Delivering quality health care for patients with acute stroke in a timely and affordable fashion is a major challenge in the early 21st century. This is especially true given the shortage of qualified physicians willing and able to treat stroke. This is occurring against a backdrop whereby in the United States, the need for healthcare reform has been identified as urgent and one of the most important national agenda items that needs to be addressed. Developing alternative networks for the delivery of health care has been a stated goal in the debate on healthcare reform. There is the acknowledged need to innovate toward new healthcare models that reduce cost and yet improve quality and accessibility.

The purpose of this letter is to outline the revolution of new technologies that are becoming available that can fundamentally change and improve how we deliver healthcare for acute stroke. More specifically, today’s communication and network technologies can be used to enable healthcare experts to deliver care remotely. Remotely enabled care allows patients the ability to access the right expertise from wherever they are, thereby improving the quality of care they can receive. Conversely, it also allows healthcare professionals the ability to provide their expertise to patients anywhere they are and at anytime and to do so more efficiently than traveling to the patient’s location. Consequently, remote care has the opportunity to significantly improve the quality care and to do so at a lower cost.

Although this remotely enabled care concept applies to healthcare delivery in general, stroke is an ideal application that can lead the way to a new and improved paradigm of healthcare delivery. Stroke is ideal because it is a large societal problem both with regard to cost and quality of life for patients with stroke. Strokes are also unscheduled and can happen to anybody at any location. Strokes require physician specialists who are in short supply to diagnose and may also require subspecialists and technologies that are geographically few and far between but necessary for life-saving treatments.

Technologies Enabling New Modalities of Healthcare Delivery

Although there are formidable healthcare challenges facing us today, the good news is that we have new tools to help address these challenges. Technology advances in healthcare informatics, remote diagnostic and therapeutic tools, telecommunications, and robotics have resulted in a convergence of enabling technologies that can be leveraged to effect new modalities of healthcare delivery (Figure 1). Internet, wireless, and cellular technologies have attained a state of maturity and integration to enable ubiquitous connectivity at an unprecedented level. Networked diagnostic devices are now commonplace for remote in-home monitoring. Medical and patient data are also moving toward becoming fully digitized. These digitized data sets can be used not only for diagnosis, but also for real-time therapies and interventions, for example, robotic surgery. In lockstep, healthcare policy has also been undergoing change to accommodate the use of these new technologies, for example, reimbursement for certain types of remote telemedicine consults.

New technologies are being leveraged as innovative, novel healthcare delivery platforms. Such solutions now allow physicians to be available on demand whenever clinical expertise is needed. Over 1 network and through a single interface, physicians would be able to access a host of devices to provide care and expert collaboration across the entire healthcare continuum, all delivered through a single backbone of connectivity services and support. This kind of enterprise network would comprise multiple devices in a spectrum of clinical applications and environments, from the prehospital first responder setting, emergency department, intensive care unit, operating room, trauma, to the clinic. These devices would be tailored for their specific targeted clinical environments. A portable computing device such as a laptop or smart phone and standard Internet would be all a remote physician would need to access any of these devices to offer continuity across the continuum of care. These systems would have been designed to enable clinicians to connect on demand and to support unscheduled consults. Furthermore, there are even technologies such as the Remote Presence robots (InTouch Health, Santa Barbara, Calif) that now afford the remote physician complete control of the mobility at the hospital and patient site as if he or she were there in person.

A Networked Healthcare Delivery System

All of these evolutions are driving toward a global hospital and physician delivery network. As these remote care deliv-
Every networks expand and overlap, a unified network is created, whereby providers are no longer selected by patients based on geographic location, but rather by their expertise, quality, cost, and convenience. Ultimately, the results will be an integrated national, international network of specialists available any time, anywhere.

The implications for the health system is a transition from “bricks to brains”—whereby the nexus of care will no longer be the traditional bricks and mortar-type hospital but a “virtual” hospital in which the focal points will be the physicians and the clinical expertise. These virtual ways of delivering care mirror the evolution that has already taken place in other industries such as financial, legal, retail, and entertainment.

Ideally, hospitals may leverage their clinical expertise resources to extend their reach efficiently and perhaps even provide care using expertise that may not be physically located in their geographic region. Physicians may be able to work remotely and be more flexible about when and where they work in relation to their respective patients. The enabling technologies may reduce the net shortage of highly trained specialists through creating fewer boundaries based on time and space. This will also support a paradigm shift in physician workflow in terms of enabling providers to better manage their time, perhaps even spend a larger proportion of time interacting with patients, and ultimately enhancing provider well-being as well. The new healthcare delivery network would promote a new efficiency model whereby the ultimate winner is the patient, who will now have immediate equitable access to the best clinical expertise regardless of where they live.

**Improving Stroke Care Over a Network**

What does this all mean for stroke care? The American Stroke Association, Brain Attack Coalition, and stroke community have advocated the development of stroke systems and networks to deliver patients to the right level of care as quickly as possible.7–9 Telemedicine can boost the power of stroke networks by facilitating the collaboration and workflow needed to deliver effective stroke care. In 2009, the Joint

![Figure 1. Convergence of enabling technologies.](image1)

![Figure 2. Example of remote stroke management using available telemedicine technologies.](image2)
The benefits of these telerestroke networks are manifold from each stakeholder’s perspective. Patients benefit from immediate 24-hour access to stroke specialist care and 24-hour access to tertiary care neuroendovascular specialists. The result from the hospital perspective includes triage of complex cases to centers of excellence for timely delivery of care, increased alignment with established care standards and best practices as well as improved capacity management and efficiency through reduced inappropriate transfers. Physicians benefit from the ability to extend care delivery beyond the traditional radius. There is also enhanced clinical mentoring, training and education for staff at spoke hospitals as well as network-wide stroke awareness and education programs. Ultimately, it is the patient who benefits with the impact being enhanced patient care and patient satisfaction.

Telerestroke networks have been developed around the globe in both rural and urban settings. Telemedicine has facilitated a 4-fold increase in the rate of administration of intravenous tissue plasminogen activator within 3 hours. Telemedicine has also demonstrated use in remote treatment and subsequent transfer of patients with acute stroke using the “drip and ship” paradigm. In the latter study, telemedicine resulted in a specific outcomes benefit for patients >80 years. Furthermore, in some networks using robotic telemedicine platforms, the mobility of the telemedicine platform used has also facilitated continuity across echelons of stroke care from the emergency department to the intensive care unit.

Networked Care Model as the Future of Healthcare Delivery

The stroke network concept and the use of telemedicine to augment those networks can revolutionize stroke care. Furthermore, similar models could be replicated in other clinical applications and around the world to give patients every-where a better chance for survival. The future of healthcare delivery will be based on networks of care that will enable valuable clinical expertise resources to be delivered virtually across geographical space and time. Just as e-commerce and e-communication has made the world a more intimate global community, similarly, healthcare delivery will inevitably take the form of a virtual networked community with the goal of getting the right clinical expertise to the right patient at the right time.

Disclosures

None.

References

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