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The Cost of Closure

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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 neuro-radiology 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 al¹ 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 market-

ing 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 sheaths⁵ and even as little as 1 hour after removal of 5F sheaths⁶ 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

rather than use the closure device, you would instead pay me \$200 dollars to do the manual compression for you, with just 8 cases per day, I could make \$8000 in a 5-day work week. If I only took 2 weeks of vacation, I could earn \$400,000 annual pretax income. That is pretty good money to do minimally skilled manual labor. With significant time between cases for coffee breaks, I would have to seriously consider such a position if it were offered. Another way to think of it is that manual compression is no more difficult than delivering a pizza, and few of us would pay someone \$200 to deliver a pizza. Seriously, if you are going to defend the use of closure devices by citing a decreased need for labor, you must consider that \$200 can buy a lot of labor.

So why are so many physicians compulsively attracted to expensive arterial closure devices? Is it the time savings that they offer to the physician? I personally see very little time savings. A closure device in a typical case probably takes about 5 minutes of operator time to deploy, and often there is a small amount of bleeding requiring a short period of compression after the device is deployed. So, perhaps 5 or 10 fewer minutes are spent at the patient's side. If someone other than the physician could be doing the manual compression, then the device is actually adding non-reimbursable physician time. Is it the added safety to the patient? There is no reason to believe that there is safety improvement,⁴ except perhaps in occasional patients with coagulopathy or requiring anticoagulation. The real reasons that percutaneous closure devices are so widely used may be the following: 1) the simple love of gadgets that is characteristic of most interventionalists, and 2) a disdain of the boredom of the 15 minutes of manual compression (this disdain is exacerbated by remembrances of local legendary cases from the past when manual compression efforts went on for an hour or more). The physician gets to play with an ingenious gadget rather than suffering the boredom and cramped hands associated with manual compression. Aggressive marketing undoubtedly has a role, but I think that the marketing is playing to the physician's natural attraction to the devices rather than generating the attraction.

In the end, individual physicians and institutions must do their own assessment of the proper role of percutaneous closure devices. I can only hope that such assessments are performed rationally.

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EDITORIAL

Comparative Studies of Different Gadolinium Agents in Brain Tumors: Differences between Gadolinium Chelates and Their Possible Influence on Imaging Features

In recent years, there have been a number of studies comparing different gadolinium chelates for MR imaging of tumors, particularly for MR imaging of intracranial neoplasms. These have included intraindividual studies that compared gadobenate dimeglumine (MultiHance; Bracco, Milan, Italy) with other gadolinium agents^{1–3} for imaging cerebral tumors, and a study similar to that of Kim et al⁴ that compared gadobutrol (Gadovist; Bayer Schering Pharma, Berlin, Germany) with gadopentetate dimeglumine (Magnevist; Bayer Schering Pharma) for imaging of cerebral metastasis.⁵

Studies comparing gadobenate dimeglumine with other gadolinium chelates have demonstrated the superiority of this agent in terms of contrast enhancement and lesion characterization, delineation, extension, and definition of internal structures at 1.5T and 3T. Lesions included were mostly intracranial tumors, with the highest percentage being intraparenchymal gliomas. Although detailed evaluation of different histologic types has yet to be performed, the superiority of gadobenate dimeglumine has been shown across all lesions, including gliomas, meningiomas, lymphomas, and metastases.

The 2 studies^{4,5} that compared gadobutrol with gadopentetate dimeglumine revealed greater enhancement and a higher rate of lesion depiction in favor of gadobutrol. These data support the fact that gadolinium contrast agents are different and that these differences potentially have important diagnostic implications.

A number of gadolinium-containing contrast agents are currently available for use in MR imaging of the central nervous system. These include gadobenate dimeglumine, gadobutrol, gadodiamide (Omniscan; Nycomed Amersham, Oslo, Norway), gadofosveset trisodium (Vasovist; Epix Pharmaceuticals, Lexington, Massachusetts), gadopentetate dimeglumine, gadoterate meglumine (Dotarem; Guerbet, Aulnay-sous-Bois, France), gadoteridol (ProHance; Bracco), and gadoversetamide (OptiMar; Mallinckrodt, St. Louis, Missouri).

Gadolinium contrast agents can be classified by the molecular structure of their gadolinium-chelate complex—macro-cyclic or linear—and by being ionic or nonionic.

Related to the structure is compound stability, with a demonstrated increased stability and consequently lower propensity to release gadolinium ions for macrocyclic agents.⁶ Release of gadolinium ions, which are toxic, is thought to be relevant to the development of nephrogenic systemic fibrosis (NSF).⁷

Most currently available gadolinium-containing contrast agents are formulated at a concentration of 0.5 mol/L, while gadobutrol is formulated at a higher concentration of 1.0 mol/L.

In an animal model of glioma, gadolinium concentration