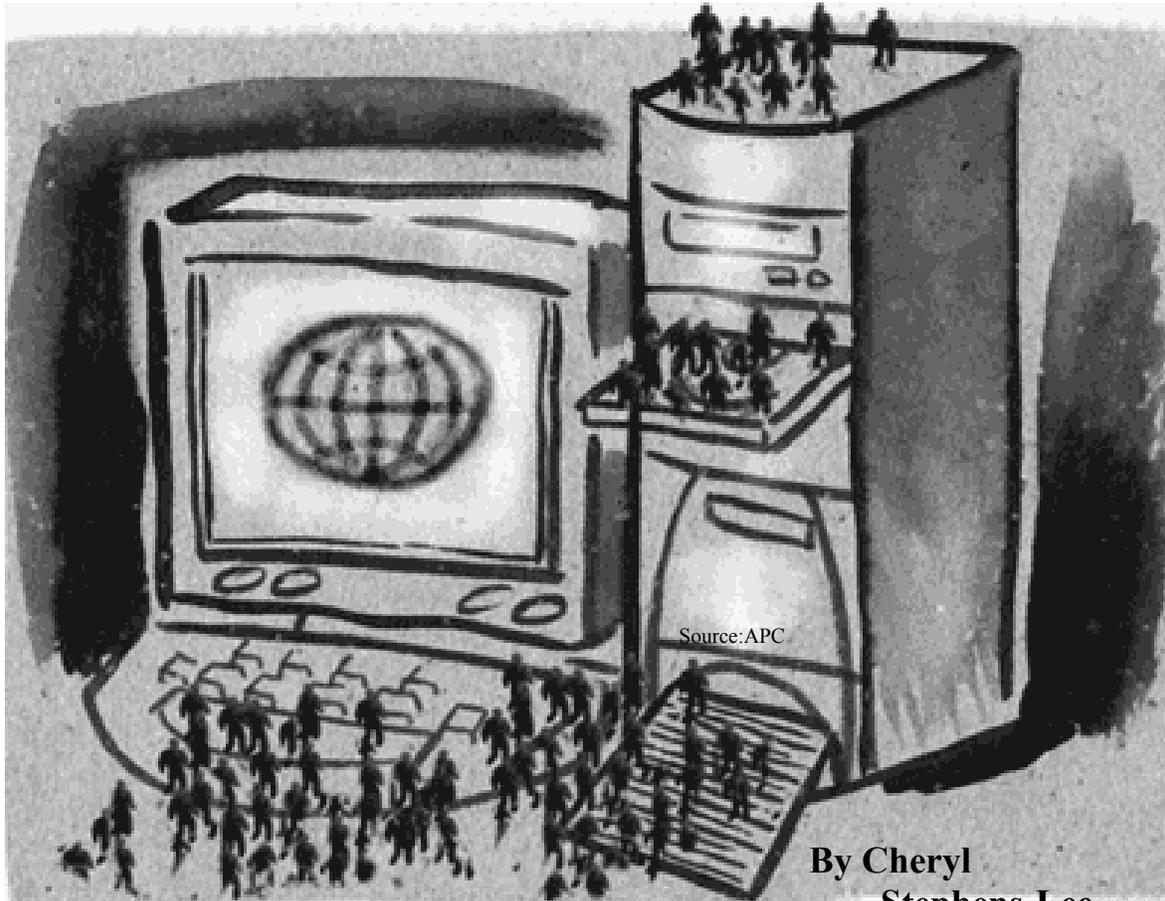


Identifying and Categorizing Health Information System Gaps



Abstract

The focus of this article is to propose a framework for identifying and categorizing health information system gaps. This framework is suited for evaluations where multiple issues are raised such as agent (end user) interviews. It is guided by five main themes and three resolution categories and offers a means of reporting evaluation results for stakeholders. The results of an evaluation conducted on the Emergency Department Information System at the Dartmouth General Hospital, Dartmouth, Nova Scotia are provided. These results are offered as an example of the framework being applied.

Introduction

The Emergency Department Information System (EDIS) has been operational at the Dartmouth General Hospital (DGH) since 08 July 2004. In the fall of 2006 EDIS was evaluated by the site EDIS clinical coordinator. Upon reflecting on the issues raised by the emergency department staff five primary themes or types of gaps were noted. It was also noted that the resolutions for the issues fell into three main categories. These observations guided the formulation of a framework for organizing health information system (HIS) gaps. The purpose of the typing and categorization of gaps is to present a heuristic framework for organizing and distributing the results of evaluations conducted on HIS solutions to key stakeholders.

Following a literature review, the author will provide background on the evaluation method used. The focus of the paper is not the evaluation but the organization of HIS gaps using the common themes observed and resolution categories. A definition of the five common types and three resolution categories will be offered with examples from the actual EDIS evaluation.

Literature Review

Using the Cumulative Index to Nursing and Allied Health (CINAHL) database with the words "evaluation" and "information system" in the abstract and limiting the search date to 2000-2007 with the journal subset: Computer/Information Science, 24 articles were retrieved. Based on the titles and abstracts, 15 articles met the inclusion criteria for review. A second search was conducted on the National Library of Medicines' PubMed database. The same search words and limiters were used. This search pulled 509 articles. After reviewing the titles the selection was quickly narrowed to 22 articles and then to 8 based on the abstracts.

The focus of a majority of the articles was the specific methodology applied to the evaluation of a specific HIS. The results of each evaluation were provided by the authors. However, the approach in this paper is to offer a framework for typing HIS further categorizing them according to how they are resolved. This framework is well suited for quantitative evaluations including end user interviews or focus groups through which a large number of issues may be identified.

Although the articles reviewed did not illustrate how to organize the results of an evaluation there was valuable knowledge shared by the authors. Four articles described the instruments the authors used in their evaluations. Hortman and Bagley (2005) and Im and Chee (2006) both used the Questionnaire for User Interaction (QUIS) survey available from the University of Maryland (<http://lap.umd.edu/QUIS/>). Lising and Kennedy (2005) used the User Assessment of Potential Effects of Computers (UAPEC) survey which is provided in the article as well as the User Satisfaction Survey (USS) (<http://www.aafp.org/fpm/20050200/ehrsurvey.pdf>). The fourth author, Lee (2004) developed a 44-item questionnaire generated from reviewing literature. Twenty-two items were selected from the pool of 44 questions to be included in the Computerized Nursing Care Plan Evaluation System (CNCPEs) instrument for evaluating a CNCP

(Computerized Nursing Care Plan) system. These instruments were of interest as they may be of value for future evaluations conducted by this author.

Another topic of interest was a framework for HIS evaluations that matches the stage of the system design and the level of the evaluation provided by Kaufman et al. (2006). The necessity for different evaluation methodologies based on the stage of the HIS was also acknowledged by Aronsky et al. (2001), who claimed "At higher levels of system implementation, the expected behavior of the targeted users and the logistical aspects of the clinical environment become more important than the technical characteristics of the system in determining the appropriate design for a clinical evaluation study". Finally, Kirkley and Rewick (2003) offer a checklist for evaluating clinical information systems. This is an excellent resource for evaluating information systems for purchase.

Roberts and Aronsky (2001) both acknowledge the importance of answering the question, "Where in the life cycle is the HIS?" This perspective is reiterated by Brender (2006) in her evaluation handbook. This book was the basis for determining the evaluation tool/s that the author chose for evaluating EDIS. Based on Brender's handbook, the hospital's EDIS is currently in the evolution phase. This phase starts when the information technology (IT) solution has achieved reasonable stability. Brender states that evaluations during this phase should address whether the desired effect or purpose of the solution has been achieved.

Evaluation Method

To determine the primary business processes involved when the patient presents to the emergency department (ED) a workflow analysis of the flow of the patient through the emergency department was conducted. As outlined in Figure 1 there are ten main steps encompassing a visit to the ED. The tenth step has three potential outcomes: discharge, admit or observe. This analysis enabled the writer to determine which functions of EDIS supported each phase of the emergency department visit. Along with mapping the processes to EDIS functionality, the agents who do the work content associated with each phase of the visit were also identified (Table1).

Using this knowledge the agents who perform the roles were interviewed on the features/screens that they used most in their every day work. The six agents identified are: (1) triage nurse, (2) registration clerk, (3) emergency department nurse, (4) emergency room physician, (5) ward clerk, and (6) porter/ward aid. The corresponding EDIS screens/features for the six different agent types were:

- **Triage nurse – triage screen** The triage screen is where the presenting assessment is input into the system. It also shows patients that need to be re-assessed depending on their triage level and time waiting.
- **Registration clerk – clerical screen and Patient Admit System (PAS) map** The clerical screen displays patient demographics. The information on this screen is linked to the organization admission/discharge/transfer system. This link is facilitated through the PAS map.

- **Emergency department nurse and physician – clinical screen**
This screen supports care provided once the patient is brought in to the emergency department through to discharge. Features include, ordering X-rays, consultant requests, entering of discharge diagnosis, discharge destination and time of discharge.
- **Ward clerk – Admit screen**
The admit screen is completed when the decision to admit a patient is made. Information captured includes the date/time of admission, diagnosis, consultant and floor allocation.
- **Porter/ward aid – Tracking screen**
This group was interviewed on the features they use most on the tracking screen. These features included; old chart and comments. The tracking screen is used by all users and provides real-time information of the flow of the patient through the ED.

Five interviews were conducted of each of the six agent types for a total of thirty interviews. The tracking screen is used by all agent types and ten agents of varying disciplines were asked to participate in a second evaluation of this feature. The concerns raised during these forty interviews were organized into a spreadsheet according to their type and resolution category. See Table 2 for the questions that guided the interviews of the triage nurse agents. These questions were modified for each agent group but the general content of the questionnaires was unchanged.

Health Information System Gap Types and Resolution Categories

The issues raised were first classified into five different HIS gap types; (1) Patient Safety Issues (PSI), (2) Efficiency, (3) Human Computer Interface (HCI), (4) Decision Support (DS), and (5) Integration/Interface Issues. These gap types were chosen based on the authors' findings of common themes that populate informatics literature. The gap types are defined by the author as follows:

Patient Safety Issues are gaps that if left unaddressed could potentially bring harm to a patient (i.e. displaying wrong patient information).

Efficiency are gaps that slow a process down and negatively impact workflow. They may lead system users to create "work-a-rounds". Work-a-rounds are alternative processes that users develop to avoid using the HIS. An efficiency gap may be illuminated when a user describes a redundant process (i.e. entering information into a system twice) or functions that require clicking through multiple screens or long lists in tables to reach a desired selection.

Human Computer Interface are often system design issues (i.e. a touch screen design without touch screen capability). These gaps may also occur as a result of a knowledge deficit on the part of the end user.

Decision Support gaps are when information to assist users to make decisions is not

timely. For example: a) an information system that links information required upon admission to a discharge diagnosis or b) information required at point of care becoming available after the patient is discharged.

Integration Issues are gaps between two or more information systems. These gaps become apparent when a user has to enter the same information into two or more different information systems to complete one process. They may also be identified when a user raises concerns of having to search for the same information in more than one system.

Resolution Categories

The various issues fell in to three categories based upon how they were resolved. These resolution categories provided a basis to further define the gaps in the HIS. The categories; (1) End User Knowledge Gaps (2) Customization Gaps and (3) Vendor Gaps are defined as follows:

End User Knowledge Gaps - are issues addressed by educating a user on an information system feature or function.

Customization Gaps - are issues resolved by the organizational information system support team. These are easy "fixes" that involve customizing the current product. Examples of these customizations include turning functionality off and on, adjusting settings, and adding selections to drop down lists.

Vendor Gaps - are issues that require vendor enhancements in future upgrades.

Results of DGH EDIS Evaluation

The agents interviewed raised 36 issues in total (Tables 3-5). Of the 36 issues, 4 were categorized as end user gaps. Seven of the issues were customization gaps and the remaining 25 fell into the vendor gap category. The number of times each issue was raised is not provided. The author would like to acknowledge that issues identified by more than one user may act as an indicator for prioritizing issues. Essentially, issues raised more than once may necessitate higher priority than those raised by a single user.

All of the end user gaps were of the HCI type. These issues are described in Table 3 along with their resolutions. The seven customization gaps described in Table 4 were categorized as efficiency gaps. Two of these issues required dual categorization to fully describe them. The vendor gaps, Table 5, presented the most varied of types and were the largest in number. They include thirteen efficiency gaps, four HCI gaps, three HCI/Efficiency gaps, two PSI/Efficiency gaps and one each of decision support, integration and PSI gap types.

Resolution Summary

All of the end user gaps were able to be resolved immediately. Three of the issues were addressed by educating the user who raised the issue. The issue regarding the

comments feature necessitated educating all users of the importance of keeping information up to date.

The seven customization gaps will require the site EDIS support team to investigate. Two of the issues were able to be resolved immediately. The issue of adding "Nursing Procedure" or "discharge planning nurse (DPN)" as a sign up selection was an easy fix. After discussing with end users which selection was the most suitable, DPN was added.

The second customization gap suited for prompt resolution was raised by clerical users. This user group desired a tick box for workers compensation on the triage screen. Having this information captured by the triage nurse and populating the clerical screen would improve the information flow pertaining to workers compensation patients.

The vendor gap category was the highest in number. These gaps also are the ones that end-users and site HIS support teams have the least control over. Of the 25 issues raised, 3 are already scheduled for resolution in the next upgrade. The remaining 22 will need to be reviewed for consideration in future upgrades.

In summary, the end user gaps were 100% resolved. 29% of the customization gaps were able to be modified immediately and 12% of the vendor gaps are scheduled for the next upgrade. Overall, 25% of the gaps could be addressed without delay. These results indicate that the end user gaps are those with the highest control over finding a resolution. Alternatively the vendor gaps are those the organization support team has the least control over. This highlights the significance of customer support when selecting HIS for implementation in clinical settings.

Conclusion

An evaluation without feedback to end users and other stakeholders serves little purpose. This framework provided opportunity to share the results of an evaluation of EDIS with end users and other stakeholders. Based on the authors' experience, this paper offers one framework for organizing and presenting HIS gaps. This framework can facilitate the sharing of issues raised and quickly differentiate those that are easy to modify from those that are not.

Figure: 1 Flow of patient through the ED

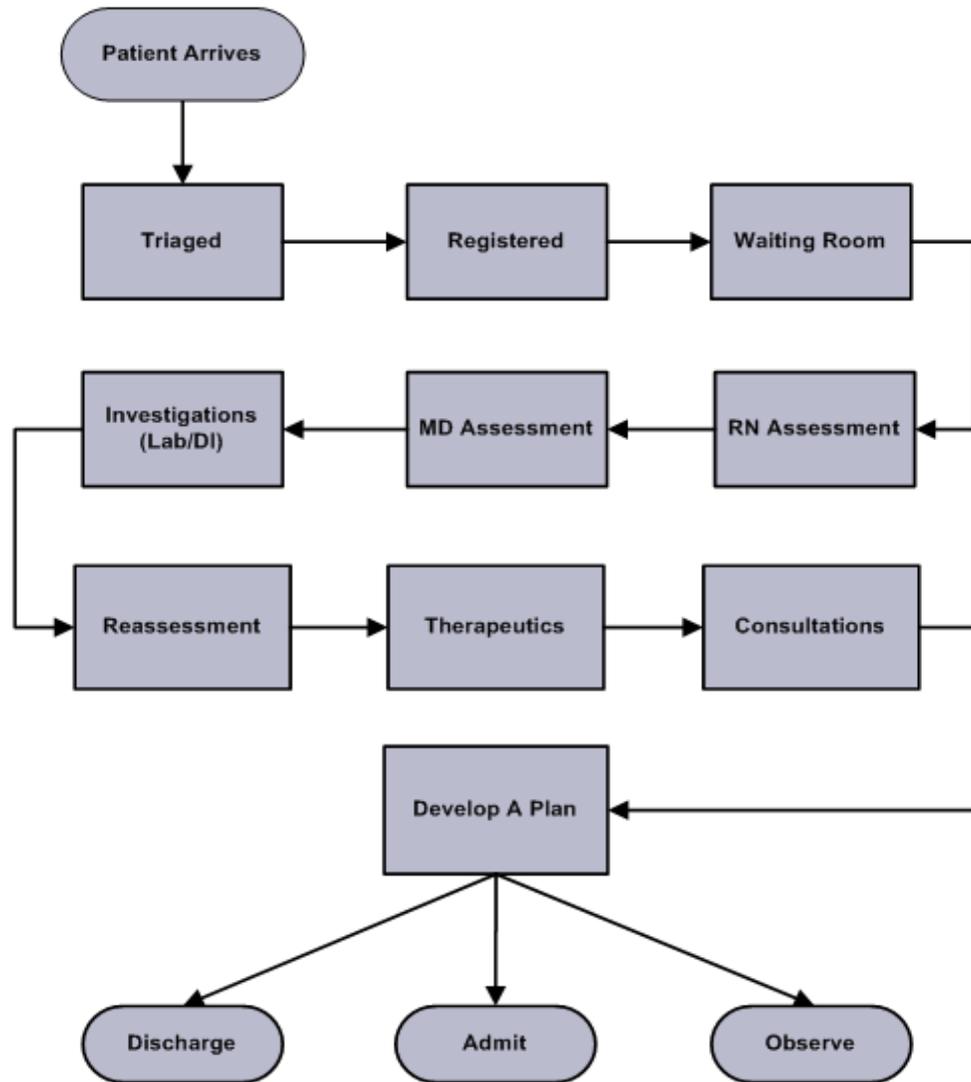


Table 1: Workflow Mapped to Agents and EDIS Functionality

Agent	ED Flow (Fig 1)	EDIS Functionality
Triage Nurse	Triaged and Waiting Room	Triage and Tracking Screens
Registration Clerk	Registered	Clerical and Tracking Screens
Primary ED Nurse	RN Assessment - Discharge	Clinical and Tracking Screens
ED Physician	MD Assessment - Discharge	Clinical and Tracking Screens
Ward Clerk	Supports the Flow Processes from RN Assessment to Develop a Plan/ Admit	Admit and Tracking Screens
Porter/ Ward Aids	Supports All Flow Processes	Tracking Screen

Table 2: EDIS Questionnaire Triage Nurse Survey

1.	Does EDIS capture all the data that is relevant for a triage assessment? Yes/No. If No, what information is missing?
2.	Is the screen easy to read? Yes/No. If No, please comment on what could improve the view.
3.	Identify one enhancement to the tracking screen that you believe would improve how EDIS supports your practice as a triage nurse.
4.	How would you describe the refresh time to the tracking screen? Very Slow ___ Slow ___ About Right ___ Fast ___ Very Fast ___ Have you noticed any factors that influence the refresh time? (i.e. departmental workload, # of patients in the Triage Re-Assess box)
5.	Have you worked in an emergency department that does not have EDIS? (alternatively did you work at the DGH prior to EDIS being implemented?) Yes/No. If Yes, has EDIS enhanced your work or impeded your work in relation to registering a patient? Enhanced/ Impeded, Briefly comment on why you feel it has enhanced or impeded your work.
6.	Has the way you communicate with your co-workers changed? Yes/No. Explain.
7.	Additional Comments: (Has EDIS improved the efficiency of the care you provide? Do you feel it has had an impact on the safety of patient care? Are there any benefits or negative aspects that you can identify to using EDIS?)

Table 3: End User (Knowledge) Gaps

Type	Issue Description	Resolution
Human Computer Interface (HCI)	It's deceptive; the text box size for the triage assessment allows you to type more than what actually prints on the chart. I would prefer to look at the patient and write on a piece of paper". (Triage Screen)	"... prints on the chart for more information. Agents can go in and look in EDIS on the Triage screen to read entire note.
HCI	Comments are ok, but can get filled with superfluous info that is not relevant to the clinical management of the patient.	Agents are all accountable for keeping the information up to date and not only entering the information but deleting it when it no longer becomes relevant. It is also essential to verbally inform of more urgent information as opposed to writing it in the comments.
HCI	Inconvenient to have to tab through all the fields to get to the next field where data needs to be input. (Triage Screen)	The agent was shown the F5 feature that automatically moves the cursor to the next mandatory field as opposed to using the tab button which will go to the next field.
HCI	Unable to edit vitals	Agent was unaware of how to edit vitals and thought they had to add a new set each time. Taught how to edit vitals.

Table 4: Customization Gaps

Type	Issue Description	Resolution
Efficiency	Would like to have a tick box for Workers compensation on the Triage screen. If this information was captured by the triage nurse and populated the clerical screen the information flow would be smoother.	Added a Workers Comp (WC) check box on the Triage screen. If checked it will show on the clerical screen. Only useful if triage nurse asks about WC and ticks the box.
Efficiency	Would be nice if an RN could sign up for returning patients who do not need to see a physician. The addition of "Nursing Procedure" or "DPN" for the times when a patient comes back to see a DPN with prewritten orders and does not need to see a physician. The way it is now we have to go and inform a physician that the patient is in the department, just so we can have a physician name to discharge the patient. It would be better if the DPN could sign up on the clinical screen and the Physician column on the tracking screen would populate with DPN or NSG Procedure.	Customizable by EDIS group. DPN added to the physician sign up selection on 19 December 2006.

(Table 4 continued on next page)

Table 4: Customization Gaps (continued)

Type	Issue Description	Resolution
Efficiency	I would like to see the chart faxed to the physicians like they do at one of the other sites (Cobequid Community Health Center). They don't mail the charts like here but they fax them. It would save a lot of work. Right now, we (1) separate the yellow copy of the chart, (2) check to see who the family doctor (FD) is and which clinic he/she works at, (3) if the FD is not in any of the common clinics, we have to check the mailbox to see if an envelope already exists for this physician, (4) if an envelope is there we can put the copy in the envelope, (5) if it's not there we have to start an envelope and create a label by looking up the clinic address in STAR or EDIS	Discharge Letter feature exists although in its current state it may not provide useful information. Survey of community physicians required to determine whether they find the notification of ED visits using the current mail out of ED record useful or would they prefer to have the faxed EDIS discharge letter. Do the community physicians have access to HPF/LIS/PACS? If not, will they be able to access this from their office in the near future? If so then it may not be redundant to provide a discharge letter.
Efficiency	I would like to see a consultant selection for sign up of the patient. Current practice is that an ERP is assigned to a patient that is coming to see a consultant.	Customizable: requires a selection of "Consultant" for the EDP column to be added for the clinical sign up selection.
Decision Support/ Efficiency	Ability to customize reports within EDIS	Customizable by EDIS group.
HCI/ Efficiency	It's hard to sometimes find the categories in the selections for presenting complaints. (Triage Screen)	Ask agents to review the list to determine if additions need to be added for Presenting Complaints and Discharge Diagnosis that come up frequently. Also inform of "Free Test" usage.

Table 5: Vendor Gaps

Type	Issue Description	Resolution
HCI	Duplication of Feature buttons that are accessible across the top tool bar on each screen.	Requires Vendor enhancement: Makes the screens to busy and takes up real-estate on the screen that could be used for something else.
HCI	Td up to date/Urine spec requested/Need med list/Not specified tick boxes on Admit/clerical screens. Information is most relevant for the Triage and Clinical Screens.	Requires Vendor enhancement: Makes the screens to busy and takes up real-estate on the screen that could be used for something else.
HCI	Vital Sign Edits: Instead of creating a new entry when a vital is edited, it would be best to just signify the edited entry with the dot and not a dot plus a second entry. Possibly a button that you could tick to track edited changes.	Customizable: Able to set editing of vitals to Modify existing as opposed to create a new set. Vendor enhancement still required to be able to view history of changes to vitals.
HCI	Slow Refresh time (Tracking/Triage)	Possibly addressed in the next upgrade.
Efficiency	The doctor/learner and ED physician fields are confusing. It would be better if the ED physician field was the mandatory field and not the doctor/learner field. They should be in reverse order on the clinical screen.	Requires vendor enhancement
Efficiency	It would be great if the consultant came across on the admit screen. Although the field is not always filled in by the nurses and doctors. It would save us from having to search for the information and put it in.	Requires Vendor enhancement.
Efficiency	It would be better for the “expects” data to populate in the triage assessment text box and not the Presenting Complaint as you can't edit the Presenting Complaint text box.	This is a Vendor issue: Information should populate in the Triage assessment text box on the Triage Screen. Requires upgrade
Efficiency	Having 2 sets of vitals display on the tracking screen (Triage Screen)	Vendor would need to redesign the triage screen to display 2.
Efficiency	Allergies/Alerts displayed on the triage screen in a text box instead of Yes/No.	Requires Vendor enhancement to triage screen. Users can view allergies/alerts by clicking on the Alerts tab in the tool bar.

Table 5: Vendor Gaps (continued)

Type	Issue Description	Resolution
Efficiency	Would like to see the Lab and DI columns show when results are back (Tracking Screen)	Scheduled for next upgrade
Efficiency	Easier ordering of X-rays from the current two step process (Clinical Screen)	Requires Vendor enhancement
Efficiency	It would be nice if it could be linked to the EKG viewer (MUSE) and HPF (Tracking Screen/Single Sign-On)	Vendor/Single Sign On solution coming within next year.
Efficiency	Easier access to prior registrations for viewing previous lab results (Tracking Screen)	Requires Vendor enhancement, currently is a 4 click process. (1) Highlight patient, (2) click Prior Reg, (3) select visit, (4) select lab results to view. Concern raised by 1 agent. Will need to discuss whether it is a required enhancement and seek suggestions.
Efficiency	It would be better if the comments for where the old chart is located could be added to the old chart feature. (Tracking Screen)	Requires Vendor enhancement but request may become obsolete over the next year with the implementation of HPF
Efficiency	It would be nice if you could enter information in the diet field on the admit screen and there was a column on the tracking screen for diets as this would save calls. It would also save time trying to create a diet list for patients that we need to order meals for. (Admit Screen)	Requires Vendor enhancement: Possibly have a list created like daily list but it would be diet list that could be accessed on the tracking screen. A button under "Orders" that will show list. This is only useful for admitted patients.
Efficiency	There are times when the patient has more than one diagnosis entered on the clinical screen but only the primary one comes across. You have to free text the remaining diagnosis in. (Admit Screen)	Requires Vendor enhancement
Efficiency	It would be nice if the consultant field had a free text option as the list changes and sometimes we go to select a consultant from the list and he/she is not in the drop down selection list. (Admit Screen)	Vendor enhancement

Table 5: Vendor Gaps (continued)

Type	Issue Description	Resolution
Integration	Information flow two ways between STAR and EDIS	This is not an EDIS issue but STAR only sends information does not receive.
Decision Support	Improve/increase Decision Support features	Requires Vendor enhancement
Patient Safety Issue (PSI)	Prior Registrations information is pulled based on the provincial health card number (HCN). If a patient presents to the ED and does not have a Nova Scotia health card the clerk will enter 0000000000 for the 10 character number. Thus multiple patients have the ten zeros for their HCN. This creates a situation where the system pulls the wrong historical records. All patients who presented with the zero HCN prior to a new presentation where the zeros are entered will be retrieved by the system. One solution may be to write a script for EDIS not to pull records if the HCN = 0000000000 or the records were able to be retrieved by another unique identifier.	Possibly addressed by Vendor
PSI/ Efficiency	If we could have the MRSA/VRE information auto-populate on to the tracking screen as opposed to writing it in the comments. It may be missed less often, as sometimes Nurses, physicians are too busy and they don't read the comments.	Requires Vendor enhancement: Can a notifier be created for these patients to signal a MRSA/VRE patient?
PSI/ Efficiency	When you access previous registrations it would be really helpful to be able to read entries from other campuses, especially with the info sharing that is happening with Horizon Patient Folder (HPF). If they want to monitor who accesses it that can be done by a mandatory password, same as making changes to the triage screen is audited. (Text Search)	Requires Vendor enhancement
HCI/ Efficiency	A drop down list for medications to save typing (Triage Screen)	Vendor enhancement required: This would work best if it was a list that matched as you started to type in information and would save time searching and typing.

Table 5: Vendor Gaps (continued)

Type	Issue Description	Resolution
HCI/ Efficiency	I find the diagnosis field can be labor intensive, clicking through fields to find the discharge diagnosis. (Clinical Screen)	You can do a text search but requires Vendor enhancement to create a drop down list that matches as information is typed in. Instead of the current touch screen design which requires you to click through until you drill down to your selection.
HCI/ Efficiency	Touch Screen Design without touch screen capability	Requires Vendor enhancement

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Title: Identifying and Categorizing Health Information System Gaps

Author: Cheryl Stephens-Lee RN, BScN

Affiliation: The University of Iowa, College of Nursing
Masters of Science in Nursing Informatics – Student

email: cheryl-stephens-lee@uiowa.edu

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