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Eliminating paper: Quantifying the impact of Computerized Clinical Documentation Systems (CCDS)

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Eliminating paper: Quantifying the impact of Computerized Clinical Documentation Systems (CCDS)

Abstract

In 2004, President George Bush announced his plan to ensure that most Americans have electronic medical records (EMRs) within the next ten years. Since then, many have vociferously argued that the transformation in health care can occur only with the widespread adoption and diffusion of EMRs throughout the healthcare value chain. We are now 4 years past the initial mandate but unfortunately, key players in the healthcare system, from hospitals to physician practices, have lagged behind considerably in adoption rates. Why has the adoption of EMRs in clinical settings been so slow? Our focus is on two key drivers of slow diffusion: one, the business case for the technology has not been rigorously and unequivocally constructed for stakeholders, and two, we lack a clear and detailed understanding of the changes to clinical routines and workflows that these technologies cause. To provide evidence related to the value of EMRs, our research program is focused on conducting studies that aid in the quantification of impact, and illuminate the barriers and facilitators of EMR adoption and use by clinicians. We report the findings from a study designed to assess the impact of implementing computerized clinical documentation system (CCDS) in the Children's National Medical Center in Washington D.C, a free-standing tertiary care pediatric hospital. We conducted a physician time-motion study and a series of clinician surveys to quantify the impact of electronic clinical documentation in a rigorous and systematic way.

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1. Introduction

In 2004, President George Bush announced his plan to ensure that most Americans have electronic medical records (EMRs) within the next ten years. Since that time many have vociferously argued that the transformation in health care can occur only with the widespread adoption and diffusion of EMRs throughout the healthcare value chain. We are now 4 years past the initial mandate, and about a decade away from the time projected for universal digitization. Unfortunately, key players in the healthcare system, from hospitals to physician practices, have lagged behind considerably in adoption rates. Recent data suggests that over one third of the hospitals in the US do not even have the underlying infrastructure necessary for the successful adoption of an EMR (HIMSS Analytics, 2007). Strikingly, the US is trailing behind other developed nations in physician adoption of EMR, with projections suggesting that at the current rate of adoption, it may take up to another 30 years for the EMR to completely diffuse among clinicians (DerGurahian, 2008). A recent study of over 2,700 physicians found that only 4% have a fully functional EMR, and 13% a basic system (DesRoches et al., 2008).

Why has the adoption of EMRs in clinical settings been so slow? Many plausible explanations have been offered for this phenomenon, ranging from financial incentives and required investments, to concerns about privacy and security, to unclear return on investment, to the fact that the EMR is an inherently disruptive innovation that causes major changes in workflow and existing practices, making the technology extremely complex to implement successfully. Our focus is on two of these drivers of slow diffusion: one, that the business case for the technology has not been rigorously and unequivocally constructed for stakeholders, and two, we lack a clear and detailed understanding of the changes to clinical routines and workflows that these technologies cause. Hospital systems need better data to convince them that EMRs will deliver on their value potential of improving the quality of care and reducing costs. Likewise, clinicians need to be convinced that the initial effort expended in learning to use the new technology as well as changing the way in which they conduct their work will be offset by longer-term benefits related to quality patient care delivery and efficiency.

To provide evidence related to the value of EMRs, our research program is focused on conducting studies that aid in the quantification of impact, and illuminating the barriers and facilitators of EMR adoption and use by clinicians. In this paper, we report the preliminary findings from a study designed to assess the impact of implementing computerized clinical documentation system (CCDS) in hospitals. The setting for the study is the Children's National Medical Center in Washington D.C, a free-standing tertiary care pediatric hospital. We conducted a physician time-motion study and a series of clinician surveys to explore the consequential nature of clinical documentation and quantify the impact in a rigorous and systematic way. In our study we found the CCDS has a positive impact on the quality of information, as well as on the efficiency of clinicians. We also found some unexpected ways in which clinician routines change, and some unanticipated effects of the CCDS that were not originally envisioned. We believe that findings from such studies can help accelerate the diffusion of EMRs by addressing the skepticism related to "what's in this for the hospital and the physician?", and also providing guidance on strategies for successful implementation.

2. Background and prior CCDS research

The EMR is not a unitary piece of software or electronic repository of data; rather, it is a complex collection of modules with distinct functionalities. As shown below in figure 1, the core components of an EMR system include Computerized Provider Order Entry (CPOE), Decision Support systems (DSS), Results Management (RM) and Health Information and Data, in which CCDS provides documentation functionalities and a centralized information repository for patient data obtained from clinician observations and decision processes (Davidson et al 2004). CCDS replaces paper based progress notes, history and physical examination notes, discharge summaries, procedure notes and data flowsheets used by nurses and other ancillary healthcare providers. CCDS supports simultaneous access to legible information by multiple individuals, flexible visualization of patient data, automatic collation of information, and generation of reports.

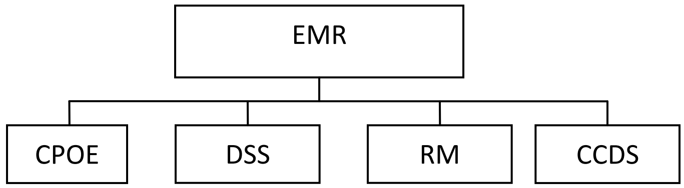

Figure 1: Core components of an EMR system*

*: based on the advisory panel to the federal government's HIT Adoption Initiative

The value potential of a CCDS is multi-dimensional:

- Improve legibility of information;
- Improve availability of information;
- Improve information accuracy;
- Increase the timeliness of information;
- Enhance information sharing;
- Support more flexible workflows

Although CCDS are beginning to take on a more prominent role in the delivery of both inpatient and outpatient medical care, despite their significant potential, the adoption of CCDS is not at the level envisioned five years ago. As suggested above, this may be a result of the paucity of information available regarding the advantages and challenges associated with the adoption of computerized documentation in the replacement of paper-based notes. Though adoption rates for computerized documentation can be rapid (Payne et al. 2006), acceptance is not always without costs. A 2004 study in the VA hospital system noted both advantages and disadvantages to the implementation of computerized documentation (Embi et al. 2004). Advantages included improved documentation availability, legibility and education opportunities. Disadvantages focused on the quality of the notes and negative impacts on workflow and communication. A 2006 editorial noted that in one institution, electronic documentation had resulted in "bloated and obfuscated" notes, "awkward" wording and carrying forward wrong information via "copy and paste" functionality (Hirschtick, 2006).

While general EMR adoption is lagging, the impact of CCDS on physicians has received less attention compared to that of CPOE and Decision Support Systems. Among the few studies focused on this technology, results have been mixed. Some reported that CCDS improved decision making (Tang et al 1999) and the quality of nursing documentation (Ammenwerth et al. 2001, Fraenkel et al. 2003, Mahler et al. 2007, Menke et al. 2001), but another study found no significant differences on the accuracy of paper versus electronic documentation in the emergency care department (Silfen 2006). Others reported a higher incidence of errors as a result of CCDS implementation (Carroll et al. 2003, Weir 2003). As to the impact on efficiency, results have been similarly mixed. While a flurry of research has failed to find any reduction in the time spent on various processes such as clinician-patient encounters or documentation procedures (Apkon and Singhaviranon 2001, Menke et al. 2001, Christensen and Grimsmo 2008, Hakes and Whittington 2008, Pizziferri et al. 2005, Lo et al. 2007, Poissant et al. 2005, Smith et al. 2005, Sullivan and Mitchell 1995), another study reported a reduction in nursing documentation time during registration (Bosman et al. 2001).

The lack of firm evidence of the impact of CCDS on healthcare quality is impeding the adoption of CCDS. The purpose of this study is to provide evidence on the following important questions about CCDS in a rigorous and systematic manner:

- How does CCDS impact information quality?
- How does CCDS impact efficiency in care delivery?
- What is the impact of CCDS on work routines in a hospital setting?
- What factors influence physicians' assimilation of CCDS?

3. Study design

Setting
We conducted the study within Children's National Medical Center, an academic tertiary care pediatrics hospital, over a period of 6 months. This hospital has 283 beds, 13,047 annual admissions, 346 physician faculty, 195 physicians in training and 992 nurses. The hospital implemented its first phase of EMR in Fall 2005 with an integrated CPOE, pharmacy information system, electronic medication administration system, results reporting platform and DS. In May 2008, it implemented the second phase of EMR, the CCDS. This study was approved by the hospital's institutional review board.

Methods
We defined three major periods for data collection: The Pre-Implementation Period occurred one month prior to the CCDS implementation: The Transition Period occurred 8 to 10 weeks after implementation; and the Post-Implementation Period will occur 6 months after implementation. To date, we have completed data collection for the first two Periods. We employed both a time-motion study and multiple user surveys to obtain detailed measures on the impact of CCDS.

Surveys
A series of user surveys were administered both the Pre-Implementation and Transition Periods. In the Pre-Implementation Period, two surveys were conducted (before and after CCDS training sessions). Prior to training, the survey questions focused on obtaining physician and nurse assessment on the information quality of paper-based clinical documents. After training, the survey questions focused on understanding physician and nurse attitude towards the adoption of the new CCDS system. In the Transition Period, the survey was conducted eight to ten weeks after CCDS went live, to measure both the adoption process and physician and nurse evaluation of the new system.

Time Motion Study
To get accurate measure of CCDS's impacts on efficiency and workflow routines, we directly observed 27 physicians during the Pre-Implementation Period and 21 physicians during the Transition Period. Physician subjects in this study work in the pediatric and neonatal intensive care units (ICU) as well as on various inpatient wards. The pre-implementation period started 2.5 weeks before the implementation of the CCDS system and the transition period was defined as 8 to 10 weeks after implementation. We measured the actual time consulting physicians spent on each activity or task during a complete patient consultation. The total logged observation time across the 48 physicians was 10,080 minutes (168 hours).

The time motion observations were conducted using software developed by our team and installed on a tablet PC (Figure 2). Although multitasking is a very common activity amongst physicians and other healthcare providers (O'Leary et al. 2006, Thielst et al. 2008), this time expenditure had not been adequately captured in previous studies (Lo et al. 2007). Using our software, we were able to record the richness and details of multiple simultaneous physician activities.

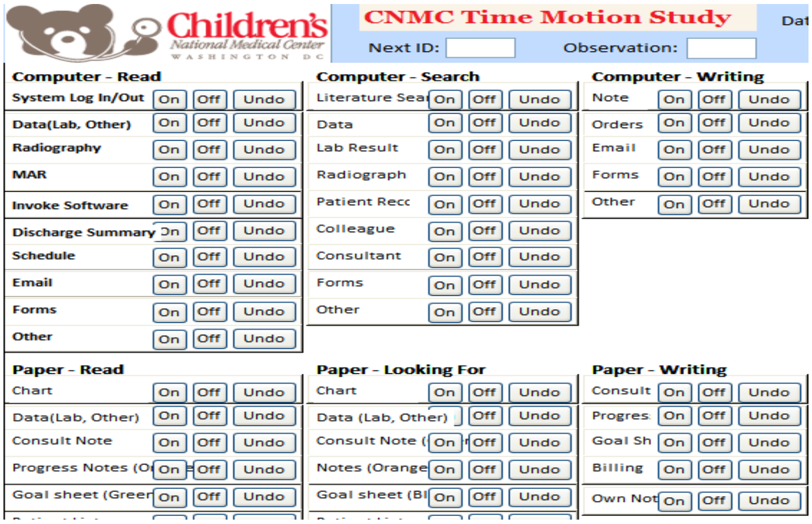

Figure 2: Screen capture of software deployed for time motion study

4. Findings

4.1 Improvement in legibility and timeliness

Description of sample

The first survey was directly administered to 364 training participants before the start of their training. For this survey, we collected a total of 244 responses (67 % response rate) comprised of 35.0% physicians and 52.5% nurses. The second survey was directly administered to 364 training participants after their training session. We collected 208 responses (57% response rate) comprised of 36.7% physicians and 51.4% nurses. The third survey was conducted online during the Transition Period, and target subjects were informed about the survey via email. Emails were sent to 1096 nurses, 456 faculty and fellows, 114 residents, and 98 respiratory therapists. We obtained a total of 350 responses (19.8%) comprised of 51.9% physicians and 38.9% nurses.

Table 1: Distribution of Respondents

Occupation	**Number of observations (n) / Percentage (%)**		
	Pre-Implementation Period		**Transition Period**
	First Survey	**Second Survey**	**Third Survey**
Physicians	76 (35.0%)	65 (36.7%)	159 (51.9%)
Nurse practitioners	4 (1.8%)	5 (2.8%)	13 (4.3%)
Nurse	114 (52.5%)	91 (51.4%)	119 (38.9%)
Respiratory Therapist	15 (6.9%)	9 (5.1%)	10 (3.3%)
Physician Assistant	4 (1.8%)	4 (2.3%)	5(1.6%)

Early Findings

We present the results for the information quality in clinical documents before and after the implementation. Means and standard deviations of legibility and timeliness were computed. Differences between means were analyzed using a t-test for correlated samples.

Legibility

In the first survey, participants were asked to rate the information quality of the paper-based clinical documentation system. Each participant rated the legibility and timeliness of the information in patient charts and two of its sub-components: the progress notes and flowsheets. The rating is based on a 7-point Likert scale, with 1 representing the lowest quality and 7 the highest. We compared the ratings in the first and third survey for the same questions.

Results from the first survey indicate that physicians perceived the legibility of paper-based documentation to be poor (M=3.78, SD=1.54). In the third survey, there was a significant increase in legibility for CCDS (M=5.67, SD=1.61. The difference between ratings of the paper-based system and CCDS was statistically significant (p<0.001)(Table 2 and Figure 3). We obtained similar findings for the increase in legibility for progress notes and flowsheets respectively.

Timeliness
Results indicate a noticeable increase in timeliness for CCDS (M=4.99, SD=1.68) as compared to the previous paper-based systems (M=4.56, SD=1.46), p=0.0012. The ease of accessing patient information anywhere at any time led to the improved perceptions toward the timeliness of information after implementation of CCDS. Similarly, we found an increase in timeliness for the electronic flowsheet compared to the paper flowsheet, although not statistically significant (see Table 2 and Figure 4).

Overall, the evidence suggests that physician's perceived legibility and timeliness of information have improved at the onset of implementation.

Table 2: Pre and post comparison results

Measures	**Pre**			**Post**			**Difference Test**		
Legibility	N	Mean	SD	N	Mean	SD	T value	df	p
Patient Chart	240	3.78	1.54	351	5.67	1.61	-14.23	589	0
Progress Notes	237	4.85	1.46	387	5.67	1.69	-6.44	556	0
Flowsheet	239	3.85	1.55	380	5.67	1.62	-13.83	617	0
Timeliness	N	Mean	SD	N	Mean	SD	T value	df	p
Patient Chart	240	4.56	1.46	350	4.99	1.68	-3.25	556	0.0012
Progress Notes	237	4.94	1.44	382	4.98	1.79	-0.32	577	0.7463
Flowsheet	239	4.62	1.48	383	5.03	1.72	-3.18	559	0.0015

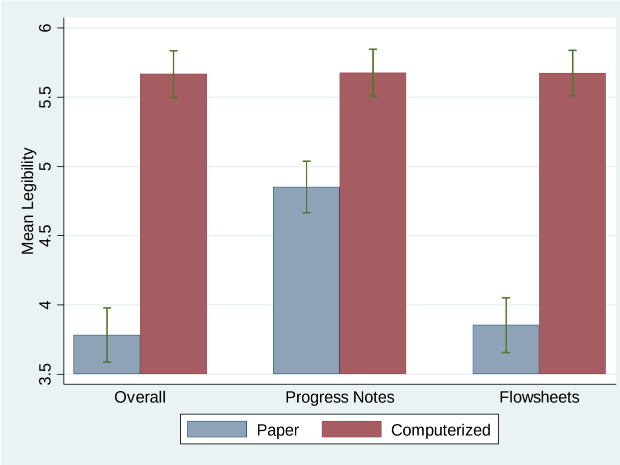

Figure 3: Information Quality – Legibility

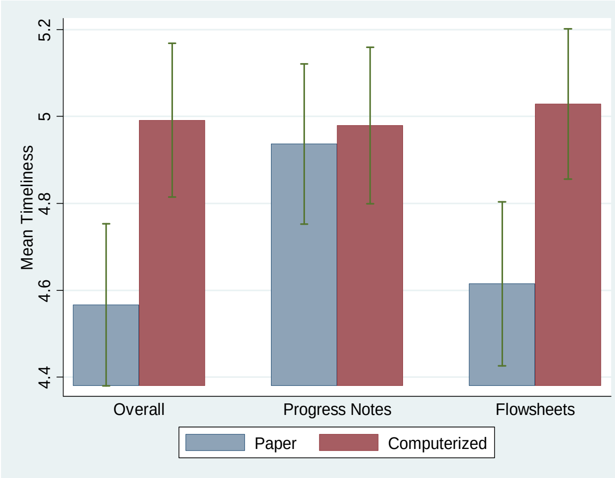

Figure 4: Information Quality – Timeliness

4.2 Impact on efficiency and routines

In the time motion study we first defined the major activities which involve a consultant physician during the patient visit. Based on the time motion study literature (Menke et al. 2001, Pizzifferri et al. 2005, Lo et al. 2007), we classified the activities into 104 different types of activities (see appendix A). These activities were grouped into five categories: using the computer, using paper documents, communicating with other physicians, examining patients, and miscellaneous. Using a different basis for classification, we also divided the 104 activities into direct and indirect patient care.

We then used the software to record the time that each physician spent on each major activity during the entire patient visit. It is interesting to note that before CCDS was implemented, communication activities accounted for most of the physician's time spent during the patient visit. In a typical visit a physician spent 21.9 minutes communicating with other clinicians, the patient or the patient's family. Physicians also spent a significant amount of time (18.1 minutes) with the paper documents.

As expected, after the CCDS implementation physicians spent much less time on paper documents, but more time on computers. The time spent on paper reduced from 18.1 to 4.5 minutes, while computer usage had increased from 7.8 to17.2 minutes. After CCDS was implemented, computer based activities constituted the category on which clinicians spent the most time.

In parallel, we noted a reduction in the time spent on paper use and communication and other activities such as walking. This was consistent with our observations of physicians who spend a lot more time searching for information using computers and less time walking and searching for paper based notes (Figure 5a). In Figure 5b, we noted a reduction in time spent in each patient care unit, which may imply an improvement in efficiency.

We also found that consulting physicians adapted to the technical change by changing the sequence of workflow to accommodate the intervention. For instance, physicians who used to be writing their progress notes when they were at the patient bedside leave documentation to the end after seeing their patient. For some, this documentation is performed on the patient care unit while for others, this activity takes place back in their offices. Formal interviews with consulting physicians will be conducted at a future time to corroborate this finding. However, this early evidence points to the fact that routines have changed when a new technological intervention is put in place and it will be interesting to isolate the impact of these routine changes on physician perceptions of the new technological intervention.

Table 3: Time utilization and efficiency gains of consulting physicians in wards

Type of Activity	**Pre** Mean±SD (Minutes)	**Post** Mean±SD (Minutes)	**P**
Computer	7.8±15.4	17.2±15.8	0.00
Paper	18.1±15.7	4.5±6.1	0.00
Communication	21.9±19.3	16.9±17.7	0.20
Patient Exam	7.1±7.6	5.0±4.2	0.11
Miscellaneous	3.2±3.9	3.1±2.7	0.89
Total Time taken for visit	58.1±44.2	41.5±36.4	0.05

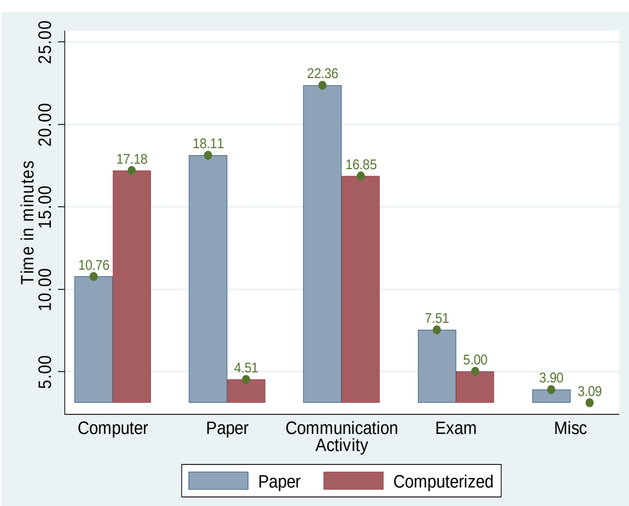

Figure 5a: Time Utilization

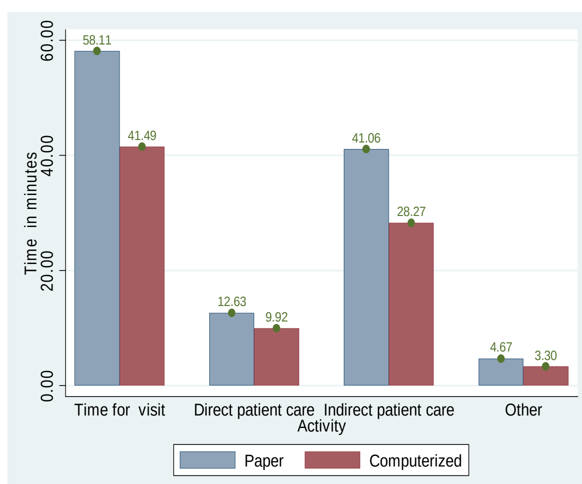

Figure 5b: Efficiency Gains

5. Discussion and conclusion

Our analysis in the transitionary period after implementation suggests that CCDS offers several noticeable improvements in information quality and efficiency. The timeliness and legibility of the information recorded in the patient chart has been significantly improved by CCDS. Furthermore, we found that physicians were more efficient in care delivery saving on average 17 minutes (26%) per consultation visit. It should be noted that these findings were based on data collected only 8 to 10 weeks after the implementation of CCDS. In addition, many of these physicians were not caring for patients continuously during this 8 to 10 week period after implementation and only on-service one to two seeks each month. As there typically is a learning curve associated with the new system, we expect CCDS' positive impact on information quality and care delivery efficiency to be more prominent when we reassess these metrics at the 6 month post-implementation timeframe.

There are several other interesting points that are worth noting:

- CCDS' impact on work flow: Although the system is designed to minimize the impact to the existing work flow, we noted that physicians have created new ways to exploit the benefits of the digitized documents. In our interviews with physicians, one frequent comment we received about the benefit of the CCDS is that physicians can now access patient information anywhere. For example, consulting physicians are able to collect up-to-date information about the patient before they do their consultations. This has the potential of improving decision making and further enhancing efficiency.

- CCDS' impact on teaching: The CCDS has put the otherwise isolated and scattered information into one common repository. Physician trainees have easy access to others' notes, which enables a new way of learning. More important, in a new paradigm shift, trainee notes are being corrected and augmented by the fellows and faculty. Finally, the faculty are now able to spend more time teaching during rounds, as documentation now occurs after rounds. These changes will likely have a positive impact on the quality of teaching.

As to next step, we plan to extend the findings from this study at the 6 month post-implementation timeframe when clinicians have had significant time to adapt to the new technology. In addition, we are exploring factors that influence the effective use of the CCDS. One of the important reasons often noted in explaining slow EMR adoption rates includes resistance from physicians. We are studying how to effectively reduce this resistance from a social perspective. Specifically, in most inpatient care settings, physicians work as teams. We expect that the culture of the team should have important influence on the effective adoption of CCDS.

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Appendix A: Classification of Activities

Category	Activities
Paper – Read:	Chart, Data, Consult Note, Progress Note, Goal sheet, Patient List, Own Notes, Forms, Other
Paper - Looking For:	Chart, Data, Consult Note, Progress Note, Goal sheet, Patient List, Own Notes, Forms, Other
Paper Filing:	Consult Note, Progress Note, Goal Sheet
Paper – Writing:	Consult Note, Progress Note, Goal Sheet, Own Notes, Form, Other
Procedures:	Exam Patient, EKG, IV, Joint Inj/ASP, Lab Test, Other
Personal:	Eating, Restroom, Blackberry, Palm/Diary, Other
Talking:	Attending, Fellow, Nurse, Resident, Patient Family, Patient, Consultant, Other Staff for Pt, Radiographer, Other
Walking:	Inside (patient bedside), Outside
Phone:	Call someone, Get Results, Schedule Test, Receive Page, Personal, Other
Computer – Read:	System Log In/Out, Data, Radiography, MAR, Email, Forms, Other
Computer – Read (Phase 2):	Consult Note, ProgressNote, IView, Assessments, Transfer or Discharge Notes, Patient List, Order, Other
Computer Search (Phase 2):	Consult Note, Progress Note, IView, Assessments, Transfer and Discharge, Patient List, Order,
Computer – Search:	Literature Search, Data, Lab Result, Radiograph, Patient Record, Colleague, Forms
Computer – Writing:	Note, Orders, Email, Forms, Other
Computer – Writing (Phase 2):	Consult, ProgressNote, IView, Assessments, Transfer and Discharge, Forms, Orders, Email, Billing, Patient List, Other