The link between life and death nursing essay

Health & Medicine, Nursing

Healthcare in Canada is big business. Healthcare spending rose to more than $207 billion CAD in 2012. It is one of the most cherished social programs and yet it is a system that has struggled to transition with changing times. In particular, with the recent struggles of eHealth, Canada is clearly not efficiently capitalizing on advanced information systems to unify healthcare at the provincial and territorial level. Ministries of Health and Local Health Integration Networks struggle to encourage hospitals to meet clinical objectives to improve healthcare access for Canadians by using various pay for performance models. But with federal budget spending plateauing, hospitals these days are increasingly pressured to do more with less. University Health Network's (UHN) emergency departments are trying to align their current work structure and strategic objectives with their use of information technology. This forms part of the hospital's balanced scorecard accountability perspective. The emergency department is looking for paperless solutions. The hospitals' core deliverables of excellent clinical care, medical education, and research all rely in part to how medical information is currently being stored, charted, and shared. In particular, the UHN's emergency departments are investigating the possibility of using a technology-based solution to improve the timely communication of essential medical data between the Toronto Emergency Medical Services (EMS) and the UHN emergency department physicians. Currently, communication is asynchronous between paramedics and emergency physicians. Communication breakdowns are common and are especially dangerous when handing over care from one person to another. Clearly this is not consistent with UHN's vision for accountability in patient care. In some cases,

a delay in relaying pertinent medical information may lead to patient morbidity and possibly even mortality. This report investigates three viable alternatives for UHN to improve the timely communication of medical information between paramedics and emergency physicians. While all three solutions have their merits, our final recommendation is for UHN's emergency department to upload electronic EMS reports to a dedicated database compatible with HL7 format. This solution would allow for secure and timely access of a patient's initial medical assessment in the field. In addition, the EMS report would be permanently linked to a patient's Electronic Patient Record and therefore accessible to all of the hospital's doctors involved in the patient's care. HL7 is the most likely format to be used for future eHealth initiatives. By using an HL7 based solution, UHN is strategically positioning itself to expand and capitalize on improved health information systems in the future.

Industry Analysis

The Role of Healthcare in Canada

Universal healthcare is one of Canada's most cherished social programs. It is also one of the most complex systems to deliver successfully. It is by no means a perfect system. Healthcare in Canada is federally funded through a series of payments and tax transfers to Canada's 10 provinces and 3 territories.[1]Healthcare spending is projected to reach $207 billion by the end of 2012 representing approximately 11. 6% of Gross Domestic Product in 2012. This percentage decreased compared to the high of 11. 9% of GDP spent in 2010. Canadians spent $4445 USD per capita on healthcare in 2010 making it the seventh largest spender of healthcare dollars in the world. As a

result of government initiatives to cut healthcare costs, the rate of annual increases on spending has slowed down in the past few years with 2012 being the lowest rate increase since 1990. Physician salaries, hospital budgets, and pharmaceutical costs accounted for 14. 4%, 29. 2%, and 15. 9% of the healthcare budget in 2012 respectively.[2]On average, provinces and territories spent about 38% of their annual budgets on healthcare related expenses.[3]Though federally funded, provinces and territories make the decisions regarding the delivery of healthcare through their ministries of health. See Exhibit #1: The Levels of Healthcare in Canada. In 1984, the Canada Health Act broadly outlined that in order for health services to qualify for federal transfers they had to be publicly administered, comprehensive, universal, accessible, and portable.[4]These 5 core principles ensure that Canadians have access to essential medical services when and where they need it.

Evaluation of Industry Forces

Health Canada is the federal department in charge of ensuring the ongoing viability of the Canadian healthcare system. The Honourable Leona Aglukkaq, the current Minister of Health, is responsible for upholding the principles and vision of healthcare in Canada, overseeing any large-scale threats to the health of Canadians, and to promote ongoing improvement of the healthcare system. In 2012, the federal government published a report through the Canadian Institute for Health Information (CIHI) called " Health Indicators 2012". This research institute uses the latest health data to help shape and guide the improvement of Canada’s healthcare system by keeping track of health and healthcare statistics.[5]Through provincial and

territorial ministries of health, federally mandated objectives are translated and disseminated through LHINs and consequently to local hospitals. Canadians are consumers of healthcare services provided by the government but also access services in the private healthcare sector. The public sector was responsible for 70% of healthcare dollars spent in 2012 while the private sector made up the remaining amount.[6]Canadian tax dollars fund essential preventative and acute medical care services. These include items such as visits to the family doctor, physician salaries, and emergent in-patient treatments and investigations. Extended healthcare services are mainly funded by the private sector. These would include items such as ambulance fees, dental visits, prescription medications, and eye care. Many of these extended healthcare services are provided via insurance plans, employee benefits, or are paid out of one's personal funds. Canada's Medicare system is the sole provider of essential healthcare services to Canadians. However, having universal access to a sole provider does not imply that all patient demands are met. In fact, there are often waiting lists for essential but not emergent health services such as hip replacements for patients with severe arthritis and kidney transplants for patients on dialysis. A 2011 report by the Fraser Institute noted that the cumulative waiting times for all procedures across all specialties in Canada increased by 104% compared to 1993 times. In 2011, 46159 Canadians paid for healthcare services in the United States instead of waiting for comparable Canadian services.[7]Currently, a two-tiered system does not exist. Canadians are not allowed to pay money to jump the queue. Clearly, deciding how to fairly

allocate limited health resources is a constant challenge for healthcare policy makers.

Extent of Globalization

Canada’s Medicare program is not unique. Many Scandinavian countries have a similarly funded universal healthcare system. But while most countries address healthcare in some way, the majority of the world’s countries do not have the same access to health coverage enjoyed by Canadians. For the most part, only Canadian citizens benefit from the Canadian healthcare system. However, with Canadians travelling abroad for business and leisure and new immigrants arriving daily to large urban Canadian cities, healthcare in Canada can no longer wholly be confined within Canadian borders. Communicable diseases such as SARS, HIV, and tuberculosis may wreak havoc across borders as easily as a plane moves from one country to another. Prime Minister Stephen Harper earmarked 0. 32% of GDP in 2012 or $5 billion for foreign aid including funds reserved for global health initiatives.[8]And with global organizations such as the Red Cross Society and Doctors Without Borders working in war torn zones and areas hit by natural disasters, healthcare can (in some ways) be a shared resource in times of need. Canadian physicians are a vocal and self-regulated group of professionals that belong to the Canadian Medical Association. Canada’s doctors influence many decisions regarding the future of healthcare in Canada and are often the main interface with which Canadians access the healthcare system. Canadian medical training is tightly regulated. After the cutbacks in medical admissions in the 1990s, medical enrollment has since increased dramatically. The number of active

physicians in Canada has increased by 87% since 1980.[9]Foreign medical graduates wishing to practice in Canada undergo rigorous residency retraining to meet strict Canadian medical standards. Canada allows only a fraction of foreign doctors to retrain and provide much needed physician support in underserviced areas in Canada. This competition for highly trained medical doctors pushes national healthcare decisions across borders.

The Importance of IT to Healthcare

eHealth has been on the federal agenda since the 1997 budget. Broadly defined, eHealth encompasses all of the uses of information technology that can be used by a health professional interacting with a patient. Doctors investigate and diagnose illnesses. Hospitals and clinics provide the necessary blood tests and imaging investigations to help doctors make diagnoses. Doctors collaborate with their colleagues and other multi-disciplinarian healthcare workers to provide a broad spectrum of healthcare services to their patients. Within one encrypted hospital network, such information is easily shared and coded under a patient's medical record number (MRN). Most hospitals use some form of an electronic medical record system to keep track of all the investigations and tests of their patients. Coded along with a patient's unique health card number, it is also a way to prevent fraudulent use of healthcare services. Sharing is limited to physicians involved in the patient's care as per the health information protection act (HIPA). It is common for a single hospital's use of information systems to be extremely multi-layered and complex. Ensuring compatibility with other systems and with new information systems initiatives is never simple. For the most part, Canadian hospitals are reliant on scanned paper-

based or dictated records that are not easily accessible to either the patient or another institution. Thus far, there is no consistent method to electronically archive and code patient information for easy recall, collaboration, and data mining amongst different hospitals. However, one patient may see multiple doctors for different ailments at a variety of hospitals in different cities. In an emergent setting, a patient may not always be taken to the hospital where the majority of his or her medical care records exist. Undoubtedly, in these situations much of this vital information could be shared efficiently via an electronic patient record system that is accessible regardless of the hospital visited. Inter-hospital compatibility is still rudimentary. For instance, since there is no common portal to make the images accessible at two different sites, it is common for imaging results performed at one facility to be faxed to another hospital where a patient is seeking emergent care. Although information technology may presumably lead to an improved accessibility to essential clinical information and decreased redundancy of tests, currently there are no nationwide standards as to how it should be implemented.

Company Analysis

University Health Network

UHN is a group of four hospitals offering comprehensive surgical and medical care services in downtown Toronto. In 1999, Toronto General Hospital (TGH), Toronto Western Hospital (TWH), and Princess Margaret Hospital (PMH) amalgamated their services into what is now referred to as UHN. Toronto Rehab joined UHN in July 2011 to provide the majority of UHN’s post-hospital care services. UHN is the largest hospital network in Toronto with

over 18500 employees, volunteers, and students.[10]Headed by CEO Dr. Robert Bell, UHN’s vision is " to achieve global impact with local accountability" by focusing on its mission of " exemplary patient care, research, and education".[11]Some notable firsts at UHN include Canada’s first clinical use of insulin to treat patients with diabetes, first successful double lung transplant, and the country’s first successfully implemented external pacemaker.

The Emergency Departments at University Health Network and Their Competitive Strategies

Ontario’s Ministry of Health and Long-term Care (MOHLTC) organizes the province’s delivery of hospital and community care into a series of 14 local health integration networks (LHINs) across the province. Each LHIN is responsible for organizing and planning the delivery of healthcare services to match the needs of the local communities it serves. Along with 14 other hospitals in Toronto, UHN’s 4 hospitals are part of Toronto Central’s Local Health Integration Network (TC LHIN).[12]See Exhibit #2: Hospitals in the Toronto Central Local Health Integration Network. TC LHIN roughly encompasses the area south of the Highway 401 to the Toronto lakeshore, with the Western border around High Park and the Eastern border around Pape and Danforth. This LHIN is responsible for the healthcare needs of 1. 14 million Ontarians.[13]TC LHIN is in charge of specifying the goals that its constituent hospitals must meet to qualify for government funding. That is, hospitals need to meet or exceed certain performance targets to gain more funding and to prevent funding claw backs." We are a caring, creative, and accountable academic hospital transforming healthcare for our patients,

community, and the world" is UHN’s purpose as a hospital. To meet its mission goals, UHN uses a balanced scorecard approach focusing on the key words " we, caring, creative, accountable, and academic" to unify the activities of the hospital.[14]See Exhibit #3: for UHN Balanced Scorecard. Broadly, UHN wishes to compete for recognition by delivering consistently on three areas: superior clinical care, medical education, and cutting edge research. Emergency doctors working at UHN are recruited and promoted based on their ability to deliver in these same three key areas. At UHN, only TGH and TWH have emergency departments with acute medical care capacity. UHN’s 60 emergency doctors provide fully accessible emergent healthcare for patients in downtown Toronto. Combined, the two sites treat approximately 320 patients of varying medical acuity levels each day. Medical services offered at both sites are to some extent complementary. For instance, congenital heart disease emergencies, transplant emergencies, and oncologic emergencies are funneled towards TGH. It is considered the " adult Sick Kids" because adults with rare diseases are treated there. TGH is UHN’s primary angioplasty centre handling major heart attacks. The hospital attracts a true cross-section of Toronto’s downtown core. It is quite common to see under housed patients being treated next to celebrities or high-powered executives on Bay Street. TGH sees a lower volume of patients but the patients seen are generally sicker. In contrast, complex neurosurgical, psychiatric, and orthopedic emergencies are funnelled towards TWH. For instance, Ultimate Fighting Championship participants get their head injuries treated at TWH. Massive strokes are triaged and treated at TWH. The hospital services a large immigrant population with 30% of patients speaking

a first language other than English.[15]TWH receives a higher volume of patients, but the patients seen tend to have a lower level of medical acuity. Having complementary services sometimes causes problems since patients who come in by themselves (and not by ambulance) do not necessarily know which site specializes in which illnesses. For instance, a patient with a broken femur will be diagnosed and stabilized at TGH but would have to be transferred to TWH for his operation. UHN is the largest academic teaching hospital affiliated with the University of Toronto's Wightman-Berris Academy (the largest academy at the university). The hospital's doctors represent 18% of the university's researchers and professors.[16]More than 300 students have their problem based learning and clinical skills groups at a UHN hospital site. In 2008, UHN became one of the primary teaching sites for the University of Toronto's Royal College Emergency Medicine residency program. Currently, about 50 emergency residents rotate through the hospital per year. UHN's emergency department has a special interest in simulation based medical education for students and emergency residents. UHN provides learners with a unique perspective on caring for complex, sick, and immunosuppressed patients with rare disease processes. Most of a student's exposure to cancer and transplant related emergencies take place at UHN. However, given the proximity of St. Michael's Hospital, Mount Sinai Hospital, and the Hospital for Sick Children, UHN currently does not have a focus on trauma, obstetrics, and pediatrics. All types of emergencies are welcomed in the emergency department, but patients requiring an admission for either of these areas would need to be repatriated to a nearby Toronto hospital with facilities to monitor pregnant women and children. The Wilson

Centre, the TGH Research Institute, and the TWH Research Institute are the main branches for UHN’s researchers to collaborate. Doctors are hired and promoted in part due to their research potential and contribution to new knowledge. UHN is a clear leader in supporting global health research initiatives. For instance, through the Toronto Addis Ababa Academic Collaboration in Emergency Medicine, UHN emergency doctors have been able to help establish a formal emergency medical training program in Ethiopia.

Market and Financial Performance at the University Health Network

Of note, 4 of the 18 hospitals making up TC LHIN are fully designated academic emergency medicine teaching hospitals. See Exhibit #2. These 4 hospitals are TGH, TWH, St. Michael’s Hospital, and Sunnybrook Health Sciences Centre. This means that most shifts at these hospitals involve clinical training of medical students rotating through their emergency medicine rotations, but more importantly include Toronto emergency residents undergoing specialty training to become fully-fledged emergency doctors. Therefore, in addition to meeting targets for clinical care as outlined by TC LHIN, academic emergency doctors at these hospitals must also meet the additional demands of delivering quality medical education and are strongly encouraged to engage in some form of medical research. Of note, waiting times are typically longer in these academic emergency hospitals since learners are typically slower than staff doctors. In addition, Mount Sinai Hospital, Toronto East General, and St. Joseph’s Hospital are also teaching hospitals affiliated with the University of Toronto. Although the emergency

departments in these 3 hospitals accept some residents for training, these residents are " off-service", that is from non-emergency medicine training programs. TC LHIN recognizes that these 7 hospitals are slightly different from other hospitals in the province. Canadian hospitals are not for profit. Nor do they generate revenue in the traditional business sense. However, hospital funding is reliant on how well a hospital meets performance targets. The main indicators for an emergency department include waiting times to see the doctor and the times taken to decide on a patient’s disposition (either discharge or admission). For emergency departments, TC LHIN created a 2010 program called " ER Pay for Results" (P4R) specifically for the above 7 academic hospitals. The main objective of this $7. 9 MM initiative was to decrease the 90th percentile patient waiting times to less than or equal to 2 hours. Hospitals were asked to meet this goal by increasing hospital capacity and by investing in IT to improve workflows. Additionally, TC LHIN’s secondary goals were as follows:[17]To have sick and admitted patients in an inpatient ward bed within 8 hoursTo have sick but non-admitted patients to be treated and discharged within 7 hoursTo have non-sick patients be treated and discharged within 4 hoursSo far, none of the TC LHIN hospitals (including UHN) have been able to meet this 90th percentile 2-hour waiting time target, although waiting times have decreased by 20% across the 7 hospitals since 2010.[18]UHN keeps personal scorecards on all their emergency doctors’ performance indicators. The December 2012 hospital emergency room data shows that despite a 5-6% annual increase in year on year patient volumes in the past few years, UHN’s two emergency departments have been able to achieve a fairly steady 90th percentile

waiting time of about 3. 1 hours.[19]Secondary goal target times have improved dramatically in the past 5 years but UHN still needs to improve by 8. 3% to meet TC LHIN's objectives.[20]See Exhibit #4: TC LHIN Indicators Compared to UHN's Performance.

Importance of Information Technology to UHN's Emergency Departments

In the hospital's balanced scorecard, the accountability perspective specifically outlines UHN's wish to take advantage of information technology (IT) to optimize the smooth flow of the hospital. UHN wishes to use IT to help facilitate information sharing, trending, and monitoring in order to make timely diagnoses and facilitate medical treatments. Shared Information Management Services (SIMS) is responsible for maintaining and accepting IT project proposals at UHN. Any physician and allied healthcare team member involved in a particular patient's care may access information from the patient's encrypted file. Currently, the UHN emergency department uses four main information systems: an electronic patient record (EPR), an electronic whiteboard, Picture Archiving and Communication System (PACS), and a Patient Distribution System (PDS). The EPR system stores a composite medical file for each patient treated at UHN. It identifies each patient using a unique medical record number (MRN). EPR stores items such as the patient's MRN, contact information, blood work and imaging results, allergies, scanned records of prior emergency visits, clinic notes, and hospital admission discharge summaries. See Exhibit #5: EPR Screenshot. The whiteboard is an electronic version of an erasable grease board. It is the main resource shared by doctors and nurses to communicate the most current status of

every patient in the emergency department. It includes information about the patient’s demographics, location in the emergency department, recent clinic notes, time of arrival, length of stay thus far, and current investigations and blood tests. The PACS system is the emergency departments method of viewing radiologic images such as XRAYS, CT scans, MRIs, and ultrasounds. Current images can be compared to prior images for all radiologic tests performed within a UHN hospital. Externally produced radiologic images on DVD may be uploaded to the UHN’s system if the patient permits this. Otherwise, PACS is hospital network specific. It is the main form of communication of results between radiologists and emergency physicians. Whiteboard and PACs screenshots are not included in this report due to patient confidentiality issues. The Patient Distribution System (PDS) is a web-based application developed by Toronto Emergency Medical Services (EMS) to help notify emergency departments regarding upcoming ambulance arrivals. EMS workers (or paramedics) communicate information such as their estimated arrival time, the patient’s CTAS score, an EMS patient trip number, the ambulance’s vehicle number, and the status of the paramedic team (active or on offload delay). PDS also tracks the time that an emergency department takes over care (TOC). Any hospital can monitor how many ambulances are flowing to all other Toronto emergency departments. PDS is used almost exclusively by triage and charge nurses to gauge incoming patient flow in order to best prepare beds and space in the emergency department. The charge nurse updates the system once the emergency department has taken over care of the patient. PDS allows the dispatcher to monitor which ambulances are on offload delay and currently

unavailable for immediate reactivation into service. See Exhibit #6: Patient Distribution System Screenshot. The above password-protected software is located on 12 computers at each hospital site. UHN's universal inbound service is based on a J2EE platform. Their interface engine is based on J2EE. EPR uses a non-SQL database based on mainframe technology. The whiteboard uses J2EE on an Oracle database. UHN uses an Oracle solution for their data warehouse. Non-operational components (such as information regarding infection control) use a . Net platform on an Oracle database.

Assessment of Information Technology's Strategic Fit at University Health Network

If patients have hard copies of their hospital treatments or DVD versions of radiologic tests performed, it is reasonably easy to reconstruct what was done at another hospital. However, patients rarely keep a comprehensive track record of their relevant healthcare information. Using a search engine called PRO in the EPR system, some scanned documents between UHN and participating downtown hospitals (like St. Michael's Hospital) may be shared. However, the scanned medical results are limited mostly to reports of imaging tests (but does not include the actual images). More comprehensive medical information such as clinic notes and discharge summaries are currently shared between hospitals via a fax request system from one hospital to another. It is important to note that this common hospital practice does not meet HIPA standards of patient information security. While the current EPR system has a moderate level of archiving ability, medical and nursing charts remain in paper form while patients are actively being treated in the emergency department. Once a patient is discharged or admitted, all

paper records related to emergency medical treatment are scanned directly into the EPR system. Once the chart is scanned into EPR there is no method of easily coding and searching the diagnostic details contained within. Scanning usually occurs within 2 weeks of a patient’s discharge from the emergency department. UHN nurses and doctors use the whiteboard to keep track of a patient’s disposition timeframe. If a patient is discharged, blood tests and reports of radiologic tests done at that particular visit may be printed out for a patient’s personal records. There is currently no way to electronically share this information to the patient’s family doctor or to other hospitals. Other than a permanent link to EPR showing a patient’s archived hospital clinic information from the past 5 years, data on the whiteboard changes hour by hour and is not kept in a permanent record. It is mainly a tool for making decisions. Sometimes patients go to different hospitals for second opinions. Sometimes patients cannot recall what tests they had done that might relate to their current presentation to the emergency department. While PRO searches help to somewhat limit unnecessary duplicate radiologic testing, doctors cannot visually compare images over time for subtle changes since only dictated reports are accessible. While PACS is useful within a specific hospital network, currently there is no way to immediately call up an image done at another hospital since this information is not linked between hospitals. Other than UHN, SIMS is also in charge of IT services at Women’s College Hospital and 7 other allied healthcare facilities. None of these other facilities are hospitals in the TC LHIN. Of note, IT at Mount Sinai Hospital, St. Michael’s Hospital, the Hospital for Sick Children, and Sunnybrook Health Sciences Centre currently use an IT service other than

SIMS.[21]This severely limits collaborative efforts between hospitals within the TC LHIN structure. In order to enhance the workflow in the emergency department and to meet TC LHIN’s targets for improving clinical care, UHN ultimately wishes to invest in paperless patient charts. Paperless systems allow improved access to patient information for all doctors and allied health professionals involved in a particular patient’s care. For instance, discharge summaries may be simultaneously sent to a patient’s family doctor for improved outpatient monitoring after a recent illness. Homecare services referrals could be made easily. A prior doctor’s record of care and investigations could also be accessed to save time during an interaction in the emergency department. In addition to saving trees and storage space, eCharts are consistently legible. As well, paperless charts allow for information coding which provides a huge source of information for future research studies. In addition to the aforementioned limitations of UHN’s current uses of IT, it is clear that the hospital is not delivering on its goal of capitalizing on the latest technological advances to improve patient care. UHN prides itself on expert clinical care as well as involvement in research. Clearly, there is a mismatch between UHN’s current information systems capability with its strategic goals and structure. Medical information should be accessible in a more timely fashion, especially when treating a sick patient. As well, if hospitals within the TC LHIN are to improve as a group, collaboration using a common information base is key.

A Business Problem:

How to Improve the Communication between EMS and the Emergency Department

Asynchronous communication of essential medical data from paramedics to emergency doctors may easily compromise a patient’s safety in hospital. Information delays are common in emergent situations. To deliver the best medical care for sick patients, emergency doctors are sometimes forced to make quick decisions regarding treatment options without a patient’s complete medical information. This is especially true when the patient is too sick to speak for himself or herself. For instance, emergency doctors rely heavily on collateral information from bystanders and first responders to help determine why a comatose patient might be sick. It could be due to alcohol use, an overdose, a head injury, a diabetic coma, or a stroke etc. In fact, in the summer of 2012, a patient who was assessed by EMS and the emergency doctor as being drunk turned out to not only be intoxicated but also head injured. Tragically, through a series of miscommunications, the patient eventually died of his head injuries. The EMS report contents indicated that the patient had fallen, but this information somehow did not get communicated to the emergency physician. Paramedics, nurses, and doctors need to have a reliable method of communicating important information to ensure timely and efficient care for their patients. Patient handover is a crucial and chaotic time in emergency medicine. Facts get miscommunicated. Assessments are affected by prior assessments. Diagnoses get anchored. It is well established that handover is the ripest time for mistakes to happen in medical care. " Caring,"[22]is a key area in

UHN’s balanced scorecard that aims for patient safety, enhanced access to care, and improvements of patient care processes in collaboration with their healthcare partners.[23]UHN’s emergency departments need to explore possible solutions to minimize the information lost on handover in order to deliver consistently excellent clinical care to their most vulnerable patients. With this in mind, this report explores several ways to improve UHN’s current system of using faxed and paper based EMS reports to communicate collateral medical information from the field to the emergency department. Ontario’s paramedics fall under the department of Emergency Medical Services (EMS). EMS works in co-operation with the Emergency Health Services Branch of the Ministry of Health and Long-Term Care to provide support organized on a municipal level.[24]Patients requiring emergent medical assistance make contact with local Central Ambulance Communications Centres (CACCs) when they dial 911. CACC dispatchers must then decide how to best allocate their EMS resources in response to the call. Factors that affect this decision include the proximity of their paramedic teams to the patient and the severity of the patient’s medical condition. Paramedics are expected to quickly assess a patient’s condition and provide only the most essential medical treatment necessary to safely get to the hospital. Upon arrival at the emergency department, the EMS team goes into an offload delay. This means that they must wait until a nurse officially accepts the care of their patient before they are free to pick up another patient. Paramedics are required to provide a brief verbal and written report of the patient’s initial health status and any treatments provided in the field. Since 2007, all Toronto paramedic teams carry a Panasonic Toughbook to

chart their medical assessments. Prior to this, EMS reports were all handwritten on carbon copy paper. Toughbooks are Windows based computers that run ZOLL medical software with a SQL server on the back end. The medical software is arranged in a series of tabs and touch screens that follow the logical steps of a patient’s medical assessment. For instance, the initial screen includes cells to prompt for a patient’s vital signs. Subsequent tab choices are arranged around body systems. This allows a paramedic to populate his or her screen with a series of treatment and intervention options most commonly associated with a specific body system. For instance, if the patient is complaining of chest pain, the cardiac screen includes intervention prompts for oxygen delivery, aspirin administration, and the initial heart rhythm strip and ECG. Once an EMS report is complete, the paramedic uploads an electronic copy of the report to the central server at EMS headquarters. After processing for about 1-2 minutes, a hard copy of the report is faxed to the hospital in question.[25]See Exhibit #7: The EMS Tough Book Screen Shot. The current process adopted by EMS and UHN involves a series of semi-automated steps vulnerable to delays and breakdown. See Exhibit #8: The EMS Report From Start to Finish. In particular, the current process involves three weak links that may result in a system failure. The first weak link starts with the timely generation of the EMS report. The Toughbook can generate a great amount of clinical detail very quickly. However, any addendums after the report has been uploaded have to go through a change request with central EMS server before being included in the faxed report. Also, since paramedics are often required to leave a hospital before finishing their electronic report, a busy team may be

several reports behind in the course of a shift. The second weak link is the fax machine. The fax machine may run out of paper and ink and get jammed. There is no one dedicated fax machine for receiving EMS reports. UHN may receive faxes from multiple sources on a busy day. The third weak link is the need for human interaction to relay information from the fax machine. This is not an automated process. Unit clerks are responsible for periodically checking the department’s fax machine to sort through the information received. EMS reports are then filed in the patient’s information slot and sometimes attached to the nursing and doctor’s chart with a paperclip. However, in addition to filing faxed reports, unit clerks are also responsible for paging, receiving calls from the public, filing charts, and faxing off clinic referrals. Of note, the current process involves sending confidential patient information over a telephone line. Strictly speaking, this does not meet HIPA standards for patient privacy. As depicted in Exhibit #9: Sources of Communication Breakdown, timely communication of patient information is an essential element of quality patient care. Sometimes this information can be life saving. The current faxed and paper-filing system used is subject to system failures but there are many ways that communication can also be lost in the emergency department. UHN clearly indicates their special focus on providing safe and timely patient care. Here is an opportunity to resolve some of the issues between pre-hospital and emergency care. UHN has prioritized information management and information integration into their 2016 strategic planning process.[26]Over the next 5 years, UHN would like to leverage IT and streamline its SIMS projects to demonstrate their accountability to patient care.[27]With the

proper use of technology, important information included in EMS reports may be automatically linked to a patient’s hospital record in a stronger form than a paperclip. The goal is a collaboration that is simple, efficient, and effective.

IT and Non-IT Based Solutions

Three possible solutions will be evaluated against the criteria outlined in Exhibit #10: COWS (Criteria, Options, Weights, Scores).

Alternative #1: Modify the Current System to Enforce a Closed Loop of Communication

As depicted in Exhibit #8, the current process of faxed and asynchronous EMS reports has many potential points of weakness. Paramedics may have already left the hospital and be en route to another emergent call before the electronic report is uploaded to the EMS central server and subsequently faxed to the hospital. When waiting times are short in the emergency department, a physician may already see a patient before the collateral report is generated. Also, paper reports can get misplaced easily. There is currently no method of confirming that the right information got to the most responsible physician in charge of a patient’s care. The first alternative is a non-IT based solution to close the loop of communication so that information is not lost at any step. This alternative requires that paramedics stay in the hospital until their report is completed. With this alternative, we also recommend that UHN’s emergency departments dedicate a fax machine to receive only EMS reports. This fax machine is to be used solely by EMS staff. Typically, it takes EMS central about 2 minutes to turn around and fax an EMS report that has been uploaded to their central server. In this alternative, paramedics would be responsible for picking up their report from the

dedicated EMS fax machine, verifying the salient medical details within, and then hand delivering the document to the unit clerk for patient filing. They would then inform EMS central that the report arrived safely and that they would be ready for the next call. In the event that the fax machine is not working properly, the paramedics will contact UHN support staff to immediately address the problem. EMS staff will provide a hand written report if they are unable to get the report through the fax machine in a timely manner.

Strengths of Alternative #1

This alternative allows paramedics more control over the timely and reliable delivery of their medical assessments. It allows them to formally acknowledge and ensure a clear handover of care to UHN staff before leaving the hospital. Any clarifications the nurse may have may be dealt with before the paramedics leave the department. This closed loop of communication is often used in medicine to ensure that both parties agree on the information being shared and that both are clear regarding future steps. This alternative establishes clear responsibilities for the paramedic team and the nurse accepting the care of the patient. Information regarding a patient’s initial assessment and any interventions made thereafter form part of the patient’s medico-legal document. If for some reason the EMS report does not arrive on time, the paramedics would be responsible for the loss. In medicine, if something isn’t written it didn’t happen. Furthermore, this alternative does not require any investment in IT changes for EMS and UHN. Other than the negligible cost of purchasing a dedicated fax machine, this solution is inexpensive to the hospital and doesn’t incur any direct costs

to EMS. Since all Toronto emergency departments currently received their reports via fax, it is a process change that (after a short time of training) could quite easily be scaled to any Toronto hospitals interested in making these changes.

Weakness of Alternative #1

Although still using a fax machine to relay the information, a verified and dedicated fax machine number ensures that the report gets sent to the correct recipient. This is more secure than the current method of a generic fax machine but still does not meet HIPA standards for patient information confidentiality. Paramedics must stay at the hospital until the report is delivered. Although this does not directly cost more money to EMS, the opportunity cost is that EMS teams may sometimes have to spend more time in offload delay before being reactivated into the field. This would only be a problem if the emergency department was not busy and handover would otherwise occur quickly. In these cases, offload delay times would be quite short and waiting for a report to be confirmed would be the rate-limiting step. Adding this built in delay partially defeats EMS Dispatch’s goal of making their staff more mobile and available in the field. One of the reasons behind using Toughbooks was to allow paramedics to easily generate and upload electronic reports regardless of where they were physically. Toughbooks were meant to help boost the number of calls a team could do in a shift. Therefore, this alternative may not seem that palatable to EMS. With this alternative, the EMS report would still be paper based resulting in only one live copy of the report. This does not really add any improved coding and sharing ability of the document and does not take advantage of

HL7. Alternative #1 is essentially an implemented behavioural change that would require buy-in in order to work effectively.

Alternative #2: Generate a PDF Version of the Report Linked to the Existent Patient Distribution System

The PDS provides hospitals the ability to view the list of patients imminently arriving by ambulance coded by unique EMS identifying numbers. PDS keeps a daily archive of ambulances that have left the hospital for that day. With this alternative, EMS would modify the PDS software by providing access to the electronic report directly through the patient's record. See Exhibit #11: Modified Patient Distribution System With Linked EMS Report. Since PDS refreshes the screen every 30 seconds, it will also check for the completed reports and update a patient's record accordingly. Anyone in the emergency department could then conveniently access the report once they saw the report link on the PDS screen.

Strengths of Alternative #2

With one fairly straightforward software modification[28], hospitals would have improved accessibility to electronic EMS reports. The costs would be minimal (approximately 120 hours). Once paramedics upload the EMS report to the central server, the report would be automatically available in the PDS within 30 seconds. The software automatically refreshes every 30 seconds to indicate the latest report availability. Since EMS' central dispatcher and Toronto emergency departments all use the same PDS, it would be easy to tell at a glance which EMS reports had already been made available and which ones were still pending. All Toronto emergency departments would immediately have access to these links so scalability would be inherent with

the modification. A brief orientation to the new link would be all the training necessary for hospital staff. Only people who are allowed access to the PDS would have access to these reports. PDS is only available on certain computers in the UHN emergency department. For example, the triage nurse and the charge nurse have this software available on their computers. These computers are solely used by the nurses in charge and are located behind a barrier preventing easy public access. Doctors and nurses have the choice of viewing the report from the screen or having it printed. Lost paper reports could easily be re-printed. The report could be saved as a blob (binary large object) in the EPR database as part of the patient's future report. A blob is a database data structure type that is used for storing pictures, audio files, etc. However, this additional functionality would require a software change in UHN's current information system.

Weaknesses of Alternative #2

This alternative has a few significant drawbacks. This information would still have to be eventually scanned into the patient's EPR file for archival purposes to become part of the patient's permanent health record. This can be time consuming and there will be a delay before the information would show up in EPR. This information would be scanned into EPR as is. There would be no possibility for coding diagnosis or search terms within the report. This method is not HL7 complaint. Moreover, once the patient's record on PDS is cleared from the queue, the report would also be cleared. Unless the report is saved locally or printed, the report will be lost. Alternative #3: Upload the EMS Report to EPR in HL7 FormatThis solution would allow an electronically generated EMS report to be uploaded to UHN

via an HL7 compatible interface and stored in a patient's EPR file. The information would be stored and accessible as one of the links in EPR. A patient would require a unique EMS number that could then be matched to the patient's unique UHN MRN to allow the information to be accessed appropriately. Once implemented, it would allow UHN to store all of a given patient's EMS report information in the EPR system where it could be then used by any healthcare professional in the hospital network.

Strengths of Alternative #3

Alternative #3 has three main advantages over the other two solutions. Firstly, it would automatically allow for information collaboration throughout the hospital by centralizing EMS reports in EPR. While emergency physicians are the doctors that work most closely with paramedics and therefore would use EMS reports the most, occasionally paramedics transport patients to hospitals but are requested to bypass the emergency department. For example, Code STEMIs may occasionally be determined in the field. Paramedics have the ability to transport these patients directly to the percutaneous coronary intervention suite for angioplasty. Occasionally, the Code STEMI is not a true code and therefore the cardiologist will request an emergent stabilization in the emergency department before the patient is safe for admission. Regardless, currently the EMS report will by default go to the emergency department and may not necessarily follow the patient's actual movement in hospital. Secondly, this solution is HL7 compliant. Any future move on UHN's part to go to paperless charts will likely be HL7 based. This could be the first step. Electronic coding and storing would allow information to be searched for retrospective research purposes. This could

be a huge data source for physicians interested in pre-hospital research. Thirdly, this solution would abide by HIPA standards for patient medical privacy. All information flowing from EMS to UHN would be encrypted. Security is very important to hospitals and this solution would help UHN meet HIPA standardsIn addition, since this alternative fully automates the flow of information, there is less reliance on data entry errors. This solution would be easy to use, would be reliably reproduced, and would be timely. Information would be accessible at a click of a button on EPR. Minimal training would be necessary since all healthcare workers at UHN already get EPR training before working at the hospital.

Weaknesses of Alternative #3

Alternative #3 requires a larger investment in information systems changes for Toronto EMS and UHN. For instance, UHN currently uses an HL7 2. 3 version of XML that is not compatible with EMS' information systems. Therefore, the EMS system would first have to convert the XML report to TEXT before the systems could share information. UHN's universal inbound service can only handle HL7 version 2. 3 which is based on an XML-like text structure. Furthermore, when UHN upgrades to HL7 version 3 in the future, the hospital would require EMS to make changes to accommodate these upgrades. This alternative would require changes in both systems and would incur additional costs for the two entities. The project will be subject to project steering approval from both sides. Its estimated cost would be about 300 hours for EMS's and 250 hours for UHN's IT teams respectively. The third significant change would require EMS to invoke UHN's Universal Inbound Service, a web service that is used by parties external to UHN. UHN's

information system will have to be changed to process the record in its integration engine in order to enable its EPR system to store the data from the report. This change will take four to five months to complete. Only hospitals willing to adapt their current information systems would be able to adopt this solution, therefore scalability is not as easily accomplished as with the other alternatives.

Recommendation

Please refer to Exhibit #12: COWS Table Analysis of the Three AlternativesWe recommend that UHN’s emergency departments implement alternative #3 since it is most consistent with the department’s goals of capitalizing on information technology to provide timely, reliable, and excellent patient care. In addition to receiving the highest COWS scores, alternative #3 would result in significant benefits at a reasonable cost. Of the 10 criteria we deemed important to UHN’s solution, four were deemed especially important to a successful solution by Dr. Sam Sabbah (the project’s main business contact). These criteria were timeliness of report generation, reliability, security, and cost. Clearly, timely handover of critical information was the driving force behind this study. EMS reports would be integrated into EPR in a fully automated manner. Reliability is essential since doctors and nurses work in a chaotic environment where communication breakdowns are common. When information goes missing, it is the patient that suffers. Patient information security is essential to maintaining patient-physician confidentiality. Hospitals take patient confidentiality seriously. As professionals, physicians need to protect their patient’s medical information and do due diligence to ensure only those

actively involved in a patient’s care have access to private information. Lastly, hospitals have to keep in mind budgetary constraints in times of lean federal funding. Finally, although this solution requires an initial investment in IT, it provides the most lasting long-term benefits. Given that health institutions are continuously moving towards adopting HL7 compliant systems, this alternative (which is based on HL7 implementation) will facilitate the adoption of eHealth type solutions and reduce the work associated with future migrations. By taking the first step to use HL7 to systematically store EMS reports, the hospital would start to gather data in a format that could be systematically coded and searched. This data would then be a huge resource for future pre-hospital research projects. Clearly this is in line with an academic hospital’s goal of using research to advance medical knowledge. This solution uses a technology-based solution compatible with HL7 that would allow inherent system compatibility should the department’s 5-year goal of paperless healthcare charts materialize.

Action and Implementation Plan

Detailed Changes Required of EMS

See Exhibit #13: Diagram of an HL7 Based Solution

EMS must implement a Listening Service (EMSReportListener) that will be notified as soon as the EMS report gets uploaded onto the EMS central server. The EMSReportListener is based on a messaging service and will subscribe to receive events of the type " EMSReportEvent". Upon receiving the notification, the EMSReportListener will invoke the Reports Generator (ReportsManager). The ReportsManager is a new component that can potentially generate reports of different formats. For our solution, the

ReportsManager will use a utility class that will convert the report from XML (EMS' current data format) to Text. Once converted, the ReportsManager will invoke the UHN Universal Inbound service providing the EMS report in its payload.

Detailed Changes Required of UHN's IT Department

UHN must implement a special handler (EMSReportHandler) for EMS reports that will be part of its integration engine. This handler will provide a mechanism to make the EMS report identifier unique by appending the EMS identification number to the system date. The EMSReportHandler will then use the patient's provincial health card number or the patient's UHN MRN to match the two systems. If both numbers are not available, the system will use the name and birth date as a secondary identification number. If the patient is admitted to the emergency department via ambulance multiple times in a day, the system will create a different record for every visit. In the event that the patient has never sought treatment at the hospital, UHN will provide a mechanism that queues the EMS report until the patient has been registered and assigned a unique, lifelong MRN. The system will check every 30 seconds to determine if the patient has been registered. Once the patient is registered into the hospital system, the EMS report will be pushed into EPR automatically.

Technical Implementation

EMS' Current Workflow: The EMS data is uploaded from Toughbook to the EMS central server through the invocation of EMS inbound web serviceThe EMS data is handled by the EMSReportsHandler module which stores the

EMS data in the EMS databaseEMS Reports Daemon faxes the report to the corresponding hospital (in this case UHN)Recommended Change to EMS' Workflow: The new workflow requires EMS to make the following changes: Implement a new module " EMSReportsListener" that is based on a messaging service such as " Java messaging System" to receive EMS report eventsImplement a new event type EMSReportEvent (this event will be used by EMSReportsListener to register with the messaging service to get notified when the report is uploaded by the paramedics)Implement a data conversion module that converts data between different data formats such as Text and XML (for this solution it is sufficient to provide conversion from XML to Text)Implement a new module " EMSReportsManager" that manages the EMS report data conversion and the communication with UHN's universal inbound web serviceProposed New Workflow for EMS: The EMS data is uploaded from Toughbook to EMS' central server through the invocation of EMS inbound web serviceThe EMS data is handled by the EMSReportsHandler Module which stores the EMS data in the EMS databaseEMSReportsHandler sends a notification to registered listeners (in this case EMSReportsListener) that a report has been receivedEMSReportsListener retrieves the report from the databaseEMSReportsListener invokes EMSReportsManager to prepare the report data in a format desired by the intended recipient (UHN)EMSReportsManager calls the conversion module to have the data converted to HL7 Text formatEMSReportsManager calls UHN universal inbound web service to pass along the EMS report in HL7 Text formatUHN's Current Workflow: EMS report is received by fax and is filed by hand into the patient's file boxRecommended Changes to UHN's Workflow: The new

workflow requires UHN to make the following changes: Implement a new module " EMSReportHandler" in the integration engine component (this module verifies a patient’s data and stores it in EPR and also provides a mechanism to make the EMS report identifier unique by appending the EMS identification number to the system’s date)Proposed New Workflow: The report is received by UHN inbound web service which passes it to the integration engine by calling EMSReportHandlerThe EMSReportHandler uses the health card number or the MRN as the primary identification of the patientIf neither is available, the system will use the name and the birth date as a secondary identification numberUnique EMS records are generated in the case that a patient uses EMS to visit the hospital more than once in a dayIf the patient has not yet been registered in the hospital, UHN will provide a mechanism that queues the EMS report until the patient has been registeredThe system will check every 30 seconds if the patient has been registeredOnce the patient is registered, the EMSReportHandler will push the EMS report into EPRThe EMS data will be available to all healthcare professionals with EPR access who are involved in the patient’s care

Project Plan Proposal

Please refer to Exhibit #14: UHN IT Vital Link Project

Prepare the Business Case

This initiative involves two parties: Toronto EMS and UHN. For both parties to undertake this initiative they need to agree that it aligns with their business strategy. A business case detailing the business problem, the list of possible alternatives, their costs and benefits, and a recommended alternative would

help UHN and EMS to decide whether to support this initiative or not. This report would form the foundation for such a business case.

Present the Business Problem

The business problem is about making process changes to how EMS data is shared and communicated to the emergency staff at UHN. Strengthening this communication channel could potentially save lives. A stronger IT partnership between EMS and UHN through more effective data and information sharing could have great benefits to the community as a whole.

Alternatives and Recommendations

Provide EMS and UHN stakeholders with the list of alternatives and the recommended option. For each alternative provide the pros and cons, lists of constraints, challenges and opportunities. For the recommended option, state the reasons why it was chosen, its cost and benefits analysis, and the implementation strategy.

Project Approval

The business case must be presented to EMS' and UHN' respective project steering committees to decide whether to proceed with the initiative or not. EMS and UHN will evaluate this initiative against competing initiatives that they are considering for possible implementation. A project proposal that includes a clear problem statement, list of stakeholders, a high level cost estimate, and the perceived business value would be required to complete the evaluation and gain approval to go ahead.

Project Planning

Once the project has been approved, the project steering committees from EMS and UHN need to assign project managers to manage the project. Alternately, EMS and UHN can agree to have one project manager to manage the project for both sides. In this case, the project manager must be given sufficient support from both sides to carry on his/her project managing duties successfully. Given that the EMS report information will become available to UHN in the form of parse-able data, many UHN subsystems may be interested in this data. The UHN project manager needs to identify those subsystems that may benefit from the data and inform them of the proposed changes to seek their input. Since UHN will be making changes to their interface engine, this would be the best time to identify any special changes and requests to determine if they are within the scope of this project. This project can be the beginning of greater cooperation between EMS' and UHN' IT departments. It is essential that upon approval of the project proposal that IT staff from EMS and UHN meet and discuss the requirements in greater detail. This would be the chance for both teams to form a joint governance body that would meet on set dates to discuss systems improvement and integration. These two teams may find opportunities for efficiencies and better practices through the sharing of information and best practices. This proposal is based on a very high-level problem statement. Given that the proposal has been accepted in principle, a detailed list of requirements would be necessary before the project could be initiated and scoped appropriately. Since the project involves two independent business entities (though partners), it is important to have a clear set of requirements from

both sides. Besides the functional requirements, both parties must agree upon and document their non–functional requirements. For example, these might include the number of retrials in the case that UHN's web service is unavailable, how long EMS must store records in their database, or whether EMS should get an acknowledgement from UHN confirming that the report has been received. For this project to be successful, UHN and EMS must work closely together to identify the dependencies, required interfaces, and expected data structure. Although UHN has an external universal web service, the web service does not accept a standard data structure that external entities can use. Therefore, UHN will have to provide EMS a detailed description of the web service and expected data structure to be used. Moreover, UHN will need to set up a testing environment so that EMS can test their implementation directly against UHN's systems. As soon as the IT team determines the project's requirements, they will need to provide high-level estimates for implementing the specified requirements. These estimates must include all activities from gathering requirements to the eventual system delivery.

Implementation

Given that the project involves two different software development teams and requires frequent integration in order to avoid surprises, we recommend that the agile methodology be used to implement this project. The two IT teams from EMS and UHN can start working in parallel iterations of the same length--preferably two weeks long. At the end of each iteration, the two teams will share development status, outstanding issues (related to

integration, testing, requirements clarity, etc.), and mutually decide on the next iteration target.

Solution Delivery

Once the system changes are complete and deployed to the production environment, the EMS report data will become available to multiple UHN departments. In order to ensure business continuity, we recommend that EMS continue to fax the reports for one full month before turning off the service. This will allow UHN staff some time to adapt to the new system while ensuring that the new process operates as expected.

Complete Service Level Agreement

When two independent entities partner to provide a solution that is beneficial to both parties, the must agree on the rules of engagement and expected behaviours of both systems so that ongoing maintenance costs are reduced and unnecessary work is avoided. EMS and UHN IT must share their system’s maintenance schedule.

Key Success Criteria

Senior management support from UHN and EMS to carry on the project’s workClear requirements from both partiesEstablish a joint governance body between UHN and EMS to monitor the project’s progress and impeding issuesContinuous integration and testing between EMS’ and UHN’s information systemsAgree on the data structure used in the web service and the resolution for unique identification for the EMS record

Glossary of Terms

Anchoring: when a patient is labeled with a diagnosis that is perpetuated despite medical evidence to the contraryAngioplasty: a medical procedure to use a balloon to open up a blocker coronary arteryBlob: A binary large object that is a collection of binary data stored as a single entity in a database management system[29]Charge nurse: the nurse in charge of maintaining patient bed flow within the department; works closely with the triage nurse and emergency doctor to ensure timely disposition decisionsCode: a situation requiring immediate resuscitation effortsCode STEMI: a massive heart attack (ST elevation myocardial infarction)Collateral: information provided by someone other than the patientCTAS: Canadian Triage and Acuity Scale that describes how sick a patient is (CTAS 1 is a patient requiring a resuscitation, CTAS 5 is a minor injury)ECG: electrocardiogram, an electronic representation of the heart’s activityField: refers to anything happening outside of the hospitalHandover: the time when a patient’s care is transferred from one healthcare professional to anotherHL7: Founded in 1987, Health Level Seven International (HL7) is a not-for-profit, ANSI-accredited standards developing organization dedicated to providing a comprehensive framework and related standards for the exchange, integration, sharing, and retrieval of electronic health information that supports clinical practice and the management, delivery and evaluation of health services. HL7's 2, 300+ members include approximately 500 corporate members who represent more than 90% of the information systems vendors serving healthcare[30]. HL7 Standard: HL7 and its members provide a framework for the exchange, integration, sharing, and

retrieval of electronic health information. These standards define how information is packaged and communicated from one party to another setting the language, structure and data types required for seamless integration between systems. HL7 standards support clinical practice and the management, delivery, and evaluation of health services, and are recognized as the most commonly used in the world[31]. Offload delay: the time that an ambulance waits in the emergency department before the emergency nurse accepts their patientPercutaneous Coronary Intervention: a procedure involving peripheral access to the coronary arteries to decide if a heart attack is due to a blockage of a blood vessel(s) that may be opened up using a series of stents and balloonsTriage nurse: the nurse in charge of assigning a CTAS score to each patientVital signs: heart rate, respiratory rate, temperature, blood pressure, and oxygen saturationXML: Extensible Markup Language (XML) is a simple, very flexible text format derived from SGML (ISO 8879). Originally designed to meet the challenges of large-scale electronic publishing, XML is also playing an increasingly important role in the exchange of a wide variety of data on the Web and elsewhere[32].