIT implementation by assessing change capacity and readiness for change. Society for Industrial and Organizational Psychology. Honolulu, Hawaii. May 2014.

Green LA, Potworowski G, Day A, May-Gentile R, Vibbert D, Maki B, Kiesel L. Can "meaningful use" be sustained in low-resource practices? 42nd North American Primary Care Research Group (NAPCRG) Annual Meeting. New York, 2014.

Invited Presentations

Green LA. Early experience with cognitive task analysis for HIT implementation support. AHRQ Annual Health IT Grantee and Contractor Meeting. Washington, DC. June 2010.

Green LA. Cognitive Task Analysis as a Change Management Tool for Health IT Implementation. In AHRQ webinar, *A National Web Conference on Managing Change to Achieve Successful Health IT Implementation,* 15 July 2014.

Subsequent Projects

Funded

Assisting Family Practices in Alberta with Transformational Change. Green LA (PI). Funding: Alberta Innovates – Health Solutions, Jan 2014-June2017. This project uses the findings of the original project, and the CTA methodology, to assist a primary care network (19 practices) with a broad range of change initiatives, including but not limited to health IT.

Maximizing Care Management Effectiveness in Primary Care. Holtrop JS (PI); Green LA (co-I). Funding: AHRQ 1 R18 HS022690-01A1. This project uses the CTA methodology and training program from the original to study the integration of care managers into primary care practices in Michigan and Colorado.

Proposed

Teaming Up To Identify Integrated Chronic Disease Management Models For Small Urban, Rural And Northern Communities. Oelke N (PI); Green LA (site PI). Funding: under review at Public Health Agency of Canada. This project uses the CTA methodology and training program from the original to study success factors for potential knowledge translation for chronic disease management programs in rural and remote communities.

Capturing the Expertise Developed for HIT Implementation Support in Low-resource Primary Care Settings. Potworowski G (PI); Green (co-I). Submitted to AHRQ for R21 FOA PA-14-001. This project will combine the CTA methodology from the original project with a novel application of Natural Language Processing to follow up questions arising from the original project.

Other Work Product

Cognitive Task Analysis in Primary Healthcare. 2-day intensive training workshop for experienced health care and research personnel (Master's in relevant discipline, or Bachelor's and substantial experience, required). Presented on 5 occasions; personnel trained for four research projects, one US healthcare payer, and one Canadian government agency. Two future sessions scheduled.

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