DEPLOYING RESOURCES TO SAVE LIVES:
PARTNERS TELE-STROKE SERVICE

Janis Gogan
Monica Garfield
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Gogan, Janis L.  jgogan@bentley.edu
Garfield, Monica,  mgarfield@bentley.edu
Bentley University, 175 Forest Street, Waltham MA 02452 USA

Abstract

Innovative ICT applications such as patient-present telemedicine consultation services can save lives, yet following pilot-testing few have achieved long-term viability. Partners Health Care’s TeleStroke service, in full operation, is financially self-sustaining. Interviews with clinical, technical and administrative personnel at Partners and two “spoke” hospitals revealed practical lessons learned. Analysis through the lens of the Resource Based View reveals that many valuable assets and capabilities that Partners and its spoke hospitals developed are necessary for a successful TeleStroke program yet could be acquired or copied (they are not rare or inimitable). We note further that Partners’ overriding goal for TeleStroke is to achieve clinical success in its catchment area, without depleting financial resources; competitive advantage is sought within the catchment area but not beyond it. Resource analysis reveals that other institutions could develop successful telemedicine services for acute stroke care, since the needed assets are readily available, most of the capabilities can be imitated, and viable substitutes are limited. We contend that the lessons learned in this case study -- about the effective deployment of assets and capabilities -- are broadly applicable to other settings, in health care and other industries.

Keywords: Telemedicine, Health Care IT, Resource-Based View

1 Introduction and Methodology

Innovative ICT applications (including patient-present telemedicine consultation, such as the TeleStroke service described in this paper) hold great promise for saving lives. Yet, few telemedicine consultation services have gone beyond pilot-testing to reach long-term financial viability. Even fewer telemedicine consultation services are directed toward urgent care, where the need is great. Many hospitals – including both small community hospitals and large tertiary care centers -- have complex or fragile network architectures and extensive interoperability issues that need to be fixed, which makes it difficult for them to implement innovations like telemedicine while working toward a coherent and modern IT and data architecture. Other diffusion barriers include issues with reimbursement, licensure, credentialing, and insurance (Tanriverdi and Iacono, 1999), poor alignment with local customs and practices (Garfield, et al., 2004; Nicolini, 2007), and problematic relationships (Paul and McDaniel, 2004).

We studied Partners Health Care’s TeleStroke service because it is in full operation, is financially self-sustaining, is vitally important, and is a rare example of telemedicine for urgent care. The TeleStroke service is provided by two Harvard-affiliated hub hospitals -- Massachusetts General Hospital (MGH) and Brigham and Women’s Hospital (the Brigham), both part of Partners HealthCare following a 1994 merger -- to 27 community hospitals in Massachusetts, Maine and New Hampshire. Stroke neurologists at one of two “hubs” (MGH or the Brigham) receive data about a patient (including a CT scan) and offer real-time patient-present video consultations to emergency department attending physicians at “spoke” community hospitals. When a patient with stroke symptoms is brought to a community hospital, clinicians and support personnel (such as lab technicians and radiologists) work under time pressure. This is because from the onset of symptoms, there is only a three-to-four hour window in which to determine whether the patient is actually having a stroke, what type of stroke, and whether the patient is a suitable candidate for...
 thrombolytic therapy. The stakes are high, since the drug of choice, tPA (tissue plasminogen activator), can seriously harm (even kill) a patient who is on blood thinners or who, for other reasons, is not a good candidate for thrombolitics. A distributed team –EMTs, hub neurologists, spoke attending physician, nurses and other personnel – must collaborate effectively and share correct information to ensure quality care that reduces the likelihood that the stroke will have debilitating or fatal effects.

Our case study revealed participant’s beliefs regarding lessons learned in implementing TeleStroke. We also analyzed the TeleStroke case through the lens of the Resource-Based View (RBV), which proposes that an organization succeeds through its control over resources (assets, capabilities) that are rare, valuable, inimitable, and non-substitutable (Barney, 1991). “Resources” include tangible assets (such as state-of- the-art medical equipment), intangible assets (such as specialized knowledge), and capabilities (such as the ability of an individual and/or team to perform a complicated surgical procedure).

Capabilities (or “competencies”), which combine technical, human, and other assets (Prahalad and Hamel, 1990), are potent because they are harder to imitate. Capabilities are harder to develop and manage than individual assets. “Dynamic” capabilities possess the added feature of being adaptable to changing environmental conditions; thus, a key managerial challenge is the “continuous development, alignment, and reconfiguration” of assets and capabilities (Augier and Teece, 2009, p. 415).

Many valuable assets or capabilities are necessary but insufficient for success; if competitors have similar resources, they no longer confer competitive advantage. Thus managers must continually assess the extent to which their organizations’ resources are rare, valuable, inimitable, and/or non-substitutable. We analyzed the assets and capabilities that Partners and its clients marshaled for TeleStroke. Note that while much prior RBV research aimed to study how companies deploy resources to achieve competitive advantage over their rivals, our study is motivated by a different purpose. While Partners Healthcare does compete with other hospitals in its tertiary-care catchment area, they claim not to compete with institutions beyond those boundaries. Thus, in revealing the successes and challenges that Partners Healthcare has had in marshaling assets and capabilities for their life-saving TeleStroke service, it is hoped that other hospitals (beyond Partners’ territory) can imitate their successes and avoid the pitfalls.

Between 2008 and 2010 we conducted interviews (30 to 90 minutes in length) with 20 individuals in clinical, administrative and technical roles at Partners and some spokes. Interviews were recorded and transcribed. We used constant-comparative analysis and snowball sampling (Stake, 1995). Interviews were recorded and transcribed. We used four forms of coding: 1) Factual coding, triangulated against information in publicly available documents; 2) Comparative coding (checking for consistency with previously-identified themes). 3) Open coding (new themes). 4) Interpretation (relationships among themes; Stake, 1995). We closely examined how assets and capabilities were deployed. Specifically:

- What valuable assets and capabilities are utilized?
- How were they developed and how are they sustained?
- To what extent are they rare, inimitable, non-substitutable?
- What were the challenges in marshaling these assets and capabilities?
- How were challenges overcome, and what are the managerial implications?

2 Findings

2.1 Case context

Acute ischemic stroke, caused when a clot blocks blood flow to the brain, is a leading cause of death and disability, especially when treatment is delayed. Chances of recovery are greatly improved if an anti-thrombolytic drug, tissue plasminogen activator (tPA) is administered within three to four hours of the
first onset of symptoms. However, a less common type of stroke or different clinical episode can cause a patient to have similar symptoms yet be an unsuitable candidate for tPA. Because it is a blood thinner, tPA can hurt a patient who is already on a blood thinner or who is experiencing internal bleeding. A neurologist with expertise in acute stroke care is best able to judge whether a patient is a candidate for tPA. After administration of the drug, the patient must be closely monitored.

Since 2005, Massachusetts Department of Public Health regulations (DPH 105 CMR 130.1400 through 105 CMR 130.1413) require ambulance personnel to bring a patient who exhibits stroke-like symptoms to a certified “primary stroke center” to be evaluated as a candidate for tPA. To be so certified, a hospital is assessed on the following capabilities, which must be available 24 hours a day, seven days a week:

1. A licensed physician with acute stroke expertise serves as Stroke Service Director or Consultant.
2. Written care protocols “including both the emergency and post-admission care of acute stroke patients by a multidisciplinary team” are available in the Emergency Department and include time targets that help ensure that eligible patients will receive tPA within the three-hour window.
3. Hospital and Emergency Medical Service (EMS) personnel coordinate effectively so that the patient with acute stroke symptoms is efficiently admitted, tested, diagnosed and treated.
4. Hospital can quickly perform and interpret brain computed tomography (CT) or magnetic resonance imaging (MRI) scans.
5. Hospital can quickly perform and evaluate chest x-rays and electrocardiograms and various laboratory services.
6. Neurosurgical evaluations and/or interventions are performed within acceptable time targets.
7. If patients need to be transferred to another hospital, there is a transfer agreement in place.
8. Hospital collects and analyzes process and outcomes data and submits required data to the Department of Public Health.
9. Physicians, nurses, allied health professionals and EMS personnel receive appropriate training on a continual basis.
10. Hospital offers community education regarding stroke.

Hospitals that otherwise qualify but lack 24/7 neurology coverage can be certified if they use a service such as TeleStroke. A “spoke” thus enters into a contract for services provided by neurologists at MGH and the Brigham. A certain number of TeleStroke consultations are provided to a participating spoke each year; if a spoke uses all pre-paid consultations before year-end, additional consultation blocks can be purchased, with some rollover into the next year. When a consultation determines that a patient should receive tPA, the drug is administered at the spoke and the patient may be immediately transferred to a hub, where a bed is guaranteed and the patient is kept under close observation.

MGH began pilot-testing TeleStroke in the late nineties, resulting in publication of scholarly papers on the efficacy of telemedicine for acute stroke consultations (Shafqat, et al., 1999; Schwamm, et al., 2004). Martha’s Vineyard Hospital was the first spoke to participate (in winter its small population does not support 24/7 neurology coverage). Partners’ CIO provided seed funding to move beyond this pilot phase. The CIO recalls that a stroke neurologist “convinced me … that this is a use of information technology that will improve care by extending the reach of our specialists into the community.”

“To gain buy-in … [this neurologist] performed high-quality studies to gauge the impact of telemedicine on acute stroke care. Those studies verified that telemedicine consultations are safe and can improve patient outcomes. I was certainly convinced that TeleStroke addresses a real clinical need. I did not require much in the way of a business case; the ‘grant’ we provided was based more on the caliber of the idea.”
By 2009, 27 spoke hospitals in Massachusetts, Maine and New Hampshire participated in the service. Each spoke has a primary contract with either MGH or the Brigham, and each hub provides 24/7 backup care for the other, in case of an unexpected spike in demand or unanticipated network problem. In an ideal consultation, ambulance personnel (Emergency Medical Specialist, or EMS) phone a spoke’s emergency department to say that a possible stroke victim is en route. A family member or co-worker may have observed the patient’s first symptoms (“At breakfast he suddenly couldn’t move his arm.”). EMS check vital signs and conduct a simple stroke screening test in the ambulance.

Meanwhile, a stroke team mobilizes at the spoke hospital. A nurse gets ready for the patient to arrive, including grabbing a stroke care packet containing a patient consent form, Emergency Department Stroke Algorithm, National Institute of Health (NIH) Stroke Scale, a sheet reminding the team of time targets (such as “Time from order of CT scan or MRI scan to performance: Within 25 minutes of order being written”), and other forms. The ED-Stroke Algorithm document describes the clinical processes (Table 1). In step 1c, Radiology is notified to place this patient next in the queue for a CT scan. The patient is brought to a treatment room that has either necessary jacks for a mobile video cart for teleconferencing, or a permanently-installed tele-conferencing unit. A nurse undresses the patient and attaches a mobile monitor so that vital signs can be observed and recorded; an emergency physician (EP) sees the patient. Members of the team recognize that “the clock is ticking.” The physician reviews the patient’s symptoms and medical history to identify anything that would disallow tPA (e.g., recent surgery; on blood thinner). If the patient is a candidate for tPA (all inclusion criteria satisfied, no exclusion criteria identified), the EP sends the patient to the CT scan and requests a neurology consultation. An on-call neurologist needs to be on the premises or within 15 minutes of the ED; if not, a TeleStroke consultation is requested and the EP has an initial telephone conversation with the consulting neurologist at the hub. Before the patient returns from the CT scan, a stroke team member ensures that the tele-conference system is connected to the network. For best viewing by the hub consultant, the camera is placed at a 45 degree angle to the patient’s bed. A clinical leader or “super user” may assist the nurse in establishing the connection.

The hub consulting neurologist needs to quickly receive and review the CT scan (target for time from completion of scan to interpretation by consultant: 20 minutes). This physician goes to a TeleStroke station to view it. If the scan reveals that the patient should not receive tPA (a frequent occurrence) the consultant informs the spoke team via telephone call. If the scan does support a diagnosis of acute ischemic stroke without exclusionary complications, the consultant agrees to a patient-present physician-to-physician video consultation. About one in five phone calls leads to a video consultation.

During the initial phone call and subsequent video consultation, the hub consultant enters lab results, Time Last Seen Well, Time Presented in the ED, and other data on a browser-based application (in future it is expected that such data will be transferred from the spoke’s clinical information system). Similar to drug-drug interaction software, the application is rule-based and has error-checking capabilities to ensure that the data captured is of high quality and that the physician does not make an error that could lead to a poor decision (e.g., if more than 3 hours has passed, the system alerts the doctor that tPA may not be an option). If the patient has not been ruled out as a tPA candidate, the NIH stroke scale appears on the neurologist’s screen to support input of the results of this test into the record. With a video connection established, the consultant now collaborates with a nurse at the spoke to put the patient through the NIH Stroke Scale tasks (stick out your tongue, raise your right hand and hold it there for five seconds, etc.). The consultant has remote control of the spoke camera and can zoom in or pan out as needed. The nurse will call the attending physician (EP) into the room once this test is done. If the two physicians agree that tPA is warranted, they discuss benefits and risk factors with the patient and family members. They might now agree to pause the video connection and step away so the patient and/or family can have a moment

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1 When an on-call TeleStroke neurologist is not located at the hub, s/he may join the consultation by logging on to a personal computer with a “light” version of the application.
alone to make their decision. If the decision is yes, a consent form is filled out (the system provides dosage information). Once tPA is administered, if medically necessary the patient is immediately put in an ambulance for transfer to the hub in Boston (“drip and ship”), where a bed is readied. The data recorded by the hub consultant becomes the official TeleStroke consultation record, and authorized spoke personnel can subsequently print this off for their paper records or cut-and-paste it into their hospital’s electronic medical record (after verifying the data against their own patient charts).

<table>
<thead>
<tr>
<th>1</th>
<th>Entry into system via ED. START STROKE PACKET.</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Patient arrives in ED as a walk-in with symptoms of stroke: Patient is triaged by a registered nurse. If symptoms began within 3 hours (document time of onset and how the time is known), patient is at least an ESI 2 Triage Level.</td>
</tr>
<tr>
<td>b)</td>
<td>Patient arrives by EMS: Stroke Screening Tool will be completed prior to arrival and ED notified that a possible stroke is coming in. Patient will be triaged upon arrival.</td>
</tr>
<tr>
<td>c)</td>
<td>CT is alerted to hold the next bed.</td>
</tr>
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</table>

| 2 | If patient is taken to appropriate room (a monitored bed with a scale). EP is notified immediately and assesses patient. |

| 3* | Patient goes to CT within 20 minutes of arrival. CT is read within 45 minutes of arrival. |

| 4 | If patient DOES NOT meet criteria for thrombolysis … patient continues on appropriate pathway for treatment. |

| 5 | If CT is consistent with a hemorrhage, prepare for transfer, as recommended by physician. Call MedFlight or ground transport; follow transfer protocol. Do not delay transfer of patient secondary to awaiting Neurologist. Neurosurgical intervention may need to be implemented. |

<table>
<thead>
<tr>
<th>6*</th>
<th>If patient DOES meet criteria for thrombolysis … alert the following:</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Go to Teleneurology algorithm.</td>
</tr>
<tr>
<td>b)</td>
<td>If teleneurology consultation is to take place, use green Teleneurology packet (located with teleneurology cart)</td>
</tr>
<tr>
<td>c)</td>
<td>Stroke Team: Call the group pager: “84” and extension number.</td>
</tr>
<tr>
<td>d)</td>
<td>Laboratory</td>
</tr>
<tr>
<td>e)</td>
<td>Neurologist on call, if available.</td>
</tr>
<tr>
<td>f)</td>
<td>Pharmacy</td>
</tr>
</tbody>
</table>

Lab work is drawn and sent ASAP in red Translogic container. Stroke Panel (CBC, BMP, PT/PTT/INR, blood bank hold). *Tubes are sent in the red Translogic container to alert the Lab that it is a high priority.*

| 8 | Stroke Orders/Packet will be instituted. |

| 9 | If tPA is ordered, it is mixed by Pharmacy if they are in house (0700-2200). When Pharmacy is not in-house, RN mixes the drug following directions in packet, and administers dose, checking with another clinician before administering the dose. Document double signatures on dosage sheet. |

| 10 | Call Lab to complete type and screen. Alert Lab that tPA has been given. |

| 11 | Patient is transferred (to the Brigham or MGH) after utilizing Teleneurology Service or per Neurologist order. Follow transfer protocol. |

*Stroke packet is to be used for all stroke patients.*

*Simultaneous actions need to occur in the interest of the critical timing criteria for stroke victims.*

**Table 1** Falmouth, Massachusetts Hospital Emergency Department – Stroke Algorithm. Revised June 2006 and slightly adapted for this paper

### 2.1 Pre-launch preparations

The first consultation was in 1999; a second hospital enrolled in the TeleStroke service in 2001. When the Massachusetts Primary Stroke Service regulations were issued, the number of spokes rapidly increased, with 15 hospitals enrolled by 2006 and 27 enrolled by 2009. The Brigham’s neurology department joined as a hub in 2006, at which time the service’s name was changed to “Partners TeleStroke”. Each spoke has a primary relationship with one hub, and hubs cover for each other. One participating spoke hospital is located less than 3 miles away; the furthest is 130 miles away. Partners serves hospitals that ordinarily refer patients to them; they have no plans to extend this service outside their tertiary-care catchment area.
MGH developed an implementation methodology and standards for preparing spoke hospitals to participate in TeleStroke. MGH also developed and maintains the browser-based software application. Several constraints affected the system architecture: MGH’s complex and aging IT infrastructure and the heterogeneity of spoke hospitals’ clinical databases and applications. Incompatibility among spoke clinical systems and incomplete internal integration at MGH necessitates re-keying of some patient data.

Most radiology departments were already transmitting CT scans to external partners, using the DICOM (Digital Imaging and Communications in Medicine) standard. However, as TeleStroke participation increased, hub consultants complained of slow transmission to their workstations. At first, CT scans were sent to the MGH main server, then copied to the TeleStroke server; this caused some of the delays. So, TeleStroke CT scans now go first to the TeleStroke server and then to the MGH main image server for archiving. A technical manager states that now, “Our physician opens up the one image viewer that they use every day, whether the patient is in house or [at a spoke] and boom! The scans are right there.”

Spokes purchase video conferencing equipment for the ED. Although a few install fixed equipment in a treatment room, most spoke hospitals buy a mobile video conferencing console (at less than $10,000) and store it in a closet (with an electric outlet; its battery is charged while stored). As needed, the cart is brought into a designated treatment room that is wired for both Internet and ISDN (ISDN is being phased out, and a few spokes are also experimenting with wireless video). Partners specifies off-the-shelf equipment that is easy to deploy and use. TeleStroke does not require exceptionally high image resolution, but does need light-sensitive image adjustment, support for remote camera control from the hub, and multi-user support (so a consultant and colleague can attend a consultation via separate devices. Multiple ports are required, since one port is dedicated to a digital video recorder for archiving). Spokes are asked to conduct a once-weekly test, which consists of sending a CT scan of a suture kit to the hub.

The stroke team at the spoke hospital needs to be taught how to hook up and use the video conferencing equipment (including placing the cart and camera in the right position). Partners provides advice regarding network connections, appropriate lighting, video cart placement, and so on. In our interviews some spoke staff questioned why Partners does not mandate a particular configuration or lease equipment to them and take charge of its maintenance, which would simplify user support and version control. Partners’ position is that their core competence is in medicine, not equipment leasing or support. They also want to avoid any appearance of conflict-of-interest (salient because of heavily criticized aggressive vendor practices; see Osborn, 2009).

Each spoke hospital analyzes their patient intake and evaluation procedures to find ways to reduce delays at each step and ensure the shortest time from a patient’s first stroke symptoms to tPA administration. Treatment rooms at one hospital are quite small; nurses learned to place the video cart in a corner, use a short cord so no one trips on it, and to turn the patient’s bed around. This required a little practice.

Emergency department nurses play a crucial role in stroke care, yet before the new DPH regulations went into effect, many clinicians were not aware of the tPA three-hour window. One explained:

“I, like many other nurses, thought that stroke was my most stable patient, because they didn’t look like they needed me. They were beating, they were breathing, I had them on a monitor. Somebody had chest pain next door; I needed to treat that because that could be a heart attack. … My whole perception of stroke was: This is a process that is going on and there is nothing much I can do about it…. Some stroke patients can’t speak; they are sitting very quietly and having their stroke and meanwhile you’re taking care of somebody else that is louder. … When these mandates came out, I realized … Wow … There are interventions that we can provide for this patient... Everybody has to work a little bit faster.”
A physician echoed her remarks: “This has absolutely changed everyone’s attitude.”

“The term ‘brain attack’ … is being used now, because ‘heart attack’ gets everybody’s attention. … People were brought up with the idea that stroke happens, you can’t do anything about it. ‘Brain attack’-- people will hopefully take that as an acute event.”

Interviewees explained that video conferencing gave rise to an adjustment in the order of steps on the NIH stroke scale. With the traditional scale the patient was asked to alternately use their face, upper body, and legs, but with video the clinician had to zoom in and out on the patient multiple times. Since every second counts, a peer-reviewed study was conducted to verify that the altered scale is clinically valid. The new NIH-approved scale is incorporated into Partners’ software.

The State mandates that an extensive record (more than 100 data points per patient chart) be maintained for each acute ischemic stroke episode at a Primary Stroke Service hospital. Partners designated its forms-based TeleStroke patient chart system (used by the consulting neurologist) as the definitive record. Spoke hospitals can cut and paste this data into their own records. Spokes also need to establish their own quality control mechanisms such as chart audits and stroke committee chart reviews.

2.3 Clinical Collaborators Reflect on Lessons learned

In this section we consider interviewees’ views regarding successes achieved and ongoing challenges in Partners TeleStroke service.

1. Nurture innovation. Interviewees revealed that physicians and nurses played crucial champion roles at some spokes. The neurologist who conceived of TeleStroke recognized the need to position this initiative in the political and cultural context of Partners. He and colleagues conducted studies to establish the efficacy of telemedicine for acute stroke care, and presented their findings at academic conferences. One observer noted that this TeleStroke champion “understood each party’s ‘what’s in it for me’ concerns.”

The TeleStroke service makes it possible for community hospital emergency departments to accept stroke patients, and for Partners to get appropriate referrals (for those challenging cases that require physicians with advanced training). Spokes pay in advance for multiple video consultations; this package pricing helped Partners to sidestep some reimbursement issues that impede telemedicine elsewhere. Neurologists contend that both patients and payers benefit from this service, since patients have fewer post-stroke complications. The CIO observed: “There are times when clinical IT investments are seen as ‘good for patients but lousy for business.’ TeleStroke did not run aground on those shoals. … It is a great example of internal innovation - moving an idea into production.”

2. Consider the context. Emergency departments differ from inpatient units, as a nurse explained: “(People who don’t work in the ED) don’t understand … what happens. On a busy day, I’ll see sixty patients. That’s sixty people that you check in, assess, give meds … check out.” She felt that some TeleStroke data entry steps impeded her ability to swiftly provide care. Another nurse noted: “(ED nurses) look at patients differently … We don’t already know their diagnosis … It’s a little different from upstairs.” Also, some participating spoke hospitals are in areas with a large elderly population; they see many stroke patients, yet few are candidates for tPA, due to other medical conditions, medications they are on, and other factors. Other participating hospitals serve a younger population; they see few stroke patients, but those who come in are more likely to be candidates for tPA. In any multi-party IT-enabled service, participants will vary, so a one-size-fits-all implementation strategy is unlikely to succeed.
3. “Cookbooks” support repeatable processes. Even though implementation challenges vary across contexts, detailed process checklists -- such as those in the mandatory stroke packets -- are invaluable for acute stroke care, as has been reported in a variety of other clinical domains (Gawande, 2009). A nurse explained: “ED nursing is cookbook medicine. There’s a protocol. … You get more of a team effort ... when you have clear guidelines.” Another noted, “This has to be a cookbook. It has to be: You do this, this, this and this. We did algorithms for everything. … When somebody comes in with a stroke you just take that packet and every single piece of paper you need is in there.” To develop a useful checklist requires a thorough process mapping and analysis at each hospital, along with periodic reviews. One hospital’s stroke packet was changed five times to improve its usability and efficacy. We conclude that for repeatable processes, detailed process guidelines are vital, especially when built into systems that support the work and are sufficiently flexible to accommodate further improvement.

4. Visit and listen to users. Many spoke nurses are ardent telemedicine champions. One, assigned to work with an IS team on an earlier project (before the hospital began using telemedicine) recalled:

“They wanted to have someone who was versed in nursing and operations to interact with people in IS, which turned out the be the most challenging job ever … It’s sort of like waking up one morning and going to work on a different planet. … It took about a year, I would say, for some … IS people to realize that it was valuable to have a nurse in their department. Their whole philosophy is, ‘This is what we’ll give them and this is what they’ll use.’ When it wouldn’t work, well ‘It’s the users’…”

This nurse added that IT people were “deathly afraid” to visit the ED to observe systems in actual use. “Some IS guys would be like, ‘Oh my god, there’s patients there!’” She questioned: If system analysts and designers fear emergency medicine, how can they do a good job? Nurses also explained the value of having “super-users” on hand to help set up portable video equipment. They described issues in the system testing procedures, and the vital importance of ongoing in-service training to refresh their skills. They also described nettlesome usability issues in early versions of the TeleStroke charting application. For example, the results of a simple test (have a patient drink a small vial of water, to test their swallow reflex) were not fully recorded, due to too many screens to traverse in the application (in light of the time pressure and nurses’ high case load). Nurses explained that when a system is used only intermittently, it is possible to have “users” who have not used it for months and thus whose skills will have grown rusty from lack of use. We conclude that the system design must be thoroughly vetted for usability, training plans must take a longer view, and resources must be allocated for periodic “refresher” training.

5. Support users the way clinicians support patients. Emergency clinicians are a dedicated group; one nurse stated, “We’ll move heaven and earth to help the patient.” Interviewees expressed the wish that technical support personnel would be as responsive as a great ED doctor or nurse. When clinicians have trouble with the video connection in the midst of a consultation, they want to know that a tech support person is on a cell phone, offering suggestions while walking briskly toward the ED, knowing that “the clock is ticking,” and mindful of the three to four hour tPA window. When a tech support person is replaced by a newcomer, the clinicians want to be informed of the change, much the way an obstetrician lets an expectant mother know that another doctor will be available when he is away on vacation. We were disheartened to hear clinician comments such as: “We were having a little bit of trouble with connections (and) it turns out that the (tech support) person who we’d worked with all along no longer worked [at the hub]. No one had told us! … Nothing bad happened …but it would have been nice to have been notified that there was a change…” We conclude that for critical IT applications, the tech support group need checklists similar to nurses’ stroke packets, to remind them of steps to take in response to users’ requests, and aggressive time and quality targets to gauge their responsiveness.
3 Resource Analysis

In this section we discuss case study findings in light of the Resource Based View (RBV). RBV specifies that successful organizations utilize assets and capabilities that are rare, valuable, inimitable and non-substitutable. A resource is rare if it is not readily available or is available only at a high cost. An asset or capability is valuable if it contributes to organizational success and benefits exceed its costs. It is inimitable if competitors have significant difficulty (in terms of time or money) acquiring or developing it. It is non-substitutable if other resources cannot fulfill the need that it fills (e.g., candy substitutes for a cookie to satisfy a “sweet tooth”). Others have observed that many valuable assets and capabilities are neither rare nor hard to imitate; similarly, we find that many assets and capabilities that Partners and its spoke hospitals developed are necessary for a successful TeleStroke program, yet could be acquired or copied. Partners claims that competitive success is not its primary aim; the overriding goal is clinical success in its catchment area, without depleting financial resources. Our analysis (below) reveals that other institutions could develop successful tele-stroke services, since the needed assets are readily available, most of the capabilities can be imitated, and substitutes are limited.

Regarding the deployment of technical assets: Partners developed software that guides collaborating clinicians through the NIH Stroke Scale steps and captures key data necessary to establish the efficacy of the treatments provided and to satisfy various public-health regulations (Massachusetts requires 102 data points for every acute ischemic stroke episode). The software is “rare” in that few other telemedicine hubs have developed applications like it. Is it inimitable? No; it is not a complex application. It is valuable, because Partners was a first-mover in developing this software, and they are able to sell it to other hospitals, who gain because they don’t have to take the time or invest money in reinventing this “wheel.”

TeleStroke relied initially on ISDN connections and is now moving to IP and wireless connectivity. While the network component is a valuable and necessary asset, it is not rare, inimitable or non-substitutable. Similarly, the video conferencing equipment that hubs and spokes need (PC, video camera, monitors) is readily available and prices are dropping (indeed, some contend that an iPhone or other inexpensive mobile device can be used for TeleStroke consultations, provided steps are taken to protect confidential patient data). Furthermore, video equipment can be repurposed if a hospital were to discontinue their participation in the TeleStroke service. Therefore, while the hardware deployed for the TeleStroke service is valuable, it is neither rare, nor inimitable, nor non-substitutable.

What about knowledge assets? A cornerstone of the service was the expertise available at the two hubs, which are prominent Harvard teaching hospitals. There is a short supply of neurologists specialized in acute stroke care, and many spokes cannot afford 24/7 coverage. Because these specialists are valuable, rare, inimitable and non-substitutable, only a few hospitals in a given catchment area could host a service like TeleStroke. Still, a few other teaching hospitals in Massachusetts do have similarly-trained stroke neurologists. For this reason, and because hospitals can “poach” each others’ physicians, Partners cannot count on a long-term local competitive advantage based on this knowledge asset. Another knowledge asset is the Stroke Packet that each spoke is required to have on hand, and which is invaluable in guiding nurses under time pressure. Most spokes borrowed a packet from another hospital and customized it to their environment. Thus, this is not a rare or inimitable asset, although it is valuable.

What about contractual assets? After some trial and error, Partners established a pricing scheme that covers their fixed costs while offering spokes some flexibility. While this has proved to be an important element in the service’s financial viability, it is easily imitated. Thus, it may be a necessary asset, but it is not sufficient for long-term success.
Other studies have found that assets rarely provide a long-term advantage because they are not rare and can be imitated or substituted. We turn next to capabilities, which some claim are more defensible.

Leadership is a valuable capability. A hub neurologist served as a champion for TeleStroke. His expertise, drive, and commitment to this program lead us to conclude that his leadership would be somewhat difficult to imitate. Still, at a competing teaching hospital or for-profit organization another physician-champion could be motivated to promote a similar service. At spoke hospitals, nurse champions were crucial to successful implementation (in terms of appropriate TeleStroke utilization and positive patient outcomes). These nurses took leadership roles and instilled a sense of excitement about the program. Some took extraordinary steps; for example, one nurse stroke coordinator lived close to the hospital and volunteered to be on informal (unpaid) call. When asked, in the middle of the night she would come over to help set up the video cart to ensure a successful consultation.

Ambulance personnel and clinicians (at both hubs and spokes) needed training and practice. Keeping TeleStroke technical and process skills fresh is an ongoing challenge, since days or weeks may go by during which a given clinician in a spoke emergency department may not encounter a single stroke patient. When a patient does arrive, the time pressure means that every member of the team needs to work correctly and swiftly. The stroke packet, training videos and in-service training, designating a stroke coordinator, and well-trained technical support personnel can help to overcome this challenge. However, technical support was a capability that needed to be improved; Nurses expressed frustration at occasional technical glitches that impeded their use of video conferencing. To cope, they took proactive steps to ensure successful collaboration during acute stroke episodes, including middle-of-the-night consultations, impromptu training sessions, affixing helpful guides to the equipment itself, etc. While an acceptance of imperfect assets and capabilities has allowed this valuable service to move forward and save lives, Partners aims to eliminate technical and administrative glitches. To that end, the CIO reported that work is proceeding to upgrade Partners’ network and to test wireless networks, “with constant vigilance regarding the protection of patient confidentiality.” Working with external standards-setting groups, Partners also plans to implement fully interoperable patient records, which will minimize data redundancy and require a redesign of the TeleStroke charting application.

Over time Partners has learned how to advise spoke hospitals as to the required technical setup, preliminary training, and other preparations (they have worked with 27 hospitals thus far). This capability is sufficiently rare and hard to imitate that Partners is able to offer it as a profitable business: today Partners also offers a consulting service to hospitals outside their catchment area who want to set up telemedicine services for stroke care.

The above analysis reveals that each valuable element of the TeleStroke service can be imitated. Consistent with prior research, we find that it is the assemblage of all these related elements that gives Partners TeleStroke its unique value and possible competitive advantage within its catchment area. However, another tertiary-care hospital (outside Partners’ catchment area) can license the software from Partners (or develop their own). They can pay for Partners’ consulting service, which makes the assets and capabilities transparent. Indeed, we are encouraged to report that TeleStroke is helping to give birth to other services that can save lives using telemedicine for acute stroke care: hospitals in three other states are working closely with Partners to launch their own telemedicine services for acute stroke care.

4 Discussion and Conclusion

The Partners TeleStroke case study findings lead us to conclude that when assets and capabilities are aligned and working coherently, telemedicine can have profoundly positive impacts for patients and their families. Interviewees informed us that when there are occasional technical or administrative glitches,
well trained spoke clinicians are able to revert to traditional modes of communication (well-honed capabilities) to overcome these obstacles and still provide good care. This leads us to a key implication: In deploying IT to assist in health care delivery, perfection (error-free implementation and ongoing use) is the goal, but imperfection is not necessarily a deal-breaker. Ideally, all stroke patients will be transported to a primary stroke service within the all-important three-hour window. The patient’s medical history and all clinical data (including clinician notes, lab results, and CT scans) will be in digital form, and all clinical applications will be fully interoperable so that all necessary clinical information is shared at the speed of light. Partners HealthCare (along with many tertiary-care and community hospitals) has much work to do before all of these ideal conditions are fully realized. Meanwhile, Partners’ experience demonstrates that it is not necessary to delay diffusion of a valuable yet imperfect IT-enabled innovation. Instead, we conclude that system designers and users need to recognize the technical and political hand they have been dealt, and accordingly establish appropriate mechanisms to carry on when glitches inevitably occur as a result. For example, if a video connection fails, clinicians know that the two Partners hub hospitals will cover for one another, and they are also fully prepared to revert to telephone conversations and other predetermined process workarounds. The lesson here is that a realistic assessment of assets and capabilities can (and should) lead system and process designers and users to establish appropriate contingency plans.

As noted above, “dynamic” capabilities are adaptable to changing environmental conditions (Augier and Teece, 2009). Because Partners was not subject to significant environmental turmoil during the period of our study, we did not directly investigate whether the TeleStroke service or its constituent capabilities were adaptable to changing conditions. Thus, this paper describes assets and capabilities but not necessarily “dynamic” capabilities. However, we did note that spoke hospital participation expanded rapidly once Massachusetts set mandatory requirements for Primary Stroke Services (a change in the regulatory context). The new regulations also mandated specific data gathering and retention requirements, combined with strict chart reviews, which provided an incentive for Partners to develop the forms-based charting application (possible evidence of a dynamic capability, in that it was an appropriate response to an environmental change). Today, Partners hosts this application for hub hospitals that now offer telemedicine services in Oklahoma, Washington State, and Virginia. This produces a revenue stream that helps defray the costs of system maintenance and enhancement. Partners has also begun to provide a consulting service to advise these and other hospitals that seek to establish their own patient-present physician-to-physician telemedicine service for acute stroke care. Thus, we anticipate that there will be future opportunities to test the adaptability of Partners’ capabilities (since the three health care systems that they currently advise are located in three different states with different regulatory structures and patient constituencies – that is, different environmental conditions). A national stroke service mandate (which has been proposed but not yet enacted) could have an even more dramatic impact on the diffusion of this life-saving innovation, and a possible opportunity to observe dynamic capabilities in action.

When technology choices are not well aligned with organizational tasks and processes, outcomes reportedly fall short of expectations (Ray, et al., 2005; Karahanna, et al., 2006). Successful implementation of an enterprise or inter-enterprise IT application hinges on making appropriate investments in complementary technologies and processes (McAfee and Brynjolfsson, 2008). Our study suggests an extension to this logic: we propose that successful implementation of ICT to support clinical collaboration in health care requires investment in a coherent assemblage of complementary technology assets, knowledge assets, and clinical, technical, and leadership capabilities. In turn, there are implications for software developers: since it is not possible to anticipate a priori all the ways that users will want to adapt an enterprise or inter-enterprise IT application to fit complementary technologies and processes, it is essential that software designers emphasize modularity and flexibility to the greatest extent possible (Varadan et al. 2008). Flexibility is an essential principle of service-oriented architectures (SOA), and our study findings suggest it to be a particularly essential criterion for software that supports clinical collaboration across organizational boundaries.
These are still early days for emergency telemedicine applications that support clinical collaboration under tight time pressure. Our resource analysis reveals few impediments that would prevent other hospitals from launching similarly valuable telemedicine services. We contend that the lessons learned in this case study are broadly applicable to other hospitals seeking to save lives through the effective deployment of complementary assets and capabilities.

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