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Drycleaning. Part 2. Commercial History and Social Impacts: Ironing Out Some Pressing Problems

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In the first part of this essay, I examined the technology of drycleaning in detail.¹ Let's focus now on the social aspects of the drycleaning business: the evolution of the drycleaning trade in the US as a neighborhood business, and public concerns about health and environmental issues confronting the industry today.

Major Trends

In the US, two trends emerged in the drycleaning industry early in this century that have had a considerable impact on the economic and sociologic role of the drycleaning trade. One trend was to combine the new drycleaning service with the already existing wet-cleaning laundry trade. Writing in a 1924 publication called *Practical Dry Cleaner, Scourer and Garment Dyer*, editors William T. Brannt and J.B. Gray noted "...the growing tendency to combine the two methods under the same roof...."² (p. 2) These gentlemen attributed the trend to the relative ease with which one could add a drycleaning plant to existing laundry facilities, and to the convenience such a combined service offered the customer.

A second major trend that emerged in the US was the decentralization of cleaning services, as noted by Albert E. Johnson, former director, Textile Trade Relations, the International Fabricare In-

stitute, Silver Spring, Maryland, in his book *Drycleaning*.³ (p. 4) He attributes this decentralization to the "...virtual abandonment of the practice of re-dyeing garments and household furnishings...." Presumably, the art of dyeing required considerable skill and was accomplished most efficiently at a centralized facility, where technical knowledge could be shared and dye vats of different colors could be maintained simultaneously. Johnson goes on to suggest that Americans gave up the practice of re-dyeing clothing for two reasons: the higher quality of modern, nonfading dyes made re-dyeing unnecessary, and in the twentieth century it has become more common to discard and replace old goods than to refurbish them.

The trend toward decentralized, neighborhood drycleaning plants would probably not have been possible without the development, in the 1930s, of non-flammable solvents. Brannt and Gray reviewed at great length the elaborate safety precautions that had to be taken in order to set up a drycleaning plant using primarily flammable solvents, such as benzene, benzol, and gasoline.² (p. 23-34) These authors cautioned that most large cities at that time had stringent laws governing the design of such plants, and that some cities, such as Paris, outlawed drycleaning plants entirely. The development and widespread availability of synthetic drycleaning sol-

vents that were nonflammable and non-explosive, discussed in detail in Part 1 of this essay, was a major achievement for the industry.¹ Maurice W. Ranney, author of the book, *Dry Cleaning and Degreasing: Chemicals and Processes*, concludes that the use of these nonflammable solvents permitted small drycleaning plants to open in metropolitan areas and shopping centers where they previously might have been banned because of the fire hazard they posed.⁴ (p. 1)

In the US, the laundry and drycleaning trades prospered in the first half of the twentieth century; according to Van Sigworth, National Institute of Drycleaning, the drycleaning industry grew from a \$55 million business in 1919 to an estimated \$2.8 billion business in the late 1960s.⁵ However, there is evidence that by the late 1960s, the industry was in trouble. Richard B. Carnes, an economist, Bureau of Labor Statistics, notes that despite a rate of productivity growth of 2.8 percent in the laundry and cleaning industry from 1965 to 1970, output and hours in this industry actually decreased.⁶ In addition, Carnes notes, "Constant dollar personal consumption expenditures for laundry and cleaning service are estimated to have declined 30 percent from 1970 to 1976." Carnes attributes some of this decline to the prevalence of home washers and dryers, the increased availability and lower cost of coin-operated laundries, and the introduction of self-service drycleaning services in the late 1950s. He suggests that, during this period, the focus of service within the professional drycleaning industry began to shift from personal cleaning services to commercial and industrial clients.

When first introduced, self-service drycleaning centers may have accounted, in part, for the decline in the professional drycleaning business. However, this new enterprise never achieved the

level of success that was anticipated in those early years.

Coin-Operated Centers

In the early 1960s, a number of popular magazines published articles hailing the arrival of the new coin-operated drycleaning machines as a low-cost, practical alternative to professional drycleaning services. In 1963, *Consumer Reports* noted that coin-operated drycleaning centers could be found in all 50 states, and that there were over 7,000 in operation.⁷ The magazine recommended these centers as a means of reducing household drycleaning bills and cutting the turnaround time for cleaning clothes. Another article, appearing in *Changing Times* also in 1963, reports that in 1962, customers spent about \$100,000,000 in the new coin-operated drycleaning machines.⁸ This article also notes that self-service drycleaning centers were being "...heavily promoted as a new type of enterprise for the would-be small businessman..." and even offered information for those interested in starting such a business. In 1964, *Better Homes & Gardens* published an article suggesting that customers could save up to 75 percent on drycleaning costs by using self-service drycleaning.⁹ All of these articles, however, go on to list the considerable limitations of the coin-operated service, together with extensive recommendations about how to protect garments when cleaning them in a self-service center.

The coin-operated machines perform only part of the drycleaning process, which, as I noted in the first part of the essay, is a process that involves many steps, considerable knowledge, special equipment, and not a little skill.¹ The self-service method only cleans and dries garments, and relies on the customer to sort clothes, remove spots, and steam

press or iron garments; ultimately, it is *more* time-consuming for the customer than professional drycleaning would be, and it also presumes that the customer knows how to sort, spot, and press the clothes as well as a skilled professional. Many customers learned the hard way that dyes can run, that some stains and spots require special treatment, and that some fabrics simply cannot be dry-cleaned in tetrachloroethylene (perchloroethylene), the solvent most often used in the coin-operated machines.

Friends recall particularly vivid examples of this last pitfall. Around the time the first coin-operated centers opened, "bonded" synthetic knits were introduced. These fabrics had a spongy foam lining (such as polyurethane foam) fused to the back. Woe to the person who tried to dryclean bonded fabrics in a self-service laundromat! The solvent melted the bonding adhesive, which in turn stained the fabric, and in some cases, the foam lining actually disintegrated.

As early as April 1963, *Time* published an account of the troubles that were already plaguing this new enterprise.¹⁰ Most of those who set up **coin-operated drycleaning** shops were not experienced drycleaning experts, but investors seeking quick profits. **Some cities were soon "swamped" with new coin-operated drycleaning centers.** "...Drycleaning even by machine turned out to be no business for beginners."¹⁰ Customers expected the operators to know as much as their professional counterparts in drycleaning shops about stain removal and fabric care. The cost of providing trained, full-time attendants ate up profits, and machine maintenance was unexpectedly difficult and expensive. At the 1963 convention of the National Institute of Drycleaning, predecessor of the current International Fabricare Institute, "...the general feeling...was that there is a con-

tinuing place for coin-ops, but that the most successful will probably be managed by professional cleaners in big operations that put coin laundry and coin drycleaning under the same roof with a full line of professional drycleaning."¹⁰

Although many industry professionals had good reason to rejoice over the outcome of this particular challenge to the drycleaning business, other events conspired to prolong the lean years through the mid-1970s. Rona S. Zable, staff writer, the *Christian Science Monitor*, points out that in the late 1960s and early 1970s, both the laundry and drycleaning industries were hard hit by the sudden popularity of polyester and other easy-care fabrics that could be laundered at home, and by the predominance of blue jeans and other casual styles. The energy crisis of 1975-1976 dealt another blow, drastically raising the price of energy, equipment, plastic garment bags, and petroleum-based solvents.¹¹

Despite this widespread, 20-year decline in business, evidence suggests that the tide has turned for the drycleaning industry, at least in the US. Earl V. Fischer, editor, *American Drycleaner*, reports that profits in this industry are again on the rise, and attributes the turnaround to a shift in styles.¹² He notes that many Americans have begun purchasing better quality clothing and showing a preference for natural fibers—wools, cottons, and silks. People are now more likely to have these clothes drycleaned. One also suspects that the growing number of two-pay-check households increases demand for drycleaning services; with two wage earners dressing for success, families have more clothes to be cleaned, less time to devote to home laundering, and more money available for luxury services.

The apparent health of the drycleaning industry today does not mean that it

is an untroubled industry. For example, an article appearing in the *Los Angeles Times* in 1984 reported a successful sex discrimination lawsuit against a local drycleaner.¹³ A customer had accused the shop of charging a higher price for cleaning a woman's shirt than for a comparable man's shirt. If drycleaners cannot successfully show that women's clothing requires more work because of the extra darts and tucks, as argued by the defendant in this case, then the industry may be in for a jolt.

One of the areas of greatest concern to the drycleaning industry is government regulation. *Chemical Marketing Reporter* recently noted that the US Environmental Protection Agency (EPA) announced that businesses that produce small quantities of hazardous waste, among them drycleaners, will be subject to new hazardous waste disposal requirements under the Resources Conservation and Recovery Act.¹⁴

But perhaps the foremost concern of those in the drycleaning industry today involves the safe handling of drycleaning solvents and the potential health risk to drycleaning workers. The controversy surrounding this question merits a closer look at the evidence.

Occupational Health and Environmental Concerns

J.C. Parker and colleagues, National Institute for Occupational Safety and Health (NIOSH), Rockville, Maryland, estimated in 1978 that approximately 500,000 workers are at risk of exposure to perchloroethylene, which is used by three-quarters of the drycleaners in the US.¹⁵ As I noted earlier, perchloroethylene is the most commonly used drycleaning solvent because it is nonflammable, gentle enough for most synthetic fibers, and an excellent chemical for dissolving grease.¹

Manufacturers of perchloroethylene have collaborated with the Laundry-Cleaning Council, an organization of textile trade associations, in producing a booklet on the safe handling of perchloroethylene.¹⁶ This booklet gives several reasons for recommending that perchloroethylene vapors should be minimized in the workplace, such as the need to conserve an expensive chemical, the need to protect worker health and alertness, the need to limit emission of hydrocarbons to the atmosphere, and the possibility that perchloroethylene may be carcinogenic.

The spectre of human toxicity, especially the risk of cancer from these solvents, haunts the drycleaning industry. No conclusive evidence has been found linking long-term exposure to perchloroethylene with cancer in humans. But a number of studies over the past 15 years suggest that there might be a connection.

In 1979, A. Blair and colleagues, National Institutes of Health (NIH), reported finding a significant excess number of deaths from cancer of the lung, cervix, and skin among 330 former laundry and drycleaning workers whose records were studied.¹⁷ However, the results of this study are not conclusive because of inadequate documentation. The solvents to which these workers were actually exposed are not recorded. Nor are the levels of exposure or other contributing factors, such as smoking habits. The records of both laundry and drycleaning workers were examined as a monolithic group. So, no distinction was made between those who had been exposed to solvents and those who had not.

In 1981, R.M. Katz and D. Jowett, Department of Science and Environmental Change, University of Wisconsin, Madison, reported the results of a study in which they examined death certificates for 671 female laundry and

drycleaning workers in Wisconsin from 1963 to 1977.¹⁸ The proportionate mortality ratios for deaths from cancer of the genitals and for deaths from cancer of the kidney were significantly higher among the laundry and drycleaning workers than among the control group of women working in other low-wage occupations. Again, the study is inconclusive for the same reasons as the one by Blair and coworkers: exact exposures, if any, are not known, nor is there any record of possible contributing factors. Nonetheless, the results suggest that there might be an association between occupation in the drycleaning industry and an increased risk of cancer.

Approaching this question from a different angle, R.S. Lin and I.I. Kessler, Department of Epidemiology and Preventive Medicine, University of Maryland School of Medicine, Baltimore, have also found evidence suggesting that employment in the drycleaning industry may expose workers to an increased cancer risk.¹⁹ Lin and Kessler studied demographic histories of 109 patients with pancreatic cancer, and found a correlation between pancreatic cancer and employment in the drycleaning industry. The major limitation of this study is that the actual solvents to which the patients had been exposed are not known.

Although most of these researchers would admit that their findings are inconclusive, their contention that more epidemiologic studies should be done is supported by the evidence published by the National Cancer Institute that perchloroethylene is carcinogenic in mice.²⁰ NIOSH was concerned enough about this issue to recommend that perchloroethylene be handled in the workplace as if it were a human carcinogen.¹⁶ Similarly, the EPA has recommended that perchloroethylene should carry a label warning that it might be carcinogenic to humans.²¹ In 1985, the EPA expects

to release a new review of the effects of perchloroethylene on human health in its attempt to determine whether this substance should be regulated as an air pollutant under the Clean Air Act.²²

Current exposure standards accepted by the Occupational Safety and Health Administration (OSHA) are a time-weighted average (TWA) of 100 parts per million (ppm), an acceptable ceiling of 200 ppm (with 100-200 permissible exposures if TWA remains less than 100 ppm), and a maximum allowable concentration of 300 ppm (with a total of no more than five minutes within any three-hour period).¹⁶ These standards were initially established to protect workers from the acute toxic effects of perchloroethylene, which are well documented in the literature. The Laundry-Cleaning Council notes that high exposures to perchloroethylene vapors can result in eye irritation (100-200 ppm), lightheadedness (200 ppm), loss of coordination (within two hours at 400 ppm), dizziness and loss of inhibitions (within 10 minutes at 600 ppm), and complete incoordination followed by unconsciousness (within 30 minutes at 1,500 ppm).¹⁶

There are other dangers from acute exposure to perchloroethylene. Brian Morgan, Mount Vernon Centre for Plastic Surgery, Middlesex, England, and Stanley Ling and William A. Lindsay, St. Helier Hospital, Surrey, England, report separate incidents in which an individual was present in a drycleaning shop when perchloroethylene was spilled; in both cases, the individual was overcome by fumes and suffered skin burns from prolonged exposure to the spilled solvent.^{23,24} Z. Abedin and coworkers, Schools of Basic Medical Sciences and Chemical Sciences, University of Illinois, Champaign-Urbana, report the case of a young man who experienced cardiac arrhythmias while working in a drycleaning plant where he was exposed

to perchloroethylene.²⁵ An arrhythmia is any variation from the normal rhythm of the heart beat. L.C. Meckler and Darwin K. Phelps, Mount Carmel Hospital and Ohio State University, Columbus, report a case of acute hepatitis following heavy exposure to perchloroethylene in a drycleaning plant.²⁶

At the Department of Hygiene, Nagoya University School of Medicine, Japan, Y. Takeuchi and coworkers, in a health survey of drycleaning workers in Nagoya, found that workers complained of eye irritation and dizziness. The workers directly engaged in drycleaning with perchloroethylene had average liver function test values significantly higher than the average values in workers whose involvement was indirect.²⁷ J.H. Gold, Department of Psychiatry, Dalhousie University, Halifax, Nova Scotia, provided an interesting case report. After chronic weekly exposures to high concentrations of perchloroethylene (when cleaning his drycleaning machines), the patient suffered severe neurologic effects, including loss of coordination, mental dullness, inappropriate affect, difficulty with short-term memory, and stammering speech.²⁸ Some of these effects appeared to be irreversible, persisting even after the man had not been exposed to perchloroethylene for 12 months.

If acute exposure is high enough, perchloroethylene can cause death. *Consumer Reports* published an account of a tragic case of accidental death by perchloroethylene poisoning that occurred in 1963, shortly after coin-operated drycleaning machines became widespread.²⁹ A 16-year-old boy slept overnight in a sleeping bag that had been cleaned the previous day, but insufficiently dried, in a self-service drycleaning machine. Apparently, the sleeping bag was never aired to allow residual vapors to disperse. The boy went into a

coma and died 11 days later from inhaling the fumes.

In the professional drycleaning environment, the major concern is not so much acute overexposure to perchloroethylene and other solvents, because most professionals know about this danger and take precautions to prevent it. The major worry is long-term, low-level exposure. Howard R. Ludwig and colleagues, Division of Surveillance, Hazard Evaluations and Field Studies, NIOSH, Cincinnati, Ohio, conducted a survey of exposure levels in 44 drycleaning plants in five states.³⁰ Machine operators were found to receive the highest exposures, ranging from 4.0 to 149.0 ppm perchloroethylene. The geometric mean exposure (22 ppm) of machine operators was significantly higher than mean exposures of pressers (3.3 ppm), seamstresses (3.0 ppm), and front counter attendants (3.1 ppm). Although in 98 percent of cases, exposure fell within the OSHA standards for acceptable levels, Ludwig and coworkers recommend that perchloroethylene levels be kept as low as possible. One specific recommendation is that combination drycleaning and drying units, which eliminate the need to transfer perchloroethylene-soaked clothes to a drier, be used. These authors make additional recommendations on ventilation, maintenance, plant layout, and personal protective equipment that can minimize worker exposure to perchloroethylene vapors.

The Laundry-Cleaning Council also notes that keeping the concentration of perchloroethylene vapors as low as possible is the single most important factor for safe operation of a drycleaning plant. The Council provides general guidelines for minimizing perchloroethylene vapors, including observation of local building codes, proper maintenance of equipment and regular inspection for leaks, immediate clean-up of any spills,

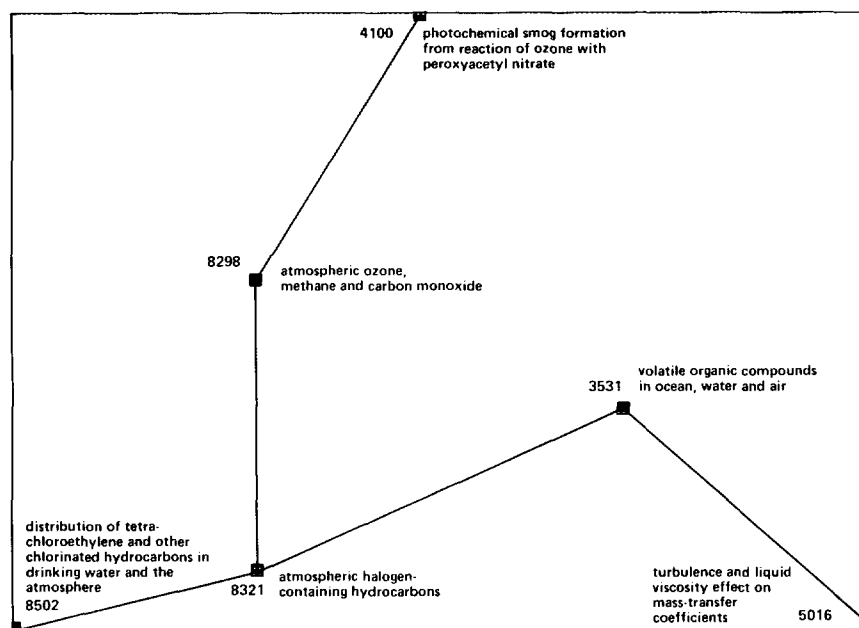
adequate ventilation of the room with fresh air, good exhaust ventilation in equipment, and a prompt analysis of breathing-zone concentrations if doubt exists about vapor levels.¹⁶

Although Parker and coworkers estimate that two-thirds of the perchloroethylene consumed in the US is used in the drycleaning industry, the problem of reducing occupational exposure to the solvent is shared by other industries. Companies that manufacture perchloroethylene and other chemicals for which it is a chemical intermediate are clearly concerned, as well as companies that use perchloroethylene as an industrial degreaser or a heat exchange fluid.¹⁵

Outside of the industries that are specifically concerned with occupational exposure, the larger question of the environmental fate of perchloroethylene has also been raised. From the ISI® database, we have identified a research front on the "Distribution of tetrachlo-

roethylene and other chlorinated hydrocarbons in drinking water and the atmosphere" (#83-8502). The two core papers, both published in 1975, report findings of scientists with the Imperial Chemical Industries, Mond Division, Runcorn, Cheshire, England: "Chlorinated Hydrocarbons and the Environment," by G. McConnell, D.M. Ferguson, and C.R. Pearson,³¹ and "Chlorinated C₁ and C₂ Hydrocarbons in the Marine Environment," by Pearson and McConnell.³² Figure 1 is a higher-level multidimensional scaling map of the research area "Atmospheric distribution of hydrocarbons and other contaminants." Research front #83-8502 is one of the six closely related research fronts on this topic. In 1983, there were 4 papers on drycleaning, 4 papers on perchloroethylene, and 21 papers on tetrachloroethylene noted in the ISI database, while in 1984 there were 4 papers on drycleaning, 7 papers on perchloro-

Figure 1: A C-2, or higher-level, multidimensional scaling map of cluster 993, "Atmospheric distribution of hydrocarbons and other contaminants."



ethylene, and 14 papers on tetrachloroethylene.

McCannell and coauthors reviewed the literature on the environmental distribution, bioaccumulation, and persistence in the environment of various chlorinated aliphatic hydrocarbons, including tetrachloroethylene. These authors conclude that "...while a number of C₁ and C₂ chlorinated aliphatic compounds are widely distributed, they do not accumulate to the same extent as the chlorinated insecticides, nor do they have their extreme persistence in the environment."³¹ Pearson, in another detailed review of the literature, confirmed these findings. He notes that "...these compounds are not persistent in the environment, and...there is not significant bioaccumulation in marine food chains."³²

So, despite the widespread use of perchloroethylene in drycleaning and other industries, the threat of environmental accumulation is apparently not a major concern at this time. At least, there do not appear to be many scientists investigating this question. It will be interesting to review the new EPA health assessment of tetrachloroethylene, slated for release this year, which will determine whether or not this chemical should be regulated as an air pollutant under the Clean Air Act.²²

There is at least one new application of drycleaning technology that will surely raise environmental concerns—that of

cleaning protective clothing worn by workers in the nuclear power industry. Joseph A. Capella, Health Physics Systems, Inc., Gainesville, Florida, reporting in the *Transactions of the American Nuclear Society*, extols the superiority of drycleaning over water washing as a means of cleaning protective clothing.³³ According to Capella, drycleaning is 250 percent more effective at removing radioactivity from the clothing, and generates 80 to 90 percent less contaminated waste. Clearly, this new-age application of drycleaning technology will require new-age safety measures and waste-disposal procedures. Although this is a small part of the overall problem of nuclear waste disposal, it does underscore the ongoing nature of waste accumulation. In a society increasingly concerned with the health and environmental consequences of modern technology, no industry is immune from public scrutiny, no matter how humble and familiar. Finding solutions to the problems of worker protection and waste disposal are among the most important challenges facing us today. Society and industry must work together to solve these problems.

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REFERENCES

1. Garfield E. Drycleaning. Part 1. The process and its history: from starch to finish. *Current Contents* (22):3-12, 3 June 1985.
2. Brannit W T & Gray J B, eds. *Practical dry cleaner, scourer and garment dyer*. New York: H.C. Baird, 1924. 378 p.
3. Johnson A E. *Drycleaning*. Watford, UK: Mellow, 1971. 45 p.
4. Ranney M W. *Dry cleaning and degreasing: chemicals and processes*. Park Ridge, NJ: Noyes Data Corporation, 1973. 312 p.
5. Sigworth V. Dry cleaning. *Encyclopedia Americana*. Chicago, IL: Encyclopedia Americana, 1981. Vol. 3. p. 424.
6. Carnes R B. Laundry and cleaning services pressed to post productivity gains. *Mon. Lab. Rev.* 101(2):38-42, 1978.

7. How to cut your dry cleaning costs in half. *Consumer Rep.* 28:20-2, 1963.
8. Do-it-yourself dry cleaning. *Changing Times* 17(5):27-8, 1963.
9. How to save with self-service dry cleaning. *Better Homes Gardens* 42(4):30, 1964.
10. The troubles of coin-ops. *Time* 81(14):92, 1963.
11. Zable R S. Dry cleaners thrive as Americans dress up. *Christian Sci. Monit.* 2 January 1981. p. 9.
12. Fischer E V. Personal communication. 20 May 1985.
13. Oliver M. Patron takes starch out of sexist pricing. *Los Angeles Times* 31 August 1984. Sec. II, p. 1.
14. RCRA to be extended to smaller firms. *Chem. Market. Rep.* 18 March 1985. p. 4; 33.
15. Parker J C, Bahlman L J, Lekdel N A, Steh H P, Thomas A W, Wolf B S & Baler E J. Tetrachloroethylene (perchloroethylene). *Amer. Ind. Hyg. Assn. J.* 39(3):A-23 - A-29, 1978.
16. Laundry-Cleaning Council. *The safe handling of perchlorethylene drycleaning solvent.* Downers Grove, IL: LCC, 1980. 12 p.
17. Blair A, Decoufle P & Grauman D. Causes of death among laundry and dry cleaning workers. *Amer. J. Public Health* 69:508-11, 1979.
18. Katz R M & Jowett D. Female laundry and dry cleaning workers in Wisconsin: a mortality analysis. *Amer. J. Public Health* 71:305-7, 1981.
19. Lin R S & Kessler I I. A multifactorial model for pancreatic cancer in man. *JAMA—J. Am. Med. Assn.* 245:147-52, 1981.
20. National Cancer Institute. *Bioassay of tetrachloroethylene for possible carcinogenicity.* Bethesda, MD: NCI, August 1977. DHEW Publ. No. (NIH) 77-813.
21. Chemicals EPA wants to label. *Chem. Week* 127(3):23-4, 1980.
22. Draft Health Assessment Document for tetrachloroethylene (perchloroethylene). *Fed. Reg.* 48(248):56847-8, 23 December 1983.
23. Morgan B. Letter to editor. (Dangers of perchlorethylene.) *Brit. Med. J.* 2:513, 1969.
24. Ling S & Lindsay W A. Letter to editor. (Perchloroethylene burns.) *Brit. Med. J.* 3:115, 1971.
25. Abedin Z, Cook R C & Milberg R M. Cardiac toxicity of perchloroethylene (a dry cleaning agent). *Southern Med. J.* 73:1081-3, 1980.
26. Meckler L C & Phelps D K. Liver disease secondary to tetrachloroethylene exposure. *JAMA—J. Am. Med. Assn.* 197:662-3, 1966.
27. Takeuchi Y, Hisanaga N, Ono Y, Iwata M, Oguri S, Tauchi T & Tanaka T. An occupational health survey on dry cleaning workers. *Jpn. J. Ind. Health* 23:407-18, 1981.
28. Gold J H. Chronic perchlorethylene poisoning. *Can. Psychiat. Assn. J.* 14:627-30, 1969.
29. Toxic vapors from coin-op dry cleaning. *Consumer Rep.* 29:317, 1964.
30. Ludwig H R, Meister M V, Roberts D R & Cox C. Worker exposure to perchloroethylene in the commercial dry cleaning industry. *Amer. Ind. Hyg. Assn. J.* 44:600-5, 1983.
31. McConnell G, Ferguson D M & Pearson C R. Chlorinated hydrocarbons and the environment. *Endeavour* 34:13-8, 1975.
32. Pearson C R & McConnell G. Chlorinated C₁ and C₂ hydrocarbons in the marine environment. *Proc. Roy. Soc. London Ser. B* 189:305-32, 1975.
33. Capella J A. Dry cleaning of protective clothing. *Trans. Amer. Nucl. Soc.* 30:675, 1978.