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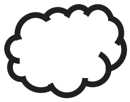
Forecast: 

Not all of us are familiar with the term "cloud computing." In computer parlance, the term "cloud" and its diagram (as above) are used to signify the Internet. Although cloud computing currently makes up only a small part of computer-related activities when compared with storage, infrastructure, and programming interfaces (such as those needed for social networking), it will become extremely important in the near future.[1] It is deemed so important that a "secret" group of individuals created the so-called "Open Cloud Computing Manifesto," which contains the principles and intentions for cloud computing providers and vendors.[2] This document angered many information technology corporations that were not included in its development, but by now, most have agreed to work together to improve it. The "Manifesto" states that cloud computing must be user-centric, philanthropic, open, transparent, representative, nondiscriminatory, evolvable, balanced, and secure.

Of course, to become immersed in the cloud, no knowledge of the underlying infrastructure is needed. In addition, you have no control over this infrastructure. Clouds are basically means of delivering hosted services through the Internet. Think about a cloud as an application that you download from the Internet, but the software, data, storage, network, and hardware are elsewhere; the only things you need are your own computer and access to the Web. What makes clouds so attractive is that in reality most of them have no centralized infrastructure, therefore making them cheap to run. Users pay only for the service and not for any initial infrastructure investment.

Clouds evolved from the simpler grids and utilities. A grid is a number of clustered computers attempting to perform 1 or more tasks, and it may be used instead of 1 supercomputer. The SETI@home Website (Search for Extraterrestrial Intelligence, http://setiathome.berkeley.edu) provides free software that interconnects many personal computers to analyze narrow-bandwidth radio signals in an attempt to recognize extraterrestrial technology and is an example of a grid. In a computer utility, computation and storage are made available in a "metered" fashion, similar to our daily utilities like water and electricity. Cloud computing includes both grids and utilities and is also capable of self-management. In reality, cloud computing is another step toward the creation of artificial intelligence, and as such, it configures and optimizes itself. A cloud has 3 basic attributes:

- It sells on demand (by amount of memory, computing power, and/or time).
- It is elastic (the user can have as little or as much as he or she wants).
- It is provider-managed (as mentioned earlier, the user needs nothing other than a computer and Internet access).

Although the term "cloud computing" dates from the 1960s, it was not until 2002 that it became widely known when Amazon began to provide public access to their systems (Amazon Web Services) on a utility basis.[3] These services are not meant to be used by you or me but are mostly geared toward software developers. Similar services are offered by other computing giants such as Microsoft[4] and Google.[5] Not only do these platforms allow one to create Web applications and services, they also allow the creation of other cloud environments. In a sense, these clouds function as utilities because the user pays per gigabyte of memory used in a certain time period.

Because real clouds may be small (let's say altocumuli) or very large (cumulonimbus), computer clouds also vary in size. Public clouds are huge and encompass information found all over the Internet (the Internet itself is formed by smaller but still public clouds). Google is a type of public cloud as it collects information from many sources, corrects your spelling, provides you with the most likely sites that fulfill your search terms (learns), allows you to create applications (apps), and keeps expanding. Services offered by most clouds are sold (to anyone) over the Internet. Businesses are probably the most common users of clouds as they can access many types of administrative and accounting services via the Web. An intermediate-sized cloud is called a "hybrid" and encompasses both a public (external) cloud and a private (internal) cloud. Hybrid clouds are generally used by companies and permit certain individuals access to private and public information. A smaller cloud is a private or internal one. Access to a patient's information and management in a hospital's Web environments is done through a type of private cloud. Private clouds reside on private servers and provide services to a limited number of individuals who do not own the hardware or software. Some individuals argue that private clouds really do not exist; because they always have some type of relationship with a bigger cloud, their information may be accessed by persons without direct authority to do so.

It is becoming clear that in the near future, all information technology services will be handled by and within 1 or more clouds. A clear example of a hybrid cloud is the Apple platform, which lets anyone create apps for iPhone and other Apple products by allowing users access to some proprietary information. In this business model, users can access the platform for free, but most of the incomes generated by the privately produced apps benefit the cloud owner. Medicine-related apps created this way included the new iMobile Health[6] and, for academics, iResearch, which allows one to save PDF files on the iPhone or iTouch and then view them later without needing to be connected to the Internet (this app is available in the iTunes store and, as of this writing, was linked to 12 scientific journals, none in medicine). Because our specialty is image-rich, we need to wait and see if it will be useful to us (in my mind, there is no question that it will be).

The smallest and most personal application of the cloud may be in the software-as-service model. In this model, the vendor provides the user with the infrastructure and software needed to handle his or her own cloud. In many of these models, the software may be limited to be compatible with products from 1 vendor or with those of other manufacturers. One can conceive of MobileMe from Apple as a tiny personal cloud (it allows you to share e-mail, contacts, calendars, and other files) between your laptop and desktop computers and your mobile devices (information can also be pushed to Microsoft services such as Outlook). Like all utilities, MobileMe is a subscription-based one defined by time and storage capabilities. In the future, it is possible that personal clouds may provide an individual access to information existing and collected by all of the devices he or she owns as long as they are interconnected via the Web. In conclusion, clouds allow users to run apps, and some examples of cloud apps include peer-to-peer (Skype), social networks (Facebook), security services, software as services (Google apps), software plus services (Microsoft on-line services), storage, and data distribution.

So why did I bring all of this up? I believe that our neuroradiology community will be ideally served by 1 cloud. Imagine a cloud with its own free-of-charge and easily downloadable software that would permit you to search across the American Society of Neuroradiology (ASNR), *Neurographics*, *American Journal of Neuroradiology* (*AJNR*), and *AJNRBlog* Websites. As all of these sites continue to be populated with an incredible amount of information, mining those data will become increasingly difficult without a special app. Information from 1 single source such as *AJNR* will play a less important role in the future because it is rigid and provides no opportunity for interactivity. However, once you combine a scientific article with opinions posted on our blog, with educational material posted in *Neurographics*, and with political and economic perspectives through the ASNR Website, you will end up with a very powerful tool. Now imagine having an even bigger cloud that would include the numerous teaching files available on-line and the ability to connect with similar materials from other neuroscience subspecialties. Clouds in the weather forecast may not be what you want, but computing clouds will certainly brighten your future days!

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EDITORIAL

The Cost of Closure

The article by McTaggart et al[1] in this issue of *American Journal of Neuroradiology* nicely highlights the use of arterial closure devices by neuroradiologists. Arterial closure devices are now a $500 million per year industry, with such devices being used in some 30%–40% of femoral artery catheterizations in the United States.[2] The global market for arterial closure devices is estimated to reach an astounding $900 million per year by 2013.[3] The development and marketing of these devices during the past decade has been quite remarkable, and it is worthwhile to pause and consider the propagation of this technology.

If we really lived in a world in which evidence-based medical practice was the norm, the widespread use of these devices would be driven by evidence that patient care is improved by their use. Yet, there is no convincing evidence that shows that these devices are an improvement in care for most patients relative to manual compression.[4] I do not dispute that percutaneous closure devices have a useful application for occasional use, such as in those who require anticoagulation, but the use of percutaneous closure devices at many institutions is beyond just the occasional patient and is becoming the standard for all patients.

So why is manual compression rapidly losing market share to expensive closure devices? Manual compression is typically applied for 15 minutes and is highly effective. While a physician might be able to find a more productive use of 15 minutes, I cannot imagine that it would be difficult to find a capable health care professional who could apply manual compression for 15 minutes. It could be a physician-in-training, a nurse, or another allied health professional. Throughout my career, I have found that it has been easy to identify and use personnel other than myself to apply manual compression following angiography. While there may be institutions that are so strapped for personnel that no one has time for manual compression, I suspect that such institutions would also have associated financial woes that would make generalized use of percutaneous closure devices prohibitively costly.

The financial cost of these devices is significant, typically at about $200 per device, and the reimbursement from third-party payers is essentially nonexistent. Arguments have been made that the cost of the device is compensated by a decreased cost in nursing care because patients can be discharged earlier. I doubt very much that a decrease in nursing care results in substantial financial savings. In fact, I doubt that there is really much decrease in nursing care at all. It has been shown to be quite safe to ambulate patients 2 hours after removal of 6F sheaths[5] and even as little as 1 hour after removal of 5F sheaths[6] when using manual compression for hemostasis. I am not aware of any scientific data that indicate that it is beneficial to use bed rest beyond 2 hours following ordinary transfemoral catheterization. Typical patients who undergo outpatient angiography with a percutaneous closure device will probably not be released until 2 hours after placement of the closure device, so I fail to see a potential savings in nursing costs. Even if you argue for observing outpatients who undergo angiography with a percutaneous closure device for less than 2 hours or for requiring patients who undergo angiography with manual compression to be at bed rest for more than 2 hours, I seriously doubt that the resulting difference in time spent on nursing care would be enough to offset the cost of the closure device. Generally, the nurses we are talking about are at the hospital and are getting paid whether or not they are still watching your patient, so you would need to demonstrate that you were able to reduce total nursing staff to prove that a real financial gain has been achieved by reducing the time spent observing these patients.

What if you just gave the $200 dollars for a closure device to a person to perform manual compression? If you decided that