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VISTA/CPRS AND THE VETERANS HEALTH  
ADMINISTRATION

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# **Understanding Methods for Reducing Redundant Medical Lab Test Ordering – A Case Study on VistA/CPRS and the Veterans Health Administration**

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## **Abstract**

*Reducing redundant medical lab tests has been discussed in the literature as a cost saving benefit of Electronic Health Record (EHR) adoption; however the literature does not provide a great deal of information on the mechanics of achieving this goal. Laboratory ordering using an EHR occurs within a complex socio-technical context that can be difficult to understand. A case study was performed on an EHR that provided insight into the interplay of these elements as well as the current state of laboratory ordering guidelines. A theoretical framework, including the Principle of Good Enough (POGE,) for technology design was used to guide the research. The result improved insight into required technological capabilities to support clinical care and the environmental contexts that shape them.*

*Keywords: Electronic Health Records, Structuration Theory, Open Source*

## **1. Introduction**

Healthcare is a very information intensive discipline. Current paper-based systems are becoming dysfunctional in light of evolving demands. Electronic Health Record systems (EHRs) are currently being sought as the solution to problems in health information integration, efficiency, dissemination and storage by various healthcare organizations (IOM, 2001).

Although many healthcare facilities have some computerization to varying degrees, few have attained fully integrated systems that are able to exchange data across facilities. One of the most notable exceptions has been the Veterans Health Administration (VHA) and its VistA/CPRS system. VistA/CPRS supports 155 medical centers and over 1400 centers of care. Vista/CPRS is an open source, publicly available EHR that has been adopted outside the VHA by other healthcare organizations in the US (Maduro, 2007b) and in other countries (Maduro, 2007a). As an organization, the VHA has had extensive experience and opportunities for “lessons learned” from developing, using and maintaining electronic health records.

Results management and reducing redundant lab testing is one of the core functionalities for an EHR specified by the Institute of Medicine (IOM) as a potential cost saving benefit of EHR adoption (IOM, 2003); however the literature does not provide a great deal of information on the mechanics of achieving this objective. This study focused on analyzing the issues and contexts that shape lab ordering problems as well as key technological capabilities supporting this healthcare function within the VHA.

## **2. The problem of redundant lab orders**

One reason physicians may repeat laboratory orders are simply because previous results cannot be found. In paper based hospital records, a single patient record may span several bound volumes all of which might not be immediately available because they are in the hands of different healthcare providers. Immediate and simultaneous accessibility are basic advantages of an EHR over paper records. This also reflects the preference for “everything being in one place” that was cited by several physicians interviewed for this study.

According to the literature on medical cost containment for laboratory ordering, different types of interventions have been tried with varying levels of success. Educating physicians on lab test costs has shown some short-term improvements (Stuebing and Miner, 2011) ; however these behaviours have been observed to drop off over time (Eisenberg and Williams, 1981) or otherwise not to be an effective cost containment strategy (Schroeder et al., 1984). Eisenberg and Williams (1981) concluded that, with special emphasis on outliers – physicians with significantly higher levels of laboratory orders - feedback was an effective mechanism. However, the auditing and reporting mechanisms of the day incurred their own costs and thus diminished the total cost savings (Eisenberg and Williams, 1981). The improved access, reporting and data visualization capabilities of VistA/CPRS, presents a new opportunity to examine redundant lab ordering problems and possible solutions.

## **3. Theory**

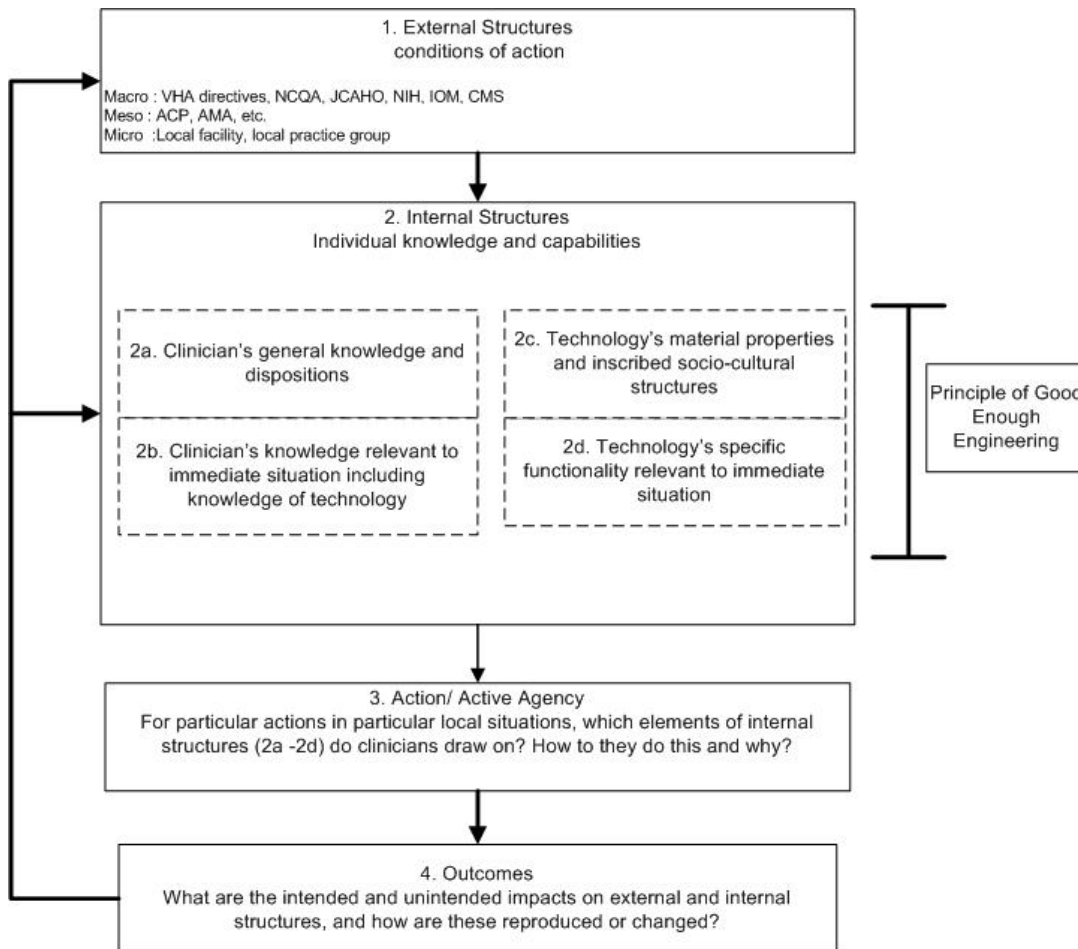
The relationships between healthcare information systems and clinical practice comprise a complex socio-technical environment. The context of the healthcare environment as well as the IT artifact requires study, the latter of which tends to be under theorized in the literature (Greenhalgh et al., 2009, Greenhalgh and Stones, 2010). Clinician behavior as well as functional

properties of the healthcare record interacts within the healthcare organization and its regulatory environment. Quantitative methods may be insufficient to understand the interplay of recursive relationships between a healthcare organization and its technology (Kaplan and Duchon, 1988) (Kaplan, 2001). Kaplan and Duchon (1988) have noted that many uncontrolled and unknown variables occurring in complex social systems are problematic when using quantitative methods in natural settings. The reductionism needed for quantitative experiments may reduce the research question to the obvious and sacrifice a deeper understanding of the phenomenon (Kaplan and Duchon, 1988). Therefore, a qualitative case study methodology was used in conjunction with a theoretical framework to provide contextual reference to technology supporting laboratory ordering and clinical records.

Structuration Theory, developed by Anthony Giddens (1984) provides an explanation of the reproduction of social systems through social actions (Giddens, 1984). This theory has been extended in Information Systems (IS) research to include the element of technology and the reciprocal effects of human interactions with technology (Orlikowski, 1992). This theoretical orientation provides advantages for studying the interplay of the EHR (VistA/CPRS) and the clinicians of the VHA. VistA/CPRS was built from within the healthcare organization of the VHA. As such, it is the result of the internal constructs of the participants – the clinicians who use it – and “constitutes a [mode] of human practice” as described by Structuration Theory (Orlikowski, 1992).

While Structuration Theory is a useful basis for describing the interactions of social structures with technology (Orlikowski, 1992), a framework by Greenhalgh and Stones (2010) was adapted to provide more theoretical focus on the technology component (Greenhalgh and Stones, 2010). Their framework using “Strong Structuration Theory” utilizes conceptual components to differentiate properties of the technology artifact within the network of human technology interactions including integration of principles taken from Actor Network Theory (ANT) (See Figure 1).

VistA/CPRS has been described by physicians in the VHA as having achieved a “Good Enough” level of functionality. This provided the opportunity to further structure the analysis by adding the “Principle of Good Enough” (POGE) in software design as an element of the analysis framework. As proposed by Yourdon (1995), POGE proposes the rationale that “good enough”, rather than optimization of all software properties can be a desirable goal, particularly in the commercial sector where economic realities are often their final determinants of software quality (Yourdon, 1995). The resulting focus for the study can be seen in Figure 1 where the framework of Strong Structuration Theory (SST) developed by Greenhalgh and Stones (2010) has been adapted to include the lens of POGE with which to examine the technology artifact.



Recursive relationships between clinicians and technology

Figure 1. Strong Structuration Theory by Greenhalgh and Stones (2010) adapted with the added focus of the Principle of Good Enough (POGE).

### 3.1 The Theoretical Lens – the Importance of Context

Contextualizing healthcare using an EHR is particularly important, given the highly regulated nature of healthcare and the influence of policy making institutions including a current emphasis on government subsidies for health IT. Healthcare organizations in and of themselves are complex entities. This backdrop is important as it affects the interactions of clinicians and the EHR.

Strong Structuration Theory (SST) provided a method both for examining and describing these forces. While SST includes principles taken from Actor Network Theory (ANT), it includes caveats regarding the frequent objections to ANT such as the perception of symmetry between people and technology in the network of interactions between the two. SST also accepts that social order can be inscribed in and magnified by technology; however the limits of this should be recognized. Finally, SST emphasizes the recursive shaping of the socio-technical network, but rejects reducing human factors to network effects. Instead, SST utilizes conceptual components to

differentiate properties of the technology within the network of human technology interactions (See Figure 1, elements 2c and 2d).

Placing these elements in context includes the external structures (Figure 1, level 1) described as Macro, Meso and Micro (Greenhalgh and Stones, 2010), respectively the oversight branches of the US government and healthcare monitoring agencies such as the Joint Commission on the Accreditation of Healthcare Organizations (JCAHO), National Committee on Quality Assurance (NCQA), National Institute of Health (NIH) and Centers for Medicare and Medicaid (CMS). Also included are professional practice organizations affecting healthcare delivery such as the American College of Physicians (ACP), American Medical Association (AMA) and finally facility level regulations and guidelines.

Level 2 of Figure 1, provides focus on theorizing human factors including the “instantiation” and “appropriation” of technology (Greenhalgh and Stones, 2010) (Figure 1, elements 2a-2d). For this research, POGE was applied to the level 2 elements to improve focus on the essential technology elements. Level 3 of Figure 1 is used to examine the interplay of action and agency between the clinician’s knowledge and situations that interplay with the EHR. This framework level was proposed to answer criticisms of ANT in that elements of human and technological interaction are under-theorized (Greenhalgh and Stones, 2010).

Level 4 of Figure 1 is for describing the outcomes of the socio-technical interactions on healthcare delivery including unintended consequences or “E-Iatrogenesis” (Koppel et al., 2005b). For this research, outcomes reflect care delivery effects rather than patient outcomes. This includes co-opting the EHR to perform functions not part of the original design. A benefit of the approach is to gain a reference point for examining the current evolutionary effects resulting from the interplay of the socio-technical system.

A summary diagram was created to illustrate the convergence of the guiding theory and data sources used (See Figure 2). This diagram was used as a mental reference during data collection to help identify the flow of dynamic elements in the socio-technical environment.

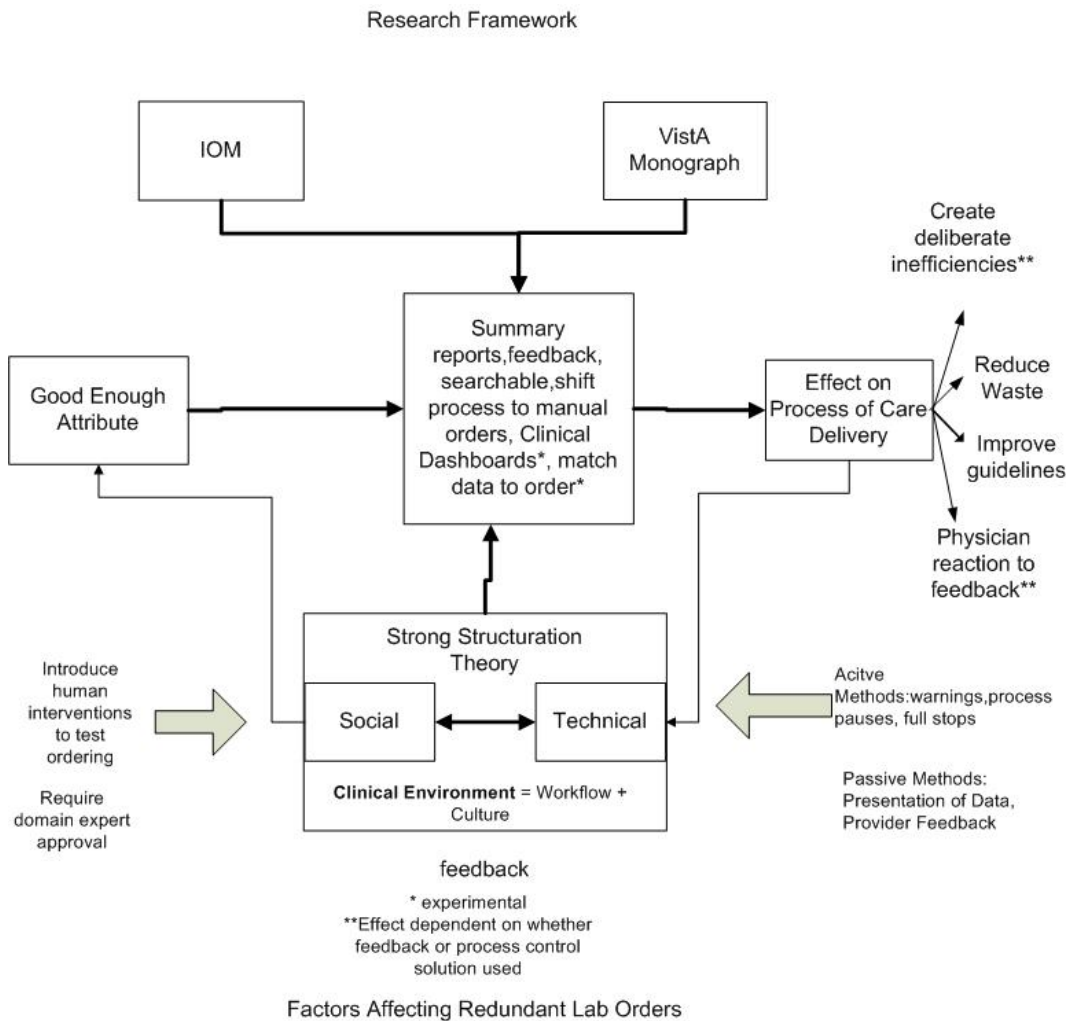


Figure 2. The Research Framework and Issues Related to Redundant Lab Ordering

## 4. Methodology

The research activities were divided into three primary phases:

1. Background analysis of VHA generated documentation
2. A focus group interview
3. Individual Interviews

In addition, documentation from the Institute of Medicine (IOM) with specifications of required capabilities for EHRs (IOM, 2003) was used as a baseline comparison to VHA specifications on VistA/CPRS, the VistA Monograph (VHA, 2008-2009). IOM specifications and VistA/CPRS properties were mapped in a side-by-side comparison using open source software for cognitive

mind-mapping. This was to test the comprehensiveness of VistA/CPRS as an EHR. This comparison was used to fulfil the requirement to define external structures driving EHR specifications (See Figure 1, box 1). The three phases of data collection followed the principles of case study methodology prescribed by Yin (1994). This methodology includes convergence of multiple sources of evidence and investigator triangulation of data in the analysis process (Yin, 1994). In this study, the sources of evidence used for triangulation included multiple types of VHA documentation on VistA/CPRS and interviews with VHA clinicians. Interview subjects were chosen for their expertise on different VistA/CPRS capabilities.

The three phases occurred in sequential order. In the first phase, analysis of VHA documents was used to develop major categories for further investigation. Due to the enormous scope of the VHA and its use of an EHR, the background documentation was analyzed to limit the research scope to a smaller number of specific categories. The documentation that was analysed included funded VHA improvement initiatives (Greenfield projects), VHA documentation on continuing technical work and improvements being made to VistA/CPRS and the results of a VHA contest on “Top 100 Innovations”. The latter was a contest wherein VHA employees suggested and voted on ideas to improve the EHR and other aspects of healthcare delivery. For this research only the suggestions directly pertaining to the EHR were used.

During phase one, the documentation was analyzed using Atlas.ti software to identify recurring concepts using grounded theory approach of coding text to develop conceptual categories (Strauss and Corbin, 1990). These categories guided the subsequent qualitative interviews in phases two and three. This process was applied at each phase to determine points of data triangulation.

In phase two, the focus group was conducted using the key concepts identified in phase one as a guide for more in depth investigation and to determine if any new categories emerged. This was then followed by phase three in which topics developed in phases one and two were examined in depth with subject matter experts. During this iterative process, the organizational goal to reduce unnecessary testing (redundant lab ordering) emerged as a concern. This topic was investigated in more depth during interviews with a clinical subject matter expert.

#### **4.1 Research Subjects**

Qualitative data was collected through a focus group with 12 participants and six individual interviews. The focus group consisted of 6 M.D.s, (5 male, 1 female) 6 Nurses (5 female, 1 male). The individual interviews were with 4 M.D.s (2 male, 2 female) and 2 nurses, both female. The interviews were conducted with individuals who were very knowledgeable about the EHR properties determined to be key points for the study. The participants were interviewed using semi-structured questions. These results including possible solutions are presented in the next sections.

### **5. Improving feedback mechanisms for clinicians**

As discussed under section 2, earlier attempts to control redundant testing were difficult due to the lack of integrated EHR systems with good reporting mechanisms. With VistA/CPRS, data extraction has become more efficient and it is possible to generate physician report cards on laboratory utilization. Clinical Dashboards that provide summary reports on EHR data extracts are currently being developed at the VHA. Currently, they are used to help physicians monitor the overall patient outcomes for their assigned patient panels. For example, they can see on average, how well their diabetic patients are maintaining their glucose levels. A physician was asked whether the Clinical Dashboards have been used to address test ordering issues:



“So, some of it is cultural probably. I mean I would think that one way to avoid redundant test ordering would be to provide feedback to people on outliers. Like, you know, you’re an outlier for CBCs. Like, compared to the average provider, with the same number of patients on their panel, you know, you’re ordering - you ordered 20% more CBCs per year ... Report cards on that might be something that could help.”

As can be inferred from the above, the “culture” of the practice of medicine, including physician autonomy, is part of the socio-technical fabric surrounding replicated lab ordering. Feedback is a passive method to elicit voluntary provider change – assuming there are no organizational sanctions based on the reports.

## 6. Control Mechanisms and Physician Behavior

A more direct method to prevent redundant orders is to provide physicians with a warning. This method is subject to the same alert fatigue problems described elsewhere in the literature (Koppel et al., 2005b, Koppel et al., 2005a, Kyle et al., 2010). As described by a Physician:

“... There’s a functionality that allows you to warn someone, to warn them that they’re ordering a duplicate study – meaning that there’s already an existing lab order for it or the study’s been resulted. ... So Lab has the ability to try to prevent you from ordering unnecessarily frequent labs. So how well does that work? Well, [name omitted] said the providers just override it. Part of it is probably just alert fatigue. Part of it is that it might not display to you the result, and the exact date that it was done.”

The presence of an EHR at the VHA creates the opportunity to explore new mechanisms for cost control beyond those commonly found in the literature. The EHR is generally thought of as a tool to introduce efficiency in healthcare; however it is conceivable that using it as a means to introduce inefficiency could be used as a cost control method. These methods include:

- Removing items from the menu – force use of more laborious process
- Require additional levels of review or approval
- Require more information to process order
- Full-stops on ordering process

According to one subject, full-stops for attempting to order a lab are not in place. “There are no full stops on lab tests – not for the routinely ordered ones. I mean certainly there are send out labs, where there’s more oversight just because they’re more expensive, but for your routine labs that we can run in our system? No - there’s no stops.”

Using more active methods can introduce new tensions into the socio-technical environment with regard to physician autonomy. As explained by a research subject, there can be clinically justified exceptions that do not fit the algorithm requiring an override and various follow-up processes to ensure patient safety. In contrast, for the medication order check, the basic functionality supports a more conservative approach. The preferred error is to be overly cautious, that is, to prevent an action.

However, laboratory ordering is a different case. Lab results provide the clinician with information to support clinical decision making and as a safeguard for patient care. Therefore, setting prohibitory conditions on lab orders can be more difficult to justify. In these cases, the

override is to maintain patient safety. This question was corroborated by a physician: "... that's why that's a warning system, you're allowed to override it."

## **7. Lack of Evidence Based Guidelines to Reduce Redundant Testing**

While the EHR can be used to directly intervene in lab ordering practices, the medical literature has not developed clear, evidence-based guidelines for developing the necessary algorithms. There are many potential clinical justifications for repeat ordering. A Physician explained that currently there is not a great deal of evidence in the medical literature to determine optimal frequencies for lab ordering:

"Like what's the next set of tests – what parameters should we put around ordering some of these other tests? Like how frequently should a patient get an ANA tested? It's an anti nucleotic – serology – that you use to assess for Lupus or something like that. If the ANA's negative – it's not going to turn positive ... you probably wouldn't have to order an ANA - ever order it more than once a year if even... and you would probably never order it ... if it's negative, it's almost always negative unless the patient really developed some full-blown symptoms. It's a funny thing. So, but you'd have to sit down with the clinical experts and work out the parameters for those. I don't think anyone has done that<sup>1</sup>."

EHR development in this area may have to be postponed until there is more evidence to guide algorithms for lab testing controls in the EHR. Other problems related to improving cost effectiveness of laboratory testing is a lack of data on the cost effectiveness of diagnostic and therapeutic services (Eisenberg and Williams, 1981). Exceptions to standard guidelines occur when a physician must give a medication despite there being contraindications and therefore, must follow the patient with more frequent testing.

While, the availability of labs in the EHR can help to avoid redundant tests by making the results more retrievable, finding the pertinent data within an ever growing patient record can work against the efficiencies of "having everything in one place". A Physician described the need to improve the presentation of relevant data: "Rather than now if I have a diabetic and I'll look at the notes I'll see what's been done and then I have to go look at the labs, and then I have to go to the consult to see if an eye exam was done. If I'm smart enough I'll look at the reminders to look at that stuff – there's lots of places you have to look." More work is necessary to determine whether improving the search capability and presentation of data will be preferable to developing algorithms to reduce lab redundancy.

## **8. Continuing Development of the EHR**

The VHA is currently developing the next-generation of VistA/CPRS. A Physician was asked what would be some of the most desirable elements to help prevent redundant ordering:

"So I think the goal of the next generation, is to have a screen that will sort of – when you open it up to the patient, you get a snapshot of the relevant things for that patient. And I think that by having that kind of a view - probably go a long way to avoiding redundancy. Because you wouldn't specifically have to look for stuff – you know it would be there for you."

Suggestions for improving the presentation of data are not surprising and are consistent with comments made by other physicians for notifications and alerts. Although the data is readily available in the EHR, large volumes of clinical notes and reports are making it increasingly difficult for physicians to find what they are looking for. It is also notable that the physicians

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<sup>1</sup> This observation may be limited to the local facility as opposed to the entire VHA.

interviewed have tended to suggest view-ability and accessibility over EHR-generated control mechanisms as remedies for increasing complexity.

A physician pointed out that waste related to lab ordering may be as much a problem related to clinical guidelines as redundancy. A suggestion was made to use improved decision support as a method to combat the problem:

“I think ... moving toward specialized menus for ordering some of the more complex things, that's ... in the future, in order to order this you have to go through - you have to come to this menu and – to order this test. And ... so by using sort of menus that drive you through a decision tree, OK, I think that you'll get better results at the end. So that's something that we're going to start working on. For some of these more complex and expensive tests, where it's not as clear why they should be ordered. Trying to send people through a decision tree that helps to determine whether it's really necessary to order - so it's not really redundant test ordering, its unnecessary test ordering.”

The problem of redundancy and waste in lab ordering is a more complex issue than record keeping and data availability. A lack of clear evidence and guidelines in the medical literature adds to the confusion as to what constitutes appropriate test frequencies. The complexity of the lab tests may require additional decision support provided by EHR algorithms. This is an area where outcomes data generated by the EHR can be part of a feedback process to generate future EHR design.

## 9. Discussion

The research results contextualized by the framework illustrate the need to improve display capabilities and clinician feedback as tools for combating redundant lab ordering. This is particularly useful information given the problems with using control mechanisms and clinician education to regulate this clinical activity. The lack of clear evidence based guidelines for lab reporting frequencies and the required flexibility for justified exceptions, suggests improved visualization and decision support tools may be a preferable solution. Due to the increasing size of individual medical records, improved search ability will also be an important part of data presentation.

While the introduction of deliberate inefficiencies may provide a more active level of control, the effects on clinician autonomy and knowledge (Figure 1, items 2a and 2b) will introduce new tensions in the socio-technical network. This may also undermine the traditional role of consultations with clinical specialists (Table 1, item 2 a-b) that would be detrimental to safety checks in the care process.

The EHR is able to support record keeping in an accessible manner for physicians. This basic retrievability of results data helps prevent waste. However, optimizing laboratory utilization is a more complex issue involving interactions between professional disciplines and requires a clear set of guidelines to govern test ordering. In this EHR study, we have seen the socio-technical use of the EHR can be used to drive the physician to seek the approval of a human gatekeeper in order to carry out an action. This raises questions regarding the human engineering that may be needed to optimize utilization efficiency. Perhaps reallocation of human checks and balances that have been a traditional part of healthcare will be part of the EHR design solution.

Strong Structuration Theory provided a disciplined methodology for iteratively examining a variety of primary and secondary sources of data. SST facilitated examination of both the external factors shaping requirements for EHR capabilities as well as the knowledge and dispositions of clinicians who interact with the technology. The explicit subdivision of internal structures into both human actions and properties of technology enabled an additional level of focus on

minimum or “good enough” EHR properties. The focus on best effort delivery is more closely aligned with the current state of VistA/CPRS capabilities.

An additional advantage of Strong Structuration Theory is the inclusion of the principles of Actor Network Theory while rejecting the view that people may be viewed as equal or even passive participants in interactions with technology. The latter aspect is particularly important for the study of healthcare systems since individual clinical judgement is required when there are still no evidence based practices to guide development of rules for EHR systems. Physicians still retain the right to autonomy and use of personal judgement in clinical practice. Acknowledgement of human effects on socio-technical networks is relevant when studying home-grown EHRs such as VistA/CPRS since VHA clinicians directly affected both the initial design as well as continuing development.

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