AHRQ GRANT FINAL PROGRESS REPORT

Title of project: Improving Accuracy of Electronic Notes Using A Faster, Simpler Approach

Principal investigator: Thomas H. Payne

Team members: Thomas H. Gallagher, Co-Investigator
Andrew White, Co-Investigator
Meliha Yetisgen, PhD, Co-Investigator
Amelia Chappelle, Research Manager
Ben Dunlap, Research Staff Assistant 9/30/14-9/15/15
Jennifer Zech, Research Staff Assistant 9/16/15-9/29/16
Andrew Markiel, Computing Engineer
Kevin Lybarger, graduate student (contractor)
David Alonso, resident (volunteer)
Ross Lordon, graduate student (volunteer)
Leo Liu, resident (volunteer)

Includes date of project: 09/30/2014 - 09/29/2016

Federal project officer: Steve Bernstein, (301) 427-1581, steve.bernstein@ahrq.hhs.gov

Acknowledgement of agency support: This project was supported by grant number R21HS023631 from the Agency for Healthcare Research and Quality. The content is solely the responsibility of the authors and does not necessarily represent the official views of the Agency for Healthcare Research and Quality.

Grant Award Number: 1R21HS023631-01

December 28, 2016

PURPOSE

Physician progress notes are an important record for clinical care and communication with care team members and patients. They also support measurements of care quality, research, automated and manual quality improvement, and billing.[1] Clinical notes are increasingly created using electronic health record (EHR) documentation tools and appear in electronic form. The transition from paper to electronic documentation yielded many advantages, including making it possible for multiple people to access notes simultaneously, improved legibility, and the ability to more easily search notes.

However, electronic notes are criticized for poor readability, overuse of copy and paste,[2] and increased length due to the importation of data stored in other parts of the EHR. Physicians have voiced strong concerns that writing notes in EHRs takes more time than using paper or dictation; a consequence is that progress notes may not be completed and available to other team members until long after the episode of care.[3] Documentation requirements have also contributed to widespread physician dissatisfaction with EHRs. Though use of voice recognition software, scribes, and other novel approaches may improve physician satisfaction in clinics, inpatient setting workflow is markedly different and is less conducive to these approaches. Traditional dictation turn-around-time and cost are barriers to broader use of dictation for inpatient progress notes.

Most concerning is the perception that electronic notes may not accurately reflect what was observed during a patient encounter, which threatens the primary use of notes—to aid in caring for patients—and also their use for scientific research.[4] Some physicians find modern EHR progress notes too unreliable to use as the basis for decision-making.

The project is an attempt to address the problems of electronic progress notes. In this paper we describe the development, implementation and evaluation of a voice-generated enhanced electronic note system (VGEENS), integrating voice recognition and transcription with natural language processing (NLP) and links to the EHR, which is designed to match physician rounding workflow. We also present results of a randomized controlled trial to determine the effect of using this new method of writing inpatient progress notes on note timeliness, quality, and physician satisfaction, in comparison with writing notes in the usual way, through typing into partially populated templates.

SCOPE

Moving from paper to electronic physician documentation has improved the availability of notes within EHRs, but is also associated with problems in the quality, timeliness of those notes, and with increased physician time spent on the process of writing them. The purpose of this project is to address these problems with a novel method of creating inpatient progress notes.

METHODS

Setting and system description

This work was conducted on the medical services of UW Medical Center and Harborview Medical Center, which are major teaching hospitals of the University of Washington. Together there are 34,915 admissions annually. The transition from paper to electronic notes occurred in 2006 using note writing applications Cerner Millennium (Cerner Corp., Kansas City, MO).

Nearly all progress notes on these inpatient services are typed using the Clinical Notes Editor, based on templates that automatically import patient-specific data such as medication lists, vital signs, and laboratory results.

After development and testing of the VGEENS system to create progress notes and integrating it into the existing commercial EHR, we used a randomized controlled trial to compare the following three outcomes between the intervention group (using this new VGEENS method) and control group (entering notes using a keyboard): 1. The time between seeing the patient on hospital rounds and the availability of the note in the EHR; 2. Physician satisfaction with this new method of writing notes in comparison with the usual method and 3. The quality of the note.

Study design

To test the effect of VGEENS on the length of time between seeing the patient on rounds and availability of notes in the EHR, on physician satisfaction with note writing, and on note quality, we conducted a randomized clinical trial. Internal medicine residents and attending hospitalist physicians were contacted through meetings and email messages and invited to participate in a trial of VGEENS. After hearing a description of the study, physicians who agreed to participate and who gave informed consent were randomly assigned to either the intervention or control group (See Figure 2). The control group created progress notes as they usually do, typing notes using a locally developed template in Cerner's Clinical Note Editor. The intervention group uses the VGEENS system to create progress notes as described above.

Data sources/collection

We gathered time of hospital rounding using times recorded on paper rounding sheets. We determined the time progress notes were available for other clinicians to view using data extracted from our EHR. Physician satisfaction was assessed using a survey delivered by email. Note quality is being assessed using manual review of notes as assessed by manual quality review using published instruments (PDQI-9). Each of these are described in greater detail in *Outcomes*, below.

Interventions

In this study we developed a system to use physician voice to create inpatient progress notes. This new system, which we call VGEENS (voice-generated enhanced electronic note system), was used by study intervention physicians while on hospital rounds. While at the bedside or after leaving it, the physician enters a 9 digit patient identifier and records a voice file on a cell phone using an Android application developed by one of the study personnel (DA). When the dictation is complete, the physician presses a 'send' button causing the voice file to be securely (via encrypted connection) transferred via the existing hospital wireless network to a server for processing and then is deleted from the phone. On the server, the file containing the digitally recorded dictation is converted to text using licensed commercial automated speech recognition software (Dragon Medical Practice Edition, Nuance) without interactive editing, using the subject's voice profile. Currently, voice commands are used to break the note into sections corresponding to the preferred UW progress note format (Chief Complaint, Interval History, Exam, Laboratory and Imaging, Assessment and Plan). During the course of the study we added features to automatically format the section headers using bold, capitalized font, and in response to voice commands to insert formatted patient vital signs and select laboratory tests The transcribed note is sent to the EHR Inbox. All these coordinated automated steps occur

within five minutes of the creation of the voice file on the VGEENS application. From the EHR Inbox, the physician can edit the document, route it to recipients and then sign it, which places it in the patient's EHR record.

Control subjects create notes using the Clinical Notes Editor[5] in which the physician types or copies and pastes text into a template automatically populated with patient medication list, vital signs, and laboratory results.

Outcomes

Here we report early results of 2 of 3 outcomes planned for this study: the time between when the subject saw the patient on rounds and time the electronic progress note was available in the EHR for authorized users to view, and satisfaction with the note writing process of both intervention and control subjects using an email questionnaire. We are currently measuring note quality using PDQI-9 and another instrument.

Measures

Both intervention and control physicians manually recorded the time they saw each patient during morning rounds on a paper rounding sheet each day in the period in which they participated in the study. The rounding sheets were placed in a box in a secure patient care area and were collected by study personnel. We used the time recorded on this rounding sheet to determine when the patient was visited on rounds, and determined the number and identity of patients in that physician's hospital census that day. Electronic progress note metadata (but not the text of the note) including EHR logging data showing when the notes were created, when they were viewable in the EHR, and when they were signed, were obtained from our analytical data repository (Amalga, Caradigm) which contains a subset of EHR data extracted for analysis and research. We determined the number of minutes between the patient visit and the availability of a viewable progress note in the EHR by subtracting the time the patient was seen on rounds from the time the note was viewable. Dictated and VGEENS notes are viewable by others when transcribed for intervention notes, and when signed for manually typed (control) notes. For this reason, we measured time until typed notes were signed and when VGEEN notes were transcribed.

Satisfaction with the process of creating notes was measured using a survey based on the Canada Health Infoway System And Use Assessment Survey.[6] Sections 1, 2 and 3 covering overall user satisfaction, system quality, and information quality.The survey was administered electronically using REDCap. A weblink to the survey was sent via email in a format familiar to UW physicians.

Note quality is being measured using the PDQI-9[7] survey and a single question: "Please rate the overall quality of this note with a 5-point Likert scale from 1 ('very poor') to 5 ('excellent')." PDQI-9 scores are being assigned by 4 reviewers. Each note is being separately scored by 2 reviewers. The sum of the PDQI-9 scores from the 2 reviewers will be averaged, as will the overall quality score. Thus, each note had 2 indicators of quality: PDQI-9 and the overall quality score.

Limitations

We limited this study to internal medicine physicians in two teaching hospitals for creating inpatient progress notes but not admission notes, procedure notes, discharge summaries or other physician documentation. The VGEENS intervention was developed for this and was enhanced with new features during the period of the study; for this reason the intervention had more features later in the study than at the beginning. There were few periods of technical difficulty (downtime, note-creation problems) but those that occurred were more common in the first few months of the study than in later months. The intervention was improved and more reliable later in the study when fewer notes were created using the enhanced version.

Measurement of note quality is labor intensive and, in the judgement of this study's investigators, is subjective and open to interpretation. We did not systematically measure how frequently copying and pasting of notes occurred, though the prevalence of this practice was one of the drivers for this work.

Statistical analysis

Testing to determine if differences observed in outcomes between intervention and control are statistically significant will be reported in a corrected version of this report.

The University of Washington Human Subjects Division approved this study under Expedited Category 7.

RESULTS

Principal findings

1. Development of application

We successfully developed and deployed our VGEENS application and supporting server application and incorporated it into the workflow of intervention physicians. All cell phone features other than Wi-Fi were disabled and the system was reviewed and approved by the UW Medicine security team. Integration with our commercial inpatient EHR was successfully achieved with very little impact on the EHR and its operation.

Monitoring software was written to assure that this system was available nearly continuously. Training materials were created, smart phones acquired, and subjects were randomized and subject assigned to the intervention arm were instructed on how to use this during hospital rounds.

There were remarkably few problems in using these phones. Occasionally (about 2 or 3 times a month), the software systems have to be restarted. Most of these problems occured early in the trial.

2. Notes written

We solicited subjects using recruitment emails to resident and attending physicians on the Medicine service at UWMC and Harborview. All were internal medicine physicians practicing on the Medicine service at UW Medical Center or Harborview Medical Center. Forty nine subjects

agreed to participate and provided informed consent. Of these 49 subjects, 49% percent were randomized to intervention and 51% to the control group. Of these, 31 contributed at least one note during the study period; 58% of those were attendings. The 18 physicians who did not contribute at least one note did not do so because they were not on a medical service rotation in which their responsibilities included writing daily progress notes during the study period or for other reasons.

We excluded from analysis discharge summaries, patients for whom there was a note but no rounding time recorded, and timing data on patients who did not have a progress note written either because the patient was discharged, transferred to another service that day, expired, or because the progress note was written that day by a physician or medical student not participating in this study.

Subjects wrote 1852 inpatient progress notes during the study period. Of these, 1143 notes (62%) were written by control subjects and 709 notes were written by intervention subjects. Most of the notes (86%) were written by attending physicians. Of the notes written by intervention subjects, 70.4% were dictated using the VGEENS application and the remainder were typed, because the VGEENS system was not operating or some technical error occurred, or because the physician elected to type a note rather than dictate using VGEENS.

Outcomes

1. Timeliness of note availability

Both intervention and control subjects recorded the time patients were seen on rounds. We received a record of time of rounding and progress note timing data on 1850 (99.9%) notes written by 31 subjects. The mean time that patients were seen on rounds was 9:58 am (median 9:40 am, earliest 1:30 am, latest 6:20 pm).

The median number of minutes between the patient being seen on rounds and the availability of a progress note in the EHR for others to view was 190 minutes for the control group (average 228, range 0 - 1149) and 227 minutes for the intervention group (mean 307, range 7 - 1425), a difference of 37 minutes longer for intervention compared with control. Within the intervention subjects, for the 70.4% of notes that were dictated using VGEENS, the median number of minutes between the patient being see on rounds and the availability of a progress note in the EHR for others to view was 198 minutes (average 238, range 5 - 1420) compared with 350 (average 472, range 7 - 1425) for notes that were typed.

2. Satisfaction with the note writing process

Forty-five of 49 subjects completed the survey, a response rate of 91%. The response rate for the 31 of these 49 subjects who completed at least one note was 100%. We excluded from analysis of satisfaction survey the 18 subjects who provided informed consent but did not write at least one note. Among intervention subjects, an equal number (40%) rated satisfaction with the VGEENS tool as either highly or moderately dissatisfied (6 each) and moderately dissatisfied or not at all satisfied (8 and 1, respectively). Among the control group, 50% of subjects rated their satisfaction with note writing as either highly or modestly satisfied (8) and one subject (6%) was moderately dissatisfied.) In general, then, control subjects were more satisfied with the note writing process than intervention subjects, though we have not yet tested to see if this difference is statistically significant.

Analysis of responses to other survey questions, studying difference in satisfaction among those who wrote more notes, and by training level and other characteristics is underway.

3. Note quality

Results are being evaluated by 4 volunteers who are rating note quality for a randomly selected subset of 100 intervention and 100 control notes. Each note is evaluated by 2 reviewers. They will receive a $25 card to compensate them for the time spent doing this review.

Discussion

The most important result from this early report from our study is that we successfully developed and deployed a simple, portable, open source application to use voice recognition to meet the rapid turnaround and challenging workflow demands of the hospital environment. In addition, our methods to measure note timing provided the data we needed to measure one of our 3 outcomes. Early results suggest that progress notes are available in the EHR for other clinicians to view later using the intervention than control. This is an unexpected result, and may be because physicians did not dictate their note at the bedside or immediately after leaving the bedside as we had anticipated. We did not instruct them when to create their notes, but if we had encouraged them to do so soon after seeing each patient then the notes would be available sooner. This could potentially be improved by encouraging and perhaps coaching physicians to create notes during or soon after bedside rounds. This would have the additional benefit of physicians being less likely to forget details from the history and physical whereas if physicians dictate notes hours later, some of these details might be forgotten or confused. After the voice file is created, the note is available for others to view within 5 minutes.

We also learned that intern and resident physicians were averse to creating notes using VGEENS. When asked why this is, their answers were that they have not had experience with dictation and are reluctant to learn a new skill during their busy clinical rotations. They also commented that they are very familiar with creating notes using typing, templates, and copy paste.

Examination of 2 notes, one from intervention and one from control gives further insight into why control notes were available faster than intervention notes. Below on the left is a VGEENS progress note which is compared to the progress note on the same patient the previous day. On the right is a control note compared to the previous day's progress note. Blue text indicates new text that day; strikethrough is the text from the previous day that was not present in the current day's note. (The VGEENS note was created before automatic formatting of section headers was available.)

In the VGEENS note, the history, physical, and most of the assessment are new. In the control note, the physical exam and most of the assessment are unchanged from the previous day.

Note created using VGEENS


Identification/chief complaint:
This is a [illegible]-year-old woman with metastatic adenocarcinoma of unknown primary mostly involving the hiphead then started and sternum admitted for pain.

Interval history:
Continues to have poorly controlled pain. She thinks her leg pain is slightly better but her chest pain continues to worsen. Her fentanyl PCA was increased further to 75 µg incremental doses with the addition of a 75 µg per hour continuous infusion. We discussed the balance between function and pain control and she may have to sacrifice wakefulness/function in order to achieve the level of pain control that she desires. She is recognizing that it may not be possible to stay awake and have improved pain level. Of note, the hospice agency has introduced the idea of sending her home directly with the 24 hour nurse.
Significantly increased pain overnight. Her fentanyl PCA had been reduced from 50 to 25 but she required several subsequent boluses. She is in significant pain this morning and is barely able to speak as a result of that. Her pain is again located in the hips and also in the chest. She also had a discussion with her oncologist earlier this hospitalization about death with dignity and had another discussion with Dr. [illegible] this morning who acted as a second opinion. The social worker for the death w/ dignity program will meet with her as well.

Medications:
Medications were reviewed. For pain, she has an intrathecal pump andwith morphine and bupivacaine. She also is on a fentanyl PCA with an incremental dose of 75 µg and a continuous infusion at 75 µg per hourmcg.

Physical exam:
Vitals: Temperature 36.2-37.63, heart rate 76-9590, respiratory rate 12-1015-16, oxygen saturation 95-97%,98% on room air, blood pressure 88-098/49-8586-98/52-62
General: Thin frailChronically ill-appearing woman lying in bed grimacingin clear distress
HEENT: Dry oral mucosa
Cardiovascular: Regular rate and rhythm
Respiratory: Breathing is unlabored,Normal respiratory effort and rate is completely normalon room air, lungs are clear anteriorly
Abdomen: Soft, nondistended
Neuro: She is fully awakeAlert and oriented, no signs of somnolence ×4

Assessment and plan:
This is a [illegible]-year-old woman with adenocarcinoma of unknown primary admitted for uncontrolled cancer related pain in the left hip and sternum. She remainedremains inpatient due to poorly controlledfor titration of her pain with a plannedmedications before discharge to inpatient hospice.

1. Acute on chronic pain: He continues to be Her pain was very poorly controlled despite an up titration of herovernight. Her fentanyl PCA. dose has subsequently been increased back to 75 µg. Her OxyContin which had been increased from 120 to 180 mg 3 times a day has been discontinued. I discussed with the patient that it is very likely she will continue to require the PCA at discharge, which she seemed agreeable to. We'll continue to work with the chronic pain service on optimizing her pain management. When she is ready to discharge, we will need to coordinate pain pump/supplies with the and work with social work on transitioning to inpatient hospice servicevs. home hospice. Of note, the transport from the hospital to hospice may be challenging due to her intrathecal catheter. We are still clarifying the logistics of this.

2. Adenoma adenocarcinomaAdenocarcinoma of unknown primary: Patient has a poor prognosis with plan dischargethe patient and her family are agreeable to inpatient hospice or home hospice. She has discussed been discussing death with dignity with her outpatient oncologist as well as Dr. [illegible] Her daughter is due to fly back from [illegible]n Sunday. She says that she does still want to remain awake enough to interact with her familySx.

3. Hypotension: Blood pressures have remained soft but stable after discontinuation of her IV fluids.

GI/FEN: General diet
Prophylaxis: Low molecular weight heparin
CODE STATUS: DNR/DNI
Disposition: Hospice potentially at home vs. inpatientEvergreen hospice once her pain regimen has been optimized.

Note created using control

Though we have not yet analyzed notes written using intervention and control methods systematically, it is our impression that control notes are created more rapidly using copying and pasting. Though copying and pasting speeds note creation, it may lead to a succession of daily progress notes which are very similar to the note from the previous day, leading the reader to be uncertain as to whether the history, physical, and assessment are accurate for that day or instead reflect prior days' observations.

Physician satisfaction appears to be higher in the control group than in the intervention group. Comments included in the survey give insight as to why this may be. They include unfamiliarity with use of dictation for progress notes, voice recognition errors, and difficulty in inserting laboratory studies (which became available later in the study period when not available to most intervention participants). VGEENS also requires that any structured plan or 'checklist' information that is often included in progress notes (phone numbers for family, code status, etc.) be manually inserted into the note. Another VGEENS enhancement that became available late in the study was the ability to say "number next" to create a numbered list. These and other features can be added to VGEENS, but time did not permit us to do so during the period of this study.

Conclusions

We have developed a system to permit physicians to create progress notes in a commercial EHR using voice using a simple approach that fits rounding workflow. Notes created are available in the EHR within 5 minutes. Early results suggest that these voice-generated electronic notes are available in the EHR later after than notes created using the keyboard at a workstation, likely because they were 'dictated' later in the day. We found also that physicians preferred the more familiar method of entering notes, though this may be because time-saving features were not available to most intervention subjects during the time of this trial. Our analysis of note quality and statistical analysis of these results is underway and will be reported in a corrected version of this report.

Significance

Preliminary analysis of a small number of control notes suggests that notes may vary less day-to-day in the control group—that is one day's note is little changed from the previous day's note—but have less similarity to the previous day's note when created using VGEENS. If this pattern is confirmed with greater analysis, it could provide evidence that note accuracy may be higher with VGEENS because copying and pasting is not needed to save time if notes are created using voice.

We have more technical enhancements to the VGEENS system underway, and others may follow after detailed outcome analysis and linguistic study of the manual note-editing process to determine if some manual editing might be automated. This analysis may lead to further improvements in the speed and accuracy of creating a note using VGEENS. Finally, we have not yet leveraged more advanced NLP techniques to correct semantic errors within the note, nor to extract encoded concepts form the narrative text. Work on these system improvements is underway. There are tools available in our EHR to use NLP to extract problem list elements from any note.

Perhaps the greatest potential for this work is that we have developed a system to create notes that capture physician thinking in electronic form as close to rounds as possible; we have the potential to suggest diagnostic and therapeutic interventions based on that thinking in near-real-time rather than the end of the day or later.

We have leveraged a commercial EHR by using mechanisms the EHR vendor provides to extract patient data and to insert notes using the same portal used by transcription services. The latter is available in most EHRs. In the future, we might use Fast Healthcare Interoperability Resources (HL7 FHIR[8]) for the same purposes, making this application more portable across commercial EHRs.

LIST OF PUBLICATIONS AND PRODUCTS

Presentations

"Learning from the Record of Hospital Care. Do Physician Progress Notes Help or Hinder?" Presentation to UW Medicine Center for Scholarship in Patient Safety and Quality Works In Progress Seminar Series, University of Washington, July 5, 2016.

"Improving Accuracy of Electronic Notes Using A Faster, Simpler Approach." Presentation to UW Medicine Center for Scholarship in Patient Safety and Quality Works In Progress Seminar Series, University of Washington, May 5, 2015.

AHRQ Web Conference about this study is scheduled for February 2017.

Posters

Liu X and Payne T. A study to imitate use of voice software and natural language processing to improve physician documentation." Poster presentation at the Washington Chapter of the American College of Physicians, Seattle, WA, November 6, 2015.

Lordon R and Payne T. Assessing the Delay in Communication Regarding Physician Digital Inpatient Documentation. Poster Presentation – National Library of Medicine Annual Training Conference 2016, June 29, 2016, Columbus, OH.

Manuscripts

There are 3 manuscripts in preparation. The first will expand on this report, include final results and statistical analysis, and will be the main product of this grant. The second manuscript tentatively titled "Augmenting automatic speech recognition to improve the clinical documentation process" describes the nature and frequency of physician edits to notes created using automatic speech recognition. The third manuscript is a description of the VGEENS system, including features of the mobile Android application, server software, and the scripts used to enhance, format, and edit the note produced by the automatic speech recognition software.

PURPOSE

Moving from paper to electronic physician documentation has improved the availability of notes within EHRs, but is also associated with perceived decline in the quality and timeliness of those notes, and with physician time spent on the process of writing them. The purpose of this project is to address these problems with a novel method of creating inpatient progress notes.

SCOPE

Our project seeks to improve daily progress notes written for hospitalized patients on the inpatient medical service in 2 teaching hospitals of the University of Washington.

METHODS

We developed and implemented a new voice-generated enhanced electronic note system integrating voice recognition and transcription with natural language processing and links to the electronic medical record

We then conducted a randomized trial to compare note timeliness, quality, and physician satisfaction with the note writing process between physicians using VGEENS compared with the usual note writing process.

RESULTS

Forty-nine subjects agreed to participate, provided informed consent, and were randomized to intervention and control groups. Of these, 31 physicians contributed at least one note. Preliminary results (to be replaced in a corrected report) show that 1852 progress notes were written by subjects, 709 by intervention and 1143 by control. Intervention notes were available 37 minutes later than control notes on average. Physicians were more satisfied with the control method. Note quality assessment and statistical testing is underway. Control notes may reflect more copying and pasting and have more similarity to prior notes.

KEY WORDS

Electronic health records
Physician documentation
Automated speed recognition
Natural language processing

REFERENCES

[1] Cusack CM, Hripcsak G, Bloomrosen M, Rosenbloom ST, Weaver CA, Wright A, Vawdrey DK, Walker J, Mamykina L. The future state of clinical data capture and documentation: a report from AMIA's 2011 Policy Meeting. J Am Med Inform Assoc. 2013 Jan 1;20(1):134-40. doi: 10.1136/amiajnl-2012-001093. Epub 2012 Sep 8. PubMed PMID: 22962195; PubMed Central PMCID: PMC3555335.

[2] Hirschtick R. Cases & Commentaries. Sloppy and Paste. AHRQ WebM&M, July 2012.

[3] Oxentenko AS, West CP, Popkave C, Weinberger SE, Kolars JC. Time spent on clinical documentation: a survey of internal medicine residents and program directors. Arch Intern Med. 2010 Feb 22;170(4):377-80. doi: 10.1001/archinternmed.2009.534. Erratum in: Arch Intern Med. 2010 Apr 12;170(7):639. PubMed PMID: 20177042.

[4] Hammond KW, Helbig ST, Benson CC, Brathwaite-Sketoe BM. Are electronic medical records trustworthy? Observations on copying, pasting and duplication. AMIA Annu Symp Proc. 2003:269-73. PubMed PMID: 14728176; PubMed Central PMCID: PMC1480345.

[5] Payne TH, tenBroek AE, Fletcher GS, Labuguen MC. Transition from paper to electronic inpatient physician notes. J Am Med Inform Assoc, 2010;17:108-111. PMID: 20064811

[6] Canada Health Infoway System And Use Assessment Survey. http://healthit.ahrq.gov/health-it-tools-and- resources/health-it-survey-compendium Accessed January 25, 2014.

[7] Stetson PD, Bakken S, Wrenn JO, Siegler EL. Assessing Electronic Note Quality Using the Physician Documentation Quality Instrument (PDQI-9). Appl Clin Inform. 2012;3(2):164-174. PubMed PMID: 22577483; PubMed Central PMCID: PMC3347480.

[8] HL7. Introducing HL7 FHIR. http://www.hl7.org/implement/ standards/fhir/summary.html Accessed January 11, 2015.