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M. Castillo

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Preservation of Knowledge, Part 2: Digital Archives

In last month's *Perspectives*, I addressed the role of paper and microfilm as media for the preservation of written knowledge, particularly biomedical literature. A significant number of journals are now electronically archived including the *American Journal of Neuroradiology* (*AJNR*). The HighWire Press data base contains 1232 journals and more than 5.6 million articles as of this writing. According to my last count, the Elsevier and Springer journal data bases contain 2320 and 2084 scientific journals, respectively! It is hard to believe all of these journals can be kept in their past and current print forms and archived for posterity. Most current journals are, however, archived in digital form. The main topic of this article is to discuss some of these electronic data bases.

Although one of the major goals of libraries is to avoid duplicated material and save space, one of the primary goals of electronic depositories is to create redundancy and several copies of their contents. The *AJNR* is preserved by a system called LOCKSS (Lots of Copies Keep Stuff Safe).[1] This system is based on technology designed by the Association of Computing Machinery. The LOCKSS system is, like the HighWire Press, based at Stanford University and provides libraries with open-source software to preserve all sorts of materials that have been published on the World Wide Web. Each library owns a LOCKSS "box" that allows perpetual access to their materials. LOCKSS has a self-checking mechanism that continuously audits and repairs the information it houses. This is accomplished by "crawlers" that compare the LOCKSS box contents with an institution's Website and constantly update the box contents.

The *AJNR* allows these crawlers on our Website where information is collected and used to update our LOCKSS files. However, unlike libraries, we do not administer this mechanism; HighWire does. Decentralization of the system assures its independence from central failures by creating multiple archives in different locations and constantly comparing these with replicas. Today, approximately 400 publishers and hundreds of libraries worldwide use LOCKSS. The next iteration of this system is CLOCKSS (the C stands for "controlled"). Through it, the main research libraries in the world and major publishers are creating a "dark" archive of all of their contents to further assure the preservation of digital data. LOCKSS can also be used to keep older literature that has been digitized. Because software and hardware are in a state of constant evolution, data may "rot," and all preservation systems need to be constantly updated.

In June 2004, the Wellcome Trust, Joint Information Systems Committee, and the US National Library of Medicine announced a joint effort to digitize back files of what they considered to be important medical journals.[2] This effort is known as the Medical Journals Backfiles Digitisation Project and is one of a total of 6 such projects in the world. All of the digitized files, some dating back 125 years, became open access. This data base does not contain any US-based imaging-related journals, but a search revealed that the *Korean Journal of Radiology* is included.[3] In addition, some radiation oncology journals are found there.

Digital archiving initiatives are vast. A complete list may be found at the National Digital Information Infrastructure and Preservation Program of the Library of Congress.[4] Other countries have also joined in this effort. The National Library of the Netherlands (KB) has created an "e-depot" system available to all publishers whose main goal is to maintain the integrity of digitally stored objects. This depository is neither "dark" nor "light," but each user has access only as established by a previous individual agreement. All publications contained in KB's e-depot that come from BioMed Central continue to be open access. The storage capacity of this site is expected to reach 1.5 petabytes soon. This endeavor is closely associated with other European ones such as Preservation and Long-Term Access through Networked Services (www.planets-project.eu), the purpose of which is to build practical services and tools to ensure access to digital culture and scientific assets. Another interesting and more far-reaching project is Cultural, Artistic and Scientific Knowledge for Preservation, Access and Retrieval (www.casparpreserves.eu), which preserves all kinds of digital data in a technology-neutral, domain-independent centralized system to assure its longevity. In the United States, another huge project is Portico (www.portico.org), which is sponsored by the Library of Congress and other nonprofit organizations. The Portico Website lists some interesting facts stressing the importance of digital archiving as follows:

- A total of 13% of articles cited by the *New England Journal of Medicine, Journal of the American Medical Association,* and *Science* are irretrievable from the original hyperlink only 27 months after publication; hence archival of all materials is important as their on-line longevity may be very short.[5]
- In 2002, a total of 70% of faculty in a survey were using electronic journals for research, and 1 year later, nearly 80% considered these as "invaluable research tools."[6]
- Like other digital archiving initiatives, Portico follows the standards set by the National Library of Medicine Journal Archiving and Interchange Suite.[7] These standards set the way documents are saved and transferred. Portico houses information from 487 libraries and 58 publishers (including Elsevier and Springer), including more than 11 million articles. Many other digital-archiving initiatives (JSTOR [Journal STORage at the Mellon Foundation], Ithaka, Aluka, *Journal of the American Medical Association* and *Archives* Journals Backfiles, etc) are available, but I cannot mention all of them in this *Perspectives* because of space limitations.

Digital archiving extends beyond science to all of our daily activities. From the movie industry to our own home videos and photographs, from the nation's digital memory to that of persons, digital archiving is of significant importance. E-futurists assure us that, in the future, all written material will be found in an electronic form and probably will be carried on portable devices. Other imaging-related journals (eg, *Radiol-*

ogy and the *American Journal of Roentgenology*) use HighWire and entrust their archives to LOCKSS. Our readers can be assured that the digital contents of *AJNR* are being adequately preserved for future generations.

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M. Castillo
Editor-in-Chief

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EDITORIAL

Randomized Vertebroplasty Trials: Bad News or Sham News?

The randomized trials on vertebroplasty treatment of painful spinal fractures by Kallmes et al[1] and Buchbinder[2] et al in the August 6, 2009 issue of the *New England Journal of Medicine* and widely reported in the popular press[3] deserve further comment.

I have performed well over 1000 vertebroplasties during a period of 9 years. I have personally treated numerous patients with osteoporotic and malignant compression fractures who were either bedridden or otherwise so limited by their pain that they became dependent on others for their daily activities. In virtually every case, vertebroplasty immediately reduced their pain and brought them to a level of function that conservative therapy would have taken at least months and several refills of narcotics to achieve. Consequently, I was surprised to see reports of these trials widely circulated in the press and to hear that referring physicians and patients may, therefore, now be reluctant to consider vertebroplasty.

When I saw the presentation of the data from a preliminary "sham" control study at a medical meeting a few years ago, I noted that the patients who had received the vertebroplasty procedure rather than the placebo (sham) procedure received minimal injections of polymethylmethacrylate (PMMA) compared with what I and others with good results typically inject. I recall others making comments on this point and on the ethics of doing such studies. I had not expected to see more of these studies because I considered vertebroplasty a "decided" matter until now.

I know from experience that the volume of cement necessary to restore axial integrity at virtually every level of the spinal column differs according to the shape, volume, and level of the vertebral body. After reading the research studies written by Kallmes et al and Buchbinder et al, my concerns of a few years ago were revived. Because there are no published post-PMMA injection images of vertebrae in the Kallmes study, I cannot conclude that the cement injections performed by this group of physicians on 68 of 131 selected patients at 11 different medical centers are anything other than minimal. By injecting only 3 mL of PMMA, the surgeons in the study of Buchbinder et al virtually guaranteed failure in all cases except fractures of the upper thoracic vertebrae. The study of Buchbinder et al of 78 patients did not give details on the spinal levels treated, so the reader is left to assume that fractures of the midlumbar region through T10 would have been most commonly encountered as is typical in most practices of experienced surgeons. Three milliliters of PMMA is generally insufficient to restore axial integrity in any of the levels that Buchbinder et al would have commonly encountered. Therefore, the study of Buchbinder is merely a comparison of nought to nought.

Second, a higher proportion (63% versus 51%) of patients who received the sham procedure in the Kallmes et al study correctly guessed the type of procedure by 14 days, and 43% of the patients who had received the sham procedure "crossed over" to get the real procedure. Notably, only 12% crossed over in the opposite direction. If the real procedure and the sham were truly equivalent, then such a lack of confidence in the sham procedure on the part of the patients who suffered the pain of the procedure—whether it was a sham or not, both types of procedures caused pain and discomfort—would not have been evident. These patients must have been thinking, "Why should I suffer another sham procedure when I know from my experience that relief of my compression fracture pain, which brought me here in the first place, will not be satisfactory?"

Third, reading of the study of Kallmes et al also revealed that enrollment of 250 patients with sufficiently painful compression fractures was an initial goal, but for numerous reasons (eg, 368 patients with suspected tumors and 704 patients who had either refused to participate or who had "other" reasons were excluded), only 131 patients were actually enrolled, thereby lessening the power of the study. There is, of course, no word as to how the group of 1072 nonenrolled patients was eventually treated.

In a busy practice in any major hospital, commonly more than 131 patients with painful compression fractures, due not only to osteoporosis, to which this study was limited, but also due to tumors and trauma that are not even addressed by this study, will be treated by the surgeons of that practice during a fraction of the time required to complete the Kallmes study. The experience of the surgeons (eg, as described by Kobayashi et al[4] and others[5-7]), the referring primary care physicians, the patients, and the caregiving family members is quite different from that indicated by the study of Kallmes et al.

I fear that this common experience will be ignored by the newly created Federal Coordinating Council for Comparitive Effectiveness Research (FCCCER) of the Department of Health and Human Services should it receive a legal mandate to determine whether any currently reimbursed medical or surgical treatment should be allowed.

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