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Technical Note

Histology safety: now and then

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Abstract

Histology safety usually focuses on general laboratory issues, but this article concentrates on the hazards affecting the individual histotech and their evolution in the last half a century. Using the information from a survey especially designed for the occasion, the hazards were divided into 4 groups, and their prevalence was expressed as percentages for national and foreign laboratories. All the laboratories received a "safety index" (SI) with an average value of 0.77 ± 0.11 for 63 national laboratories and 0.69 ± 0.13 for 22 foreign laboratories, these 2 averages being statistically different ($P < .02$). The historical evolution of the SI required answering the same questionnaire retrospectively, and so it was done for 17 laboratories with an SI average of 0.27 ± 0.12 for 1955/1989 and 0.77 ± 0.13, almost 3 times larger for 1990/2007, with improvement of all safety issues. The technological, organizational, and regulatory advances before 1989 showed an unremarkable effect on the SI, and the only circumstance considered as the driving force behind the almost triple increment of the SI during 1990/2007 was the awareness that the AIDS epidemic instilled in the minds and consciences of the medical laboratory personnel in general. Even after almost tripling the average SI value in 2007, national histology laboratories obtained a grade average of "C+" only, leaving room for improvement.

Keywords: Safety hazards; Safety index; AIDS epidemic effect on safety

1. Introduction

All forms of human activity involve safety risks, some, such as fishermen, miners, or lumberjacks [1], are riskier, but even the most sedentary jobs involve health risks, such as the development of a potentially lethal leg blood clog after sitting for long periods of time.

Medical laboratory (ML) jobs in general and histology tasks in particular are not risks-free activities because of the wide range of chemical, mechanical, biologic, and environmental hazards the histotech (HT) is exposed to, all of which can pose immediate or long-term health consequences.

Although safety issues have been in the mind of almost everybody for more than 30 years, not many articles on the subject have been published. *Laboratory Medicine*, from the American Society for Clinical Pathology, has published since 1979 fifteen articles on histology safety, out of 50 on the general subject. The *Journal of Histotechnology*, official publication of the National Society for Histotechnology, published 24 articles since 1977, and *Histologic*, first sponsored by Miles (1971) and later by Sakura (1995), has published only 9 short articles about safety.

Safety issues play such an important role today that each laboratory has a safety officer whose work is appreciated by the average HT from being a great help to an absolute hindrance, being the length the HT has been in the field inversely reflected in that scale. With exceptions, "survivors" of the nasty histology environment are the least appreciative of safety measures, and the rejection exists either if the safety officer comes from the laboratory ranks or from its bureaucracy, because many of their indications are seen as disruptive, having nothing to do with any sort of "suicidal attitude."

This article deals with hazards the histology personnel has been exposed to in a historical context, comparing their evolution from the 1950s until present day regulations and safer environment. The changes have been dramatic, but there is still room for improvement, especially in personal awareness of the risks, mainly in small and specialized laboratories both in the United States and abroad.

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Histology is an art performed in very consistent ways around the world [2], so we HTs belong to a class not limited by country frontiers and are exposed to similar hazards all around the world.

2. Materials and methods

During the last week of March 2007, 82 colleagues from the United States and 11 foreign countries answered a questionnaire specifically designed to determine the HTs' personal safety conditions. The questionnaire was distributed and answered using the resources of *Histonet*, a free list server with more than 1600 members worldwide (http://www.histonet@utsouthwestern.edu).

The 72 questions, some self-excluding, focused on activities representing personal risks of chemical, mechanical, biologic, or environmental nature, each with a "correct" or "safe" answer. The total of "safe" answers, divided by the total number of questions applicable to each laboratory, permitted to calculate a "safety index" (SI) with theoretical limits between 0 and 1, similar to grading an academic test.

The answers, grouped into categories for national and foreign laboratories, and expressed as percentages of "unsafe" conditions, were tested for statistical significance of the observed differences using standard procedures, with P value less than .05 as the accepted limit and an α-type error [3].

Evaluating the evolution of the SI during the last 50 years required answering the same questionnaire in retrospect, remembering the working conditions years ago. Completing this fundamental phase required the contribution of 9 "seasoned" colleagues specially recruited for the task, to add to the author's retrospect, and included data from 17 laboratories.

3. Results

3.1. Chemical hazards

Even when some toxic chemicals with 8 hours of time-weighted averages (TWAs) ranging from 0.1 ppb (mercury oxide) to 1 ppm (benzene and dioxane) or 2 ppm (aniline oil and chloroform) have been almost completely eradicated from the histology laboratory, the average HT is still exposed to many other chemicals, some with similar or even higher toxic levels (Table 1).

Although with very different TWA levels, the 2 fundamental chemical hazards for the HT are formalin (TWA, 0.75 ppm) and xylene (TWA, 100 ppm), both known for their long-term effects [6,7].

The principal chemical hazards (Table 2) vary from risks when performing special stains manually to processing some tissues manually, and although the percentages are higher for half of the sources in foreign laboratories, the overall difference is not statistically significant (t_{18} = 0.43, P > .70, NS). Processing tissues manually is a risk now in the rise because of the increased use of nonautomated microwave ovens.

Table 1
Eight hours of TWA for some chemicals frequently used in the histology laboratory [4]

Toxic level at	Chemical substance
0.01 ppb	Silver nitrate (silver metal dust/fumes)
0.02 ppb	Osmium tetroxide
0.05 ppb	Potassium dichromate; uranyl nitrate [a]
0.1 ppb	Iodine; picric acid (explosive)
0.2 ppb	Potassium permanganate
0.5 ppb	Chromium trioxide (chromic acid)
1 ppb	Ferric chloride; oxalic, phosphotungstic, and sulfuric acids
2 ppb	Hydroquinone; paraffin wax fumes; sodium hydroxide
10 ppb	Aluminum hydroxide; glycerin mist
0.1 ppm	Potassium iodide; sodium barbital
0.2 ppm	Glutaraldehyde (mutagenic agent)
0.5 ppm	Chlorine
0.75 ppm	Formalin; paraformaldehyde (both carcinogens)
1 ppm	Hydrogen peroxide
2 ppm	Nitric acid; sodium hydroxide
5 ppm	Formic and hydrochloric acids; phenol
10 ppm	Acetic acid
25 ppm	Ammonium hydroxide
100 ppm	Xylene

ppb = parts per billion (equivalent to mg/m^3); ppm = parts per million (equivalent to g/m^3, 1 ppm = 1000 ppb).

[a] One hundred milliliter of 1% aqueous solution of uranyl nitrate undergoes about 12 000 disintegrations/s (a specific activity of 123 Bq/mL) equivalent to 0.26 μg of radium [5].

Performing special stains manually or preparing the staining solutions in the laboratory is cost effective [8] but involves handling toxic chemicals.

Again, in spite of the known chemical hazard they pose, formalin is still the fixative of choice and xylene the most used antemedium, but it is interesting to note that both are used less in foreign countries than in the United States in disregard for known alternatives [9-13].

Similarly, recycling xylene is costwise and environmentally advisable, but the practice imposes additional exposure to it, especially when using distilling recyclers, to be coped with not always followed additional precautions. The same concerns apply to recycling ethanol and especially formaldehyde, even with nondistilling recyclers.

3.2. Personal risks

Personal risks vary from injuries in the laboratory to long-term effects from not ergonomically designed work stations or repetitive motion injuries due to larger and heavier manual microtomes. These types of conditions are more evident now with a prevalently aging histology workforce [14-16].

All personal risks are higher in foreign countries (Table 3) for a significant difference (t_{12} = 2.67*, P < .05).

Among the most notable improvements are the almost total substitution of the dangerous-to-handle large steel