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Preservation of Knowledge, Part 1: Paper and Microfilm

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Preservation of Knowledge, Part 1: Paper and Microfilm

In his wonderful, award-winning book *Double Fold*, Nicholson Baker makes a plea for preservation of printed materials, particularly newspapers.[1] He reports on the constant destruction of printed materials that have been preserved on microfilm, the latter presumably being more resilient to the passage of time than paper itself. Historically, paper was made from plants with long fibers (such as linen, cotton, and esparto), yielding a high-quality and long-lasting product. Some of the best linen paper, made in Japan, can survive for centuries. In a similar fashion, cotton-based paper is also of very high quality and long lasting. With the ever-increasing popularity of the printed word, new and more efficient ways of manufacturing paper were sought, and at approximately the mid-1800s it was discovered that wood pulp could be used for this purpose.[2] The Swedish were the first to use wood pulp for paper on an industrial basis.

Plants and trees, the main source of pulp for papermaking, also contain important polymers called lignins. These serve a function in the transport of water and in giving plants their structural strength. Here is an analogy: lignins are to plants as concrete is to a brick wall. If we grind a tree, the resulting pulp will contain lignin and fibers. To make stiff and strong paper (such as that found in supermarket bags), one needs a lot of lignins. The problem is, with time, lignins deteriorate and give off acids (particularly carboxylic ones). These acids cause paper to turn yellow (this is no problem with brown paper bags and other dark products with a short life). Exposure to light hastens this process, as does exposure to ambient air (comic book collectors tend to keep them in plastic bags). The by-products of lignin deterioration damage cellulose, and the paper becomes brittle. That is why old newspapers are yellow-to-brown and tend to break off at creases.

One way to remove lignins is bleaching. Once the pulp has been extracted, it can be treated with a mild base (usually calcium or magnesium bicarbonate) to neutralize the naturally occurring acids. Additional base may be added to prevent acidity brought on by the process of "sizing." Sizing generally involves the application of an acidic polymer to the surface of the paper that will basically prevent ink from spreading too much in the paper fibers (paper for color laser printing is heavily sized, making it is difficult to write on with a fountain pen, as the ink will not be absorbed and takes a long time to dry). Extraction and neutralizing of lignins make paper white (brown paper bags may contain up to 55% of unbleached pulp).

The process of bleaching builds into paper the so-called alkaline reserve. For paper to last at least 100 years, its alkaline reserve needs to be approximately 2%. Alkaline paper (called acid-free) can survive anywhere from 500 to 1000 years depending on its quality. Alkaline paper has innumerable advantages vs traditional acid paper including less wear on the machinery that produces it, papermaking by-products that are recyclable, less energy needed to dry it, and the paper itself being easier to recycle. In the paradoxic sense, as we add more recycled paper into new, we are increasing the content of post-consumer fibers and, again, introducing lignins and acidity. For completeness' sake, I would like to note that the absolute whiteness of the paper we commonly use cannot be achieved solely by bleaching. Initially, the pulp is thermo-treated (basically cooked), and whatever lignin is left behind from this process is then removed by bleaching. Bleaching initially involved the use of chlorine, but because of environmental concerns, other chemicals are now used. Thus, the first step in preservation of printed materials is improvement of the quality of paper.

As early as 1930, librarian William J. Barrow noted the deterioration of paper publications. He wrote several seminal articles on this topic from the 1940s to the 1960s and headed an important laboratory concerned with investigations regarding the quality of paper. Barrow's initial observations went basically unheard until the Council on Library Resources and the American Library Association granted him monies to pursue his investigations. In 1988, the National Endowment for the Humanities began the Brittle Books Program, which involved the microfilming of 3 million decaying books. The program also includes the deacidification of books that are still in good condition (because this is an aggressive process, it will actually damage those books that are decaying).

Microfilming, as evidenced by Mr. Baker's book, is highly controversial. Microfilm can last for approximately 500 years (less than high-quality paper), but it needs to be stored in proper conditions and viewed with special machines. Unfortunately, the quality of the material archived on microfilm is highly variable and many times is unreadable because sufficient care was not taken to optimally photograph the original publications. In 1984, the National Information Standards Organization (www.niso.org) proposed voluntary standards for paper manufacturing that included pH value (the pH of alkaline paper is 6.0–7.0), tear resistance, alkaline reserve, and lignin concentration. If followed, paper complying with these suggestions may last thousands of years. In 1994, the International Standardization Organization (www.iso.org) proposed international equivalent standards. Furthermore, both organizations suggest that publications of special significance be printed on archival-grade paper. The highest quality of this type of paper is called museum grade and is cotton based.

In 1987, the National Library of Medicine (NLM) created the Permanent Paper Task Force.[3] This institution encourages the use of permanent paper that meets the criteria outlined in the Permanence of Paper for Publications and Documents in Libraries and Archives Act; all journals must be printed on acid-free paper and are identified as such in PubMed. Our printer, Cadmus, uses acid-free paper for the cover and contents of the *American Journal of Neuroradiology* (*AJNR*) and meets the requirements of the American National Standards Institute (www.ansi.org). The mill that produces our paper uses environmentally friendly chlorine-free bleaching.

So, although the issue of paper preservation has been at least partially solved, the problem regarding the amount of space required to store scientific journals has not. Of course, archiving on microfilm and microfiche has not proved to be as easy or reliable as initially thought. The NLM has a section dedicated to preservation and collection management that

deals with these issues. Storage requires controlled temperature, humidity, light, and shelving; transportation is delicate and tricky, and viewing exposes film to significant physical stress that contributes to its deterioration. Microfilm is a cellulose acetate-based product that is very sensitive to physical trauma. Most university libraries own equipment that will allow one to print, e-mail, save images to USB devices, or burn them on CD or DVD. Loading the film tapes into these machines can be risky, and specific instructions need to be followed. Digitization of microfilm is being done but requires scanners capable of resolutions close to 10,000 dots per inch.

The one thing microfilm has clearly achieved is space savings. Storage requirements are reduced by nearly 95%. It also prevents further deterioration of original manuscripts by avoiding repeated handling. Color microfilm is extremely expensive; thus, most archives are only in black and white. Why the NLM chose microfilm to archive its material has been addressed in many articles and books. The development of microfilm during the First World War was related to espionage activities. Before becoming the NLM, this repository was called the Army Medical Library, and it was not until the mid-1950s that the Department of Defense transferred it to the Public Health Service. I doubt many neuroradiologists have consulted the microfiche carriage in our local library lately, as most biomedical data are now stored electronically. Next issue, I will continue this *Perspectives* with a brief account of digital storage activities as they relate to the sciences and to *AJNR*.

References

1. Baker N. *Double Fold: Libraries & the Assault on Paper*. New York: Random House; 2001
2. Lister D. The Lister List. Acid Paper. Available at: http://www.britishorigami.info/academic/lister/acidpaper.php. Accessed March 25, 2009
3. Preservation and Collection Management Section, National Library of Medicine. Acid-Free Paper for Biomedical Literature. Available at: http://www.nlm.nih.gov/pubs/factsheets/acidfree.html. Accessed March 25, 2009

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EDITORIAL

Second Branchial Cleft Cyst: NOT!!

That tobacco use and alcohol intake increase the risk for head and neck squamous cell carcinoma (HNSCC) is a fact that all health care professionals, including radiologists, are taught early in their careers.[1] Among other molecular events, tobacco causes mutations in the *p53* tumor-suppressor gene, leaving the patient at increased risk for malignancy in multiple sites.[2] The well-known exception is nasopharyngeal carcinoma, endemic in Southeast Asia and one of the most common cancers.[3] Epstein-Barr virus exposure and nuclear antigen presence in epithelial cells have been implicated in HNSCC in the nasopharyngeal subsite. In the United States, populations at risk for this virally associated malignancy are immigrants from Southeast Asia; African-American adolescents have an even higher incidence.[4]

The recent proved association of human papillomavirus 16 (HPV) and cervical cancer and the development of a protective vaccine resulted in a seismic shift in our understanding of oncogenesis.[5] Previously, behavior modification was the only way a patient could potentially affect the risk of developing cancer. Tobacco cessation, limited alcohol intake, sunscreen, and lower estrogen doses to treat menopausal symptoms are among the protective steps available. However, virally mediated tumorigenesis is more common than the North American medical community imagined, and the idea that a protective vaccination had been developed was an exciting addition to the prevention steps a patient could make.

Now, oropharyngeal HPV infection, with the same viral type associated with cervical cancer, HPV 16, has been shown to be strongly associated with HNSCC, especially the tonsil and base of tongue (BOT) subsites.[6] Squamous cell carcinoma (SCC) of the oropharynx to date has almost always been associated with tobacco and alcohol exposure, occurred in late middle-aged and elderly patients, and was more common in men. However, patients with HPV-associated oropharyngeal SCC have different demographics. Compared with tobacco- and alcohol-related oropharyngeal SCC, patients with HPV-associated tumors tend to be younger, do not currently or have not ever smoked, and have a better prognosis after chemoradiation therapy.[7] Whether populations at risk, including adolescent boys, should be vaccinated against HPV, just as young sexually active girls are now, will be determined by public health officials in the next several years.[8]

Why is this information important for the neuroradiologist? One of the most common presentations for HPV-related oropharyngeal carcinoma is a new neck mass. Of 198 HPV-positive cases of stage III or IV oropharyngeal SCC, >90% of patients had metastatic adenopathy at presentation (M. Gillison, personal communication, May 2009). Cross-sectional imaging, either CT or MR imaging, is virtually always requested as part of the work-up and staging for the patient with metastatic cervical adenopathy.

The nodes associated with HPV-related SCC are usually in level IIa, ipsilateral to the primary tumor, and are either necrotic or truly cystic.[9] Furthermore, the primary tumor in the tonsil or BOT may be small and, unless the radiologist suspects the diagnosis, can be easily overlooked.

Consider the other lesion that can present in this location. The second branchial cleft cyst is a non-nodal congenital lesion, also presents as a cystic structure in level IIa, and usually presents in the first 2 decades of life. Second branchial cleft cysts are unilocular, smooth, and well-circumscribed, with no associated stranding or induration of surrounding structures, significant wall enhancement, or enhancing nodule. Rarely, if infected, the cyst may display minimal enhancement, but that is definitely the exception to the rule. Even when it presents after 30 years of age, the patient will often give a history of chronic neck fullness or mass following an upper respiratory infection. Contrast that to nodal metastases from tobacco-induced SCC of the oropharynx, when the patient has no history of a prior neck mass. It is my experience, as part of a team caring for patients with HNSCC, that a Level IIa necrotic node is often described by radiologists as a "branchial cleft cyst," despite the fact that the patient is older, has risk factors for