TELEHOSPITALIST PROGRAM AT SWEDISH MEDICAL CENTER:

OVERVIEW AND CASE STUDY OF A NOVEL TELEMEDICINE APPLICATION

By

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Abstract

Swedish Medical Center (SMC) in Seattle has been performing acute medical hospital admissions via Telemedicine since 2012. To date, no studies have been published to determine if this novel technological application is safe and effective. Telemedicine applications (namely, Telestroke and Tele-ICU), coupled with the shortage of physician resources, have been the basis for the creation of a “Telehospitalist” model. The current Telehospitalist model at SMC, including the technological and training requirements involved in its operation will be described in this capstone.

A case study of a non-critical medical patient admitted to the hospital via telemedicine will be presented. This case shows a successful patient Telemedicine admission, as evidenced by the determination of an accurate early diagnosis and prompt initiation of treatment, patient improvement and hospital discharge with no complications, and an overall favorable patient experience.

In conclusion, telemedicine may be a safe and effective way to conduct acute medical hospital admissions that do not require critical care services, and could represent a paradigm shift in the way patients are evaluated and admitted to the hospital when clinician resources are scarce.

Introduction and Background

The American Telemedicine Association defines Telemedicine as “the use of medical information exchanged from one site to another via electronic communications to improve a patient’s clinical health status. Telemedicine includes a growing variety of applications and services using two-way video, email, smart phones, wireless tools and other forms of telecommunications technology” (1).

Certain uses of this technology have been demonstrated to be effective in the acute care setting; for example, Telestroke applications have helped rural emergency physicians make the determination of whether to use thrombolytics in patients with acute stroke symptoms in communities where timely neurological consultation is not available (2). Observational studies in Telestroke have shown favorable outcomes when comparing face-to-face and videoconferencing-assisted thrombolysis, with no significant differences in survival and intracerebral bleeds (3). Telemedicine is also being utilized in the intensive care unit (ICU) setting, applying technology to provide care to critically ill patients by off-site clinical providers. A systematic review in 2011 has also shown Tele-ICU coverage is associated with lower ICU mortality and length of stay (4). Other studies have also shown improved clinical outcomes and hospital financial performance, as well as cost-effectiveness (5, 6). Telemedicine can potentially be used to remotely evaluate and perform hospital admissions of certain acutely-ill medical patients that require hospital care, especially in underserved areas where there are shortages of physicians (7, 8) or in other areas where leveling of physician resources cannot be achieved otherwise (9).

This capstone seeks to show that telemedicine (in the form of a “Telehospitalist” program) can potentially provide immediate, remote reliable evaluation of certain medical patients requiring admission to the hospital (after bedside evaluation by an Emergency physician) where an internist or hospitalist may not available at the bedside for several hours, therefore making it possible to make an early diagnosis, immediately discuss the treatment plan with the patient and his family, and initiate treatment without delays (10).

At a larger scale, this new Telemedicine approach can also assist in more effective use of workforce resources by linking appropriate experts at central sites to patients and practitioners at remote sites. Positive effects on recruitment and retention of health providers and morale of the local workforce could then be expected as a result of this collaborative effort (11, 12, 13).

An appropriate and reliable audio-visual infrastructure, including reliable and HIPAA-compliant, encrypted Internet connectivity is a prerequisite for successful program development, deployment, and operation (see Appendix B). Thoughtful and targeted physician and telepresenter (usually an experienced RN facilitating the admission process at the bedside) training is paramount for the success of a telemedicine admissions program (14).

Telemedicine admissions – if safe and effective – may prove to be useful as an adjunct to future modes of acute care delivery (for example, the “Hospital at Home” model) (15). The key to telemedicine success in the future is to view it as an integral part of health care services and not as a stand-alone project (17). Evaluation of patient satisfaction is paramount to ensure widespread acceptance of this technology as a new method of health care delivery (18).

After thorough literature review, no studies evaluating the safety and effectiveness of the use of telemedicine as a substitute for bedside evaluation of medical patients requiring acute medical hospital admission by a physician were found. Showing the safety and effectiveness of a telemedicine admissions (“Telehospitalist”) program is the first step in the integration of this technology into the health care delivery of underserved populations, especially in light of the current and predicted hospitalist shortages (19).

In this paper, the background and rationale behind the initiation of the Telehospitalist program at Swedish Medical Center in Seattle, WA (SMC), including a description of the different technological and clinical pieces that make up the program are detailed. Finally, a case study showing the viability and efficacy of this program, as well as the satisfaction with this new approach to acute medical care from the patient and family perspectives is reported.

Telehospitalist Program at Swedish Medical Center (Seattle, WA)

Swedish Medical Center in Seattle, WA has been utilizing telemedicine since 2004, with the inception of its Tele-ICU program, followed by Telestroke in 2007, and the Telehospitalist program, initiated in 2012 (20).

SMC's Tele-ICU program was established as a solution to the immediate problem posed by a prolonged shortage of available intensivists, in order to provide intensive care coverage for two of the three SMC hospitals in the central Seattle area during nighttime hours. The teleintensivist was located in a central hub away from the ICU, and had real-time access to all patient's telemetry monitors, vital signs, and oxymetry readings in both ICUs (with an average 40-50 combined patient census), allowing for rapid evaluation of acute or active patient issues during the night. The monitored ICU rooms were equipped with a camera and two-way audio communication equipment, which allowed nurses and other bedside providers to discuss any clinical concerns with the remote intensivist in real time. The intensivist had real-time visual access to the patient via the camera in the room. No peripheral equipment (digital stethoscope, otoscope, etc.), however, was yet available at this time, and no admissions were performed remotely via Telemedicine.

SMC's Telestroke program was initiated three years later to provide remote Neurology consultation to area Emergency Departments that lacked a readily available neurologist in the local community. This program was the first at SMC that utilized real-time patient evaluation via two-way audio-visual interaction between the patient and the treating Emergency Physician requesting the consultation at the bedside, and the remote teleneurologist in order to expedite critical decision making in regards to whether to use thrombolytics in patients presenting with acute neurological deficits. These two programs are still active and thriving to this date at SMC.

Given the success of these first two Telehealth- based programs, a Telehospitalist program was proposed initially to leverage night hospitalist (nocturnist) coverage among the three SMC campuses in Seattle: Swedish First Hill (FH), Swedish Cherry Hill (CH), and Swedish Ballard (SB), in order to accommodate surges in workload at the main two downtown campuses (FH and CH) during evening and nighttime. These surges were infrequent enough that the hiring of a second fulltime nocturnist to cover the downtown campuses was not economically justifiable or feasible, but certainly overwhelming enough when they happened that additional physician coverage was needed during those critical “flood” points to provide timely and safe inpatient care.

This was initially accomplished by having a nocturnist physically travel to one of the two downtown campuses, leaving their home base campus (SB, about 10 miles away) temporarily uncovered for new admissions. When a patient would require admission at the SB campus and their assigned nocturnist was assisting the downtown “surge”, a delay of care of up to six hours would occur before the patient could be evaluated at the bedside. As a result, the Telehospitalist program was implemented to facilitate prompt patient evaluation from the remote location when bedside evaluation was not immediately available.

The selection of patients to be evaluated via Telemedicine was solely determined by the location of the nocturnist at the time of admission; if the nocturnist were needed downtown, telemedicine would be used, and if the nocturnist were physically present at the SB campus, a usual bedside admission would be completed. The design of the telepresenter role (a health care provider -usually a trained RN skilled at physical assessment- that facilitates the remote telemedicine evaluation by explaining the procedure at the bedside to the patient and his/her family, establishing the computer connection with the physician's workstation, and conducting the physical evaluation with the aid of the digital peripherals under the guidance of the remote physician), the admissions workflow, as well as the telepresenter and telehospitalist training programs were the product of a multidisciplinary technical and clinical team at SMC (see Appendices C and D).

A small pilot study was conducted between July and October 2012 at SB, a small community hospital with no ICU or intermediate Care Unit (IMCU) beds, where medical patients were admitted to the hospital from the Emergency Department via telemedicine. This process utilized a telemedicine cart equipped with a two-way, high-resolution, audio-visual encrypted connection and peripheral attachments, including digital Bluetooth stethoscope, otoscope, ophthalmoscope, and high-resolution hand-held camera (see Appendix A). A nurse telepresenter conducted the exam at the bedside while the physician directed the encounter sequence remotely. Patients were selected based on level of acuity (patients not requiring hospital care in an ICU or IMCU setting, deemed to be “medically stable”) after evaluation by an Emergency physician in the Emergency Department. No direct admissions (i.e., admissions from remote locations other than the SB ED) were included in this pilot.

Case severity index was equivalent to patients admitted by a bedside physician, and included diagnoses such as sepsis, pneumonia, GI bleed with acute blood loss anemia, asthma exacerbation, neutropenic fever, acute pancreatitis, atrial fibrillation with rapid ventricular response, syncope, and acute encephalopathy. Diagnostic accuracy (by comparing admitting diagnosis vs. discharge diagnosis), length of stay, unexpected transfers to a higher level of care, hospital readmissions, and patient satisfaction were compared.

After pilot completion, and given the overall positive results, SMC transitioned the pilot program to a full Telehospitalist program in October 2012, which has since been expanded to the larger Providence Health System (which SMC is a part of). SMC has also developed an inpatient Telepediatrics program, and outpatient Telepsychiatry and Teledermatology services based on the success of the Telehospitalist program.

Telemedicine is now being widely utilized in the outpatient and home care settings for monitoring chronic illness; for example, it has shown to be effective in the remote evaluation and diagnosis of skin cancer (27), and in the long-term management of hypertension (28) and diabetes (29). The motivation for the selection this capstone topic is the fact that the value of existing Telehospitalist programs and their inpatient Telemedicine applications has not been formally evaluated via published quantitative research; available literature is very scarce regarding the details of these programs' design and operations, their safety and efficacy with regard to patient care, and overall patient satisfaction with their implementation. Given that this novel Telemedicine application could represent a paradigm shift in the evaluation and care of medical patients being admitted to the hospital for further care, possibly challenging the "gold standard" of bedside physician evaluation, further investigation and research is needed to evaluate its clinical, economic and societal value.

Methods

Literature Search Strategy

I conducted a literature search utilizing the OHSU Library Database access website and the Swedish Medical Center library. Ovid Medline, Global Health, and EBM reviews were queried with the terms "acute telemedicine", "hospital telemedicine", "telemedicine and hospitalization", "telemedicine and hospital care”, “acute care telemedicine”, “telemedicine clinical outcomes”, “Rural telemedicine”, “rural hospitalists”, “hospitalist shortage”, “nocturnists and telemedicine”, “telemedicine technology”, “telemedicine patient satisfaction”. Appropriate articles referencing telemedicine uses in acute care applications were selected and reviewed. Articles referencing telemedicine uses in the outpatient setting were not included as references. No articles describing a “Telehospitalist” program or quantitative research specifically referencing acute medical admissions to the hospital via Telemedicine were found.

SMC Telehospitalist Program Technology and Infrastructure

(See Appendix A)

The program’s infrastructure, equipment, telepresenter and telehospitalist training during the pilot and the post-implementation phases were essentially the same, with only minimal refinements as the pilot progressed, mostly having to do with the sequence and flow of the physical exam components and the timing of software connection of the peripheral equipment software during the exam. These changes were minor, and focused mainly on fluidity improvements and workflow optimization during patient evaluation. For example, instead of waiting until after the patient history was obtained, the workflow for the stethoscope connection was changed so that it would be already established and ready to go as the Telemedicine cart was started up during the initiation of the evaluation, so that the patient would not have to wait for this to happen, right before the physical exam portion was conducted. The physical exam sequence was changed so that all portions requiring the use of a certain peripheral equipment piece would be done sequentially prior to switching to a different peripheral to allow for a smoother exam workflow (for example, all physical exam systems requiring auscultation with the stethoscope would be done first, followed by all systems requiring visualization with the high resolution hand-held camera, and progressing in this fashion to the other parts of the exam requiring different peripherals).

1. Internet Connection

A wired, high-speed broadband (minimum 5-7 megabits per second downstream, 3-6 megabits per second upstream) Internet connection using 128-bit AES encryption is utilized for audio-visual, real-time communication and remote patient examination. Both the bedside Telemedicine cart and the remote physician computer station are connected to the Internet via Ethernet (wireless connections have so far been avoided due to security and reliability concerns).

2. Bedside Telemedicine Cart

A mobile "workstation on wheels" (WOW) equipped with a high-definition screen, and a high definition camera is deployed during the patient evaluation and rolled into the room. This WOW has the necessary hardware and software to conduct an encrypted, real-time two-way interview and patient physical exam.

3. Peripheral Handheld Equipment

A Bluetooth 3M Littmann digital stethoscope, as well as a digital otoscope, ophthalmoscope, and high-definition hand-held camera are available and are securely kept inside the cart. The stethoscope offers the usual bell and diaphragm listening positions, and it is capable of recording heart sounds. The visual peripherals offer the capability of capturing digital photos of the tympanic membrane, optic fundus, and pertinent skin findings. These high quality images are easily pasted into the patient's chart for documentation.

4. Software

Vidyo is a software-based telemedicine communications solution, which is scalable, flexible, not dependent on specific hardware, and offers the advantage of "in-house" code editing capabilities depending on the needs of the institution, without any proprietary restrictions (22). This reduces turn-around time for upgrades and repairs, and eliminates dependence on vendor response and third party software and hardware maintenance costs. This software is deployed on both the bedside cart and the remote physician workstations, and it offers easy connectivity, audio-visual adjustments including volume adjustment, video zooming, and remote repositioning of the camera. Software customization, as well as testing, editing, verification, and validation were done in house by the IT and Swedish Telehealth technical departments prior to go-live of the pilot phase.

5. Remote Workstation

The physician conducting the offsite exam connects remotely to the bedside cart via a computer workstation with a high-definition video screen and a mounted, portable, USB high-definition camera. Vidyo and Littmann stethoscope software are installed and regularly updated. A Bluetooth digital stethoscope is kept in the Telemedicine "hub" (a private, telemedicine-dedicated office in the hospital).

SMC Telepresenter and Telehospitalist Training

Telepresenters and staff hospitalists initially undergo a short didactic session where they learn the Vidyo software operation, how to establish remote connectivity, and stethoscope operation. A "test" connection with the remote site is conducted to ensure user learning and competence with the software and equipment. Several training sessions are then held until proficiency with the equipment and defined telepresenter physical assessment competencies are attained (these sessions focus mainly in adequate stethoscope placement for auscultation of heart and lung sounds, as well as focused teaching of appropriate abdominal exam techniques) (see Appendix C).

SMC Telemedicine Admission Workflow

The treating Emergency Department physician (ED MD) pages the hospitalist on call when the decision to admit a patient to the hospital has been made.

Hospitalist calls back and discusses the case, reviews preliminary data, labs, EKG and available imaging. If the decision to admit the patient is made, the telepresenter is contacted to set up the Telemedicine cart at the bedside for patient evaluation.

The telepresenter then discusses the admission and Telemedicine evaluation process with the patient and their family, obtains verbal consent, and contacts the telehospitalist when ready to start. Vidyo and stethoscope software connection is made, and the evaluation proceeds.

A history is taken in the usual fashion via two-way audio and video. The presence of the patient's family at the bedside in the Emergency Department is helpful in "filling the gaps" in the patient's history. This does not always happen when bedside admissions are delayed, as the family members may no longer be at the bedside. After the history is taken, the physical exam sequence proceeds in a predetermined order as defined in the evaluation protocol, conducted by the telepresenter, and guided by the remote physician, with the aid of the peripheral equipment.

After the history and physical are performed, and the available data is reviewed, discussion about the diagnosis, treatment plan and expectations is undertaken with the patient and their family, and all their questions are answered. Physician and Telepresenter then sign off and terminate the connection.

Case Study

Mr. HM is a 85 year old male with a history of coronary artery disease (CAD), status post myocardial infarction (MI) x 4, six-vessel coronary artery bypass grafting (CABG) in 1997, status post pacemaker placement for 3rd degree heart block in 2011, hypertension, status post cholecystectomy, two glass of wine per night drinker presenting to SB with complaints of intermittent, crampy, non-exertional left lower chest and left upper quadrant pain, 4/10 intensity, possibly worsened to 8/10 with fatty food intake, and possibly worsened with certain positions since last the evening prior to presentation. He denied substernal chest pain (his usual "anginal" pain), dyspnea, or diaphoresis. He reported mild nausea, but denied fevers, chills, shortness of breath, cough, diaphoresis, vomiting, chest pain, diarrhea, urinary symptoms, shoulder pain, or back pain. He had no history of thromboembolic disease. He reported no new medications or medication dose increases (this is the history obtained by the admitting telehospitalist).

The ED MD who evaluated Mr. HM obtained a slightly different history. The patient described his symptoms to him as a "sudden onset of left lower lateral chest pain that lasted for about an hour last night and 2 hours tonight, sharp and tender to touch in the left lower chest".

Physical exam revealed normal vital signs in the ED. The ED MD noted his abdominal exam was completely benign except for maybe subtle left upper quadrant tenderness. The rest of his exam was unremarkable.

Preliminary laboratory data showed a normal chest x-ray, a paced rhythm on electrocardiogram, normal D-dimer and troponin. White blood cell count was elevated at 14,000. Live enzymes were normal. A pancreatic amylase or lipase was not obtained.

After discussion over the phone with the on-call cardiologist, the decision was made to admit the patient to rule out acute coronary syndrome, and the nocturnist on call was contacted for evaluation prior to transfer to CH (the SMC cardiac care center downtown, where possible cardiac patients are routinely transferred for presumed acute coronary syndrome evaluation and treatment). Since the nocturnist was helping out a colleague at FH and would not be able to promptly evaluate the patient at the bedside, a Telemedicine evaluation was set up.

After the Telemedicine cart and stethoscope software connections were initiated, the telehospitalist proceeded with the physical exam, which was remarkable for exquisite tenderness in the left upper abdominal quadrant (as repeatedly elicited by palpation by the Telepresenter at the bedside), associated with some voluntary guarding, but no obvious rebound tenderness.

Given these findings, the telehospitalist asked the ED MD to obtain a pancreatic lipase (which was markedly elevated at 900 units/liter- normal lipase being less than 180 units/liter), and an abdominal CT scan (which confirmed acute pancreatitis). After the correct diagnosis was made, the patient's transfer to the cardiac hospital was cancelled, he was admitted to medical floor at SB, and treated in the usual fashion.

The patient's hospital course was uneventful; he was discharged from the hospital in good condition two days later, and went back to his home in California. He recovered well without post-hospitalization complications.

Case Discussion

This case illustrates several important points. First, Telemedicine evaluation was initiated in the Emergency Department shortly after the initial request by the ED MD, allowing for a prompt second physician evaluation, which otherwise would have been delayed. As it is often the case, the history given by patients to two different providers can vary significantly depending on the timing of the history taking and the patient's recall bias (22). In this case, the slightly different version of the history given to the telehospitalist, and the supporting physical findings elicited by the telepresenter lead to a different diagnostic path that yielded the correct diagnosis; this situation is not uncommon in Hospital Medicine, as diagnostic and therapeutic changes occur as a result of the discovery of new pieces of history, new physical findings, or new laboratory data obtained at different times by different providers in the episode of care continuum. The significance in this setting, however, is that findings obtained via Telemedicine evaluation (both in the history and the physical exam) were pivotal in avoiding an unnecessary transfer to another hospital, therefore eliminating extra ambulance transfer costs, patient anxiety and inconvenience, unnecessary cardiac testing and consultations, and it allowed the implementation of the appropriate early treatment after the correct diagnosis was made.

Another interesting point that this case illustrates is the fact that the telepresenter was able to elicit positive findings during the abdominal exam that led to the correct diagnosis. The abdominal exam is felt to be one of the weak links in the evaluation of patients via telemedicine, since no direct touching of the patient by the physician is possible during a remote consultation. However, this limitation can be overcome by utilizing the physical assessment skills of an experienced nurse telepresenter at the bedside, and the visual cues gathered by the physician during this evaluation (10). The task of visually interpreting the significance of an abdominal exam performed by another provider is always challenging, and there is no substitute for having direct hands-on contact with the patient's abdomen. Due to this acknowledged limitation, special attention is devoted to teaching telepresenters appropriate techniques to perform a good quality, reproducible, and reliable abdominal examination during their training.

From the technical standpoint, the connection from the remote Telehospitalist hub to the bedside Telemedicine cart was made without difficulty via Vidyo software. The stethoscope software connection was successfully made, and the quality of the audio and video were high during the duration of the consult, allowing a comfortable and reliable interaction between the patient, the bedside telepresenter, and the remote telehospitalist. There were no hindering technical issues during the two-way interaction.

Patient Satisfaction

Upon discharge, patients are asked to fill out a Patient Satisfaction Survey consisting of 10 questions evaluating their experience with the Telemedicine encounter. The responses are rated from 1 (very dissatisfied) to 5 (very satisfied). These are the survey questions (see Appendix E):

1. I was adequately prepared about what to expect during my exam using videoconferencing
2. I was treated with courtesy and respect
3. My nurse listened carefully to my questions regarding being examined by a provider using videoconferencing
4. My nurse adequately answered my questions regarding being examined by a provider using videoconferencing
5. My provider explained things in a way that I could understand

6. I was able to see and talk with the provider just as though this was a normal exam
7. Today's appointment met my healthcare needs
8. I would use Telehealth again for my healthcare
9. I was satisfied with the quality of healthcare I received
10. I would recommend using Swedish Telehealth services to my family and friends

Questions 1-5 were designed to determine patient understanding of the rationale for conducting the Telemedicine encounter (rather than an initial bedside physician evaluation), to assess adequate provider communication and patient guidance before and during the evaluation, and to gauge their level of overall comfort and understanding of this new process. Question 6 evaluates the quality of the technology to determine if it is adequate for patient acceptance of this new style of patient-provider interaction, and to compare their experience to the familiarity of the bedside evaluation. Questions 7-10 look for patient validation and overall satisfaction with the Telemedicine encounter.

During the pilot phase, no patients declined Telemedicine evaluation, and patients and family members present at the bedside during these evaluations were generally pleased with the use of technology to expedite prompt hospitalist evaluation and hospital admission.

The overall feedback received from patients (including Mr. HM) was favorable, and even though they initially reported a guarded attitude due to unfamiliarity with the technology, they recognized its utility and value by the end of the encounter. Some patients were initially skeptical, but they became more at ease when they were informed that a physician would be at the bedside the next morning to evaluate them, and that telemedicine was a novel application to expedite evaluation during their acute illness presentation.

Patient Satisfaction surveys can be a valuable tool to assess professional-patient interaction, the patient's feeling about the consultation, and technical aspects of the consultation; still, these surveys can demonstrate validity limitations. Many studies evaluating patient satisfaction with Telemedicine exhibit serious methodological weaknesses related to design and data collection instruments. In addition, the construct of satisfaction is largely undefined and is not clear. Even recognizing these caveats, the results of the study do offer some evidence that patient satisfaction will not impede the deployment of telemedicine (21).

In a 2004 systematic review of limitations of patient satisfaction with Telemedicine, only 33% of the studies included a measure of preference between telemedicine and face-to-face consultation. Almost half the studies measured only one or two dimensions of satisfaction. Reported levels of satisfaction with telemedicine are consistently greater than 80%, and frequently reported at 100% (31).

This lack of response variability, however, may be due to a “ceiling effect” (which can lead to low response sensitivity, and therefore, lower survey reliability), depending on the structure of survey questionnaires and their rating scales, rather than to true patient satisfaction. A potential solution is to create greater discrimination by manipulating the labels of the rating scale in order to increase response reliability (32).

Progressive acceptance and implementation of Telemedicine services need to be supported by improved research into patients' satisfaction, and further investigation of factors that influence patient acceptance of telemedicine is indicated.

Caveats and Limitations

This case report illustrates a successful Telehospitalist admission to a small community hospital. Based on this single report, however, one cannot make any generalized recommendations regarding long-term efficacy, safety, or reliability of such a program. More data is needed to evaluate clinical outcomes, appropriate clinical use, optimal patient selection, and technological challenges.

The patients currently being admitted via Telemedicine at SMC are a subset of acutely ill medical patients requiring hospitalization that are stable enough not to require intensive or intermediate care unit admission. An important part of this admission process is that an ED MD initially evaluates all of these patients, offering an initial expert assessment of patient acuity and stability (no direct admissions are allowed currently). It is also yet to be determined if telemedicine is an appropriate initial approach for evaluation and admission of critically ill patients, and patients not evaluated in the ED prior to admission.

Another important point is that the initial ED evaluation, the admission process and patient care hand-offs in this Telehospitalist program occur among providers within the same institution, working with well-defined communication and transfer of care pathways. Clearly, a well-established hand-off process is critical for the success of any Telehospitalist program, especially if there is lack of familiarity between different providers and different transfer of care procedures at different institutions.

A reliable process for evaluation and transfer of deteriorating patients on the medical floor after Telemedicine admission is also needed for the sake of patient safety. Acutely ill patients that appear stable on admission can rapidly deteriorate even hours after admission. A safety net consisting of a well-established rapid response and critical care algorithm for these patients needs to be established in advance. This procedure would probably involve a call to the Emergency Physician working at the admitting institution by the telehospitalist, if bedside evaluation due to a life-threatening change in the patient's condition or if emergency procedures (such as endotracheal intubation for acute respiratory failure, or the placement of a central line for rapid administration of intravenous fluids or anti-arrhythmic drugs) were emergently required. A predetermined arrangement and specified workflow needs to be in place in case that such procedures or a patient transfer to a medical center with an intensive care unit is needed to institute a higher level of care.

Telemedicine offers high quality digital alternatives to the usual bedside examination. High quality stethoscopes, otoscopes, and ophthalmoscopes, for example, provide high quality, reliable analogues to remotely perform a routine physical exam. The abdominal exam, however, is inevitably the weakest link in the Telemedicine physical exam. Certain subtle findings such as the presence of organomegaly, a pulsating abdominal aortic aneurysm or an abdominal mass cannot be determined visually. These limitations can, however, be minimized with the help of a skilled, well-trained telepresenter, good communication skills among the team providers, and excellent teamwork (as shown in this case report).

Patient acceptance of this new hospital admission method needs further evaluation. Even though SMC's pilot has shown favorable patient satisfaction scores, the lack of familiarity with the technology, lack of information regarding its reliability and clinical efficacy, the obvious change from the usual method of evaluation by a doctor at the bedside, and the attitudes of growing elderly populations (including lack of comfort and doubts about new technologies in general), and the design of patient satisfaction surveys will need to be taken into consideration with future research (30).

On the technical side, there is always the possibility of poor Internet connectivity due to insufficient or fluctuating bandwidth, unexpected dropped connections, software glitches leading to poor quality audio or video pixelation, stethoscope software connectivity issues, equipment malfunction, forgotten access passwords, etc. Since these issues do occasionally occur and cannot be eliminated 100% of the time, a proactive approach including extensive stress testing needs to be performed prior to implementation. The system's hardware and software need to be thoroughly tested, and new user training and field-testing by running through simulated patient encounters need to be implemented before the program's "go-live" (just as, for example, any EHR testing would proceed) to minimize predictable system-level failures. Several "test patient" run-throughs are advisable prior to program deployment to ensure proper functioning of the hardware, confirm that the software is functional, defect-free, it performs as intended, and all the necessary features needed for successful patient evaluation are present and operational (verification and validation).

These tests also aid in verifying that telehospitalist and telepresenter training is appropriate, by evaluating their level of understanding of the operation and proper use of the hardware and software; they offer a chance to review the optimal patient evaluation workflow sequence, and an opportunity to refine the admission procedure and established workflows by obtaining feedback from the fresh perspective of new users.

Conclusion

This capstone is a description of the technical and logistic framework of an established Telehospitalist program operating at a multi-institution healthcare organization. SMC's Telehospitalist program was initiated in October 2012 and it continues to be operational. To date, more than 500 Telehospitalist admissions have been performed at SMC since the program's inception. This patient data set is yet to be formally evaluated for safety and efficacy, but clearly, the program has been successful, as it continues to expand throughout the Providence Health System (of which SMC is a member), namely at Providence St. Vincent Medical Center in Portland, OR, which now has secured contracts with several smaller area hospitals to provide Telehospitalist services at night.

The case study reported in this capstone describes the typical patient experience during a Telemedicine hospital admission encounter, including the technical and clinical aspects of the interaction, and the patient's point of view of his experience as a recipient of a new application of this technology. As described above, satisfaction surveys returned since the inception of SMC's Telehospitalist program have reflected its positive acceptance by patients, but more statistically powerful, better-structured surveys are still needed to determine their specificity and validity. Although younger patients seem to be more comfortable with this novel use of technology (especially in the age of Skype, Facebook, Instagram, Twitter, etc…), it is yet to be determined whether the more mature generations will be willing to embrace this technology as well.

Future Directions

More formal studies are needed to evaluate the clinical and economic value of this particular use of Telemedicine technology. SMC plans to conduct a retrospective independent cohort study comparing two patient cohorts; one cohort will be comprised of all telehospitalist admissions to SMC to date, and the other cohort will be comprised of a similar number of patients admitted to the same institution in the usual bedside fashion. Case severity index, diagnostic accuracy, inpatient hospital length of stay, unexpected transfers to a higher level of care, and hospital readmissions at 2 weeks will be evaluated and compared. More refined patient satisfaction surveys obtained after hospital discharge from acute medical patients admitted via initial Telemedicine will also be qualitatively evaluated.

SMC's Telehospitalist program has so far shown that Telemedicine technology has matured and become more reliable. Mr. HM's successful encounter described in the above case report, as evidenced by the establishment of an early diagnosis leading to expeditious initiation of treatment, satisfactory clinical outcome and recovery, comfortable interaction with the technology, and positive engagement with the clinical team is worthy of further evaluation at a larger scale to confirm its potential value as an alternative clinical tool.

References

1. American Telemedicine Association. http://www.americantelemed.org/about-telemedicine/what-is-telemedicine (last accessed June 2nd, 2015)
2. Levine SR, Gorman M., “Telestroke": the application of telemedicine for stroke. Stroke. 1999 Feb; 30(2):464-9
3. Jhaveri D, Larkins S. Sabesan S.Telestroke, tele-oncology and teledialysis: a systematic review to analyse the outcomes of active therapies delivered with telemedicine support. J Telemed Telecare. 2015 Feb 12.
4. Young JB et al. Impact of a telemedicine intensive care unit coverage on patient outcomes: a systematic review and meta-analysis. Arch Intern Med. 2011 Mar 28:171(6):498-506
5. Breslow MJ et al. Effect of a multiple-site intensive care unit telemedicine program on clinical and economic outcomes: an alternative paradigm for intensivist staffing. Crit Care Med. 2004 Jan:32(1):31-8
6. Franzini L, Sail KR, Thomas EJ, Wueste L. Costs and cost-effectiveness of a telemedicine intensive care unit program in 6 intensive care units in a large health care system. J Crit Care. 2011 Jun;26(3):329.e1-6.
7. Sanders RB., Simpson KN., Kazley AS., Giarrizzi DP. New Hospital Telemedicine Services: Potential Market for a Nighttime Telehospitalist Service. Telemed J E Health. 2014 Oct 1; 20(10): 902–908.

8. American Association of Medical Colleges. The complexities of projecting physician supply & demand through 2025. Available at https://members.aamc.org/eweb/upload/The%20Complexities%20of%20Physician%20Supply.pdf (last accessed Feb 10th, 2015)
9. Nesbitt TS., Ellis JC., Kuenneth CA. A proposed model for telemedicine to supplement the physician workforce in the USA. J Telemed Telecare 1999 ;5(Suppl 2):S10–S26
10. Godamunne K. Mobile telepresence to admit patients in the emergency room: A remote hospitalist study. White paper. 2008. Available at www.eaglehospitalphysicians.com (last accessed February 6th, 2015)
11. Watanabe M., Jennett P., Watson M. The effect of information technology on the physician workforce and health care in isolated communities: The Canadian picture. J Telemed Telecare 1999 ;5(Suppl 2):S11–S19
12. Bashshur RL., Shannon GW, et al. National telemedicine initiatives: Essential to healthcare reform. Telemed J E Health 2009 ;15:600–610
13. Gagnon MP, et al. Exploring the effects of telehealth on medical human resources supply: A qualitative case study in remote regions. BMC Health Serv Res 2007 ;7:6.
14. Telemedicine and security. Confidentiality, integrity, and availability: a Canadian perspective. Stud Health Technol Inform. 1996 ;29:286-98.
15. Leff B, et al. Hospital at home: Feasibility and outcomes of a program to provide Hospital-level care at home for acutely ill older patients. Ann Intern Med 2005; 143: 798-808

16. US Department of Health and Human Services: HIPAA Administrative Simplification. http://www.hhs.gov/ocr/privacy/hipaa/administrative/combined/hipaa-simplification-201303.pdf (last accessed June 2nd, 2015)
17. LeRouge, C., & Garfield, M. J. (2013). Crossing the Telemedicine Chasm: Have the U.S. Barriers to Widespread Adoption of Telemedicine Been Significantly Reduced? International Journal of Environmental Research and Public Health, 10 (12), 6472–6484.
18. Patient satisfaction with physician-patient communication during telemedicine. Telemed J E Health. 2009 Nov ;15(9):830-9.
19. Kuo YF., Gulshan S., Freeman JL., Goodwin JS. Growth in the care of older patients by hospitalists in the United Sates. N Engl J Med 2011;360:1102–1110
20. Swedish Telehealth Program. A video overview. https://www.youtube.com/watch?v=AkSqfVn4HdM (last accessed June 2nd, 2015)
21. Whitten P, Love B. Patient and provider satisfaction with the use of telemedicine: Overview and rationale for cautious enthusiasm. J Postgrad Med 2005;51:294-300
22. Vidyo Teleconferencing Software. http://www.vidyo.com (last accessed on June 2nd, 2015)
23. Mayer, D. Essential Evidence-Based Medicine. Cambridge University Press, Jun 17, 2004, pg. 200

24. Rubbermaid healthcare Telemedicine Cart. http://www.rubbermaidhealthcare.com/products/Catalog/Pages/Product-Detail.aspx?sku=-98 (last accessed June 3rd, 2015)

25. 3M Littman electronic stethoscope. http://www.littmann.com/wps/portal/3M/en_US/3M-Littmann/stethoscope/stethoscope-catalog/catalog/~/3M-Littmann-Electronic-Stethoscope-Model-3200-Black-Tube-27-inch-3200BK27?N=5932256+4294958300&rt=d (last accessed June 3rd, 2015)

26. Jedmed Telemedicine Equipment. http://www.jedmed.com/pages/telemedicine-equipment (last accessed June 3rd, 2015)

27. Moreno-Ramirez D, et al. Store-and-forward teledermatology in skin cancer triage. Arch Dermatol 2007; 143: 479-484

28. Artinian NT, et al. Effects of nurse-managed telemonitoring on blood pressure at 12 month follow-up among urban African-Americans. Nursing Res 2007; 56: 312-322

29. Levin K, et al. J Diabetes Sci Technol. 2013 May 1;7(3):58795.Telemedicine diabetes consultations are cost-effective, and effects on essential diabetes treatment parameters are similar to conventional treatment: 7-year results from the Svendborg Telemedicine Diabetes Project.

30. Magsamen K, et al. Bridging the divide: Using UTAUT to predict multigenerational tablet adoption practices. Computers in Human

Behavior, 2015; 50: 186

31. Williams TL, May CR, Esmail A. Limitations of Patient Satisfaction Studies in Telehealthcare: A Systematic Review of the Literature.Telemedicine Journal and e-Health. December 2001, 7(4): 293-316.

32. Masino C, Lam T. Choice of Rating Scale Labels: Implication for Minimizing Patient Satisfaction Response Ceiling Effect in Telemedicine Surveys. Telemedicine and e-Health. December 2014, 20(12): 1150-1155.

Appendix A: SMC Telehospitalist Equipment

Telemedicine Video Cart- Rubbermaid Healthcare

It provides high definition video conferencing compatible with Vidyo software. It allows the use and management of peripheral devices such as exam cameras, stethoscopes, and otoscopes through ports such as HDMI, VGA, S-Video, composite video, USB, and Ethernet data (24).

3M Littmann Model 3200 Electronic Stethoscope

The 3M Littmann Electronic Stethoscope Model 3200 combines Ambient Noise Reduction technology and frictional noise dampening features with amplification, Bluetooth technology. It records and saves up to twelve 30-second patient sound tracks. It transmits sounds via Bluetooth technology, and it allows for remote connection via 3M Littmann TeleSteth System, eliminating 85% of ambient noise, while amplifying sounds up to 24 times (25).

Horus HD Multiple Scope System

The Horus HD Digital Scope System, designed specifically for telemedicine, is a hand-held video system that uses interchangeable attachments. This system incorporates High Definition (1080p) camera technology and offers multiple video output options. Still images and videos can also be captured with just the touch of a button and transferred seamlessly to a laptop or PC (26).

Appendix B- Telehealth HIPAA Requirements

Telehealth provision or use does not alter a covered entity's obligations under HIPAA, nor does HIPAA contain any special section devoted to Telehealth. Therefore, if a covered entity utilizes Telehealth that involves PHI, the entity must meet the same HIPAA requirements that it would for a service provided in person. The entity will need to conduct an accurate and thorough assessment of the potential risks and vulnerabilities to PHI confidentiality, integrity and availability. While some specifications exist, each entity must assess what are reasonable and appropriate security measures for their situation.

Use of specific Telehealth equipment or technology cannot ensure that an entity is "HIPAA-compliant" because HIPAA addresses more than features or technical specifications. Nevertheless, certain features may help a covered entity meet its compliance obligations. For example, a Telehealth software program may contain an encryption feature, or the technology might provide security through the use of required passwords. However, these examples only provide elements or tools to help a covered entity meet its obligations under HIPAA; they do not ensure compliance, and cannot substitute for an organized, documented set of security practices (16).

Appendix C- Telepresenter Role

Title	**Role**
Tele and Telepresenter to support	All clinical staff responsible for the presenting of patients to Hospitalist services shall be proficient in assisting in facilitating components of the physical exam typically covered for internal medicine consultations via Telehealth technologies. All clinical staff responsible for the presenting of patients to Hospitalist services shall be appropriately trained.
Pre Consult Preparation	

Responsibilities

- Appropriate documentation evaluated before consultation – diagnostic images, labs, referring provider H&P and problem note, path reports, any recent surgical notes
- Prepare technology to include: videoconferencing cart to include codec and telemedicine peripherals (digital stethoscope, exam camera). Assure patient positioning, adequate room lighting, videoconferencing cart placement and noise control.
- Assess and implement an appropriate plan for cultural, language, and/or disability issues
- VS performed: HR/BP/Weight/Height/Temp/02Sats
- Assure relevant diagnostic images have been pushed to Swedish TeleHealth PACs

Pre-Assessment Physical Exam	

Responsibilities

- Completed ROS per current specialty protocol faxed to designated location
- Set of VS: HR/BP/T/02Sats; Height/Weight
- Patient education performed

Assisting Provider with Physical Exam	**The TeleHealth Nurse Clinician must be prepared to assist with the following**

	physical exam. The role is to enhance and facilitate the assessment, which is to be completed by the physician. The provider will direct the nurse in the room.
Responsibilities	

Physician completes ROS with patient: Telehealth presenter facilitates clarification of questions as needed.

General Exam: Telepresenter to facilitate if requested. Patient should be sitting, or as necessary lying, in exam bed

- Lungs:
  - Telepresenter to use telemedicine stethoscope and place limited pressure with the stethoscope at the 6 posterior lung fields for 1 cycle.
    - Posterior assessment: begin with the upper lung lobes, moving the diaphragm of the stethoscope in a ladder-like pattern, from one side to the other
    - Anterior assessment: place the stethoscope on the chest to allow for auscultation of the 2 anterior lung fields (perihilar)
    - Trachea assessment: medial anterior base of throat
- Heart:
  - Telepresenter will place the digital stethoscope over the appropriate heart sounds while instructing patient to lean slightly forward
    - Aortic valve: 2nd right intercostal space at the sternal border
    - Pulmonic valve: 2nd left intercostal space at sternal border
    - Secondary aortic: 3rd left intercostal space at sternal border
    - Tricuspid valve: left sternal border at 5th intercostal space
    - Mitral valve at apex: 5th left intercostal space at midclavicular line
    - Carotids:
      - With the patient sitting at a 90-degree angle on the edge of the exam table or laying supine the head elevated 30 degrees, place the digital stethoscope on the lower third of the neck, medial to the sternocleidomastoid muscles. Assess carotid pulse bilaterally. Never palpate or press both carotids at the same time; this may decrease blood flow to the brain

and induce syncope. Decreased pulsations may be caused by decreased stroke volume, but may also result from local factors in the artery such as atherosclerotic narrowing or occlusion.

- Abdomen:
  - Telepresenter will facilitate in the assessment by palpating abdomen if requested

- Other miscellaneous exam elements which may be requested by Gastroenterologist as clinically indicated:

D. Post physical exam

1. When the clinical exam is completed, reframe the patient appropriately so that the patient and provider have good positions for their closing discussion. Physician will be able to pan/tilt/zoom camera.
2. Turn off all equipment and move out of the patient's direct view of the video system.

E. Post Consult Considerations

1. Reinforce any patient teaching.
2. Facilitate any follow up scheduling, tests, clarification of patient/family questions

Appendix D- Telemedicine Admission Workflow

Ballard TeleAHT Workflow

ED Physician requests TeleAHT Consult

- ***ED physician to call Swedish Transfer Center (CAPP), AHT notified***
- ***AHT provides time of consult***
- ***AHT notifies Telepresenter (via cell: 206.265.9172) when connected indicate time of consult, focus of exam –*** announce request for TeleAHT consult (RN sup will answer if available), indicate exam needs**,** be sure to include AHT pager # if RN sup is unavailable

↓

Pre- Consult Preparation by Telepresenter:

Communicate w/ patient's nurse, verify timing of consultation
Provide patient education/obtain verbal consent
Prepare Telehealth cart and environment.
Complete vital signs and pre-consult assessments

↓

Consultation with AHT:

Introductions – **be sure to put badge up to camera to provide visual validation**
Assessment –enhanced and facilitated by Telepresenter

↓

Post Consultation

Telepresenter: Brief report/handoff to staff RN; Telehealth cart/equipment cleaned & put away.
Documents encounter in Epic Telepresenter note
SMC AHT: calls referring provider and provides recommendations, documents (dictates?) consult note in EPIC

(AHT = Adult Hospitalist Team)

Appendix E- Patient Satisfaction Survey

Patient Satisfaction Survey – Telehealth

Swedish Health Services is piloting an innovative way to better serve our patient's needs. We are very interested in hearing from you regarding your feelings about receiving your care using this state of the art technology. Your opinion matters so please answer all questions honestly.

Please answer each question	1 very dissatisfied	2 somewhat dissatisfied	3 Neutral	4 somewhat satisfied	5 very satisfied
I was adequately prepared about what to expect during my exam using videoconferencing					
I was treated with courtesy and respect					
My nurse listened carefully to my questions regarding being examined by a provider using videoconferencing					
My nurse adequately answered my questions regarding be examined by a provider using videoconferencing					
My provider explained things in a way that I could understand					
I was able to see and talk with the provider just as though this was a normal exam					
Today's appointment met my healthcare needs					
I would use Telehealth again for my healthcare					
I was satisfied with the quality of healthcare I received					
I would recommend using Swedish Telehealth services to my family and friends					

Comments:

For Department Use Only: TeleNeurology; Telestroke; TeleHospitalist, TelePsychiatry, TeleWound, TelePediatrics, TelePediatrics Intensivist; TeleMovement Disorders; TeleCase Management; TeleMovement