First, Do No Harm

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The challenge intrinsic to healthcare is how to provide high-quality treatment in an ever-changing environment. New science and technological innovations constantly require healthcare providers to transform the way they deliver services. Over the last ten years, the new science linking chemical contaminants in the environment and the incidence of disease has created an additional impetus for the transformation of healthcare practice. This paper explores the implications of this new science linking contaminants and health and discusses the environmental innovations that hospitals are implementing to not only create more optimal conditions for healing in their institutions, but also to prevent disease in the general public.

Our rising disease burden

Chronic diseases and disabilities now affect more than 90 million men, women, and children, more than one-third of our population (CDC 2005a). In spite of the many advancements in medical practice, the best available data shows an increase in the incidence of asthma, autism, birth defects, childhood brain cancer, acute lymphocytic leukemia, endometriosis, Parkinson's disease, and infertility (Trasande and Landrigan 2004, Jahnke et al. 2005).

Some of the highlights of Americans' disease burden are summarized below.

- The lifetime risk of getting cancer is 1 in 2 for men and 1 in 3 for women; 1 in 12 and 1 in 11, respectively, will develop invasive cancer before the age of 60 (ACS 2005).
- The risk of breast cancer has almost tripled from more than 1 in 20 to 1 in 8 in the last forty years (ACS 2005).
- Asthma rates doubled between 1980 and 1995 (Mannino et al. 2002).
- Non-Hodgkin's lymphoma has nearly doubled since the 1970s (RPCI 2005).
- In America, 127 million people are overweight; 60 million are obese (AOA 2006).
- Between 1997 and 2004, diabetes incidence increased 45 percent among 18-44 year olds (CDC 2005b).
- Endometriosis, linked to dioxin exposure, now affects 10 percent to 15 percent of the US female population (Holloway 1994, Suchy and Stepan 2004).

The picture is profoundly troubling. The human cost for families and communities is immeasurable, particularly those already disadvantaged by persistent economic disparities. The economic cost of these diseases by 2020 will exceed $1 trillion yearly in healthcare costs and lost productivity (Goldman 2001).

The new field of environmental health is linking each of these diseases and disorders to exposure to toxic chemicals (CHE 2006, Heindel 2003). The old way of looking at chemical risk and safety would have missed these links, as they are not as simple as single cause and single effect. But through the new lens

of environmental health science, we are learning that exposure to toxic chemicals, at levels thought to have been safe, is increasing the chronic disease burden of millions of Americans.

The new findings in environmental health science show that:

1. Chemical exposure at incredibly small levels can impact the hormonal system and disrupt the body's normal development, including interacting with genes that can damage the delicate balance in the human body. New science is revealing that genes and chemicals work together to contribute to disease onset.
2. Babies in the womb and young children are more vulnerable to chemical exposure than average adults.
3. Chemical exposure at important windows of human development can set in motion changes that only manifest themselves as health impacts later in life.
4. Chemicals can interact in a synergistic way in our bodies to contribute to a health impact or exacerbate a health problem.

This new science is coupled with the increasing understanding that industrial chemicals are present in our food, air, soil, water, homes, schools, workplaces, and even in our bodies. Our exposures come from food, cleaning and disinfection products, personal-care products, pesticide and herbicide applications, emissions from chemical manufacturing and disposal sites, pharmaceuticals, and a multitude of other sources, some known and some unknown.

In the past five years, the Centers for Disease Control and Prevention (CDC), has released three biomonitoring studies detailing toxic chemical loads among the American public. The CDC's "Third National Report on Human Exposure to Environmental Chemicals" looked at 148 environmental chemicals—including lead, mercury, cadmium, and other metals; dioxin, furans, and PCBs (polychlorinated biphenyls) and forty-two pesticides—in the bodies of thousands of participants (CDC 2005c). The conclusions are startling. Without our knowledge or informed consent, all of us carry the products and byproducts of the chemical industry—carcinogens, reproductive toxins, neurotoxicants, mutagens, and chemicals that impact a broad set of bodily systems.

In a biomonitoring study of umbilical cord blood of newborn babies, the Environmental Working Group detected 287 chemicals in all and an average of 200 chemicals in each child (EWG 2006). Of the 287 chemicals detected in umbilical cord blood, 180 cause cancer in humans or animals, 217 are toxic to the brain and nervous system, and 208 cause birth defects or abnormal development in animal tests.

In separate biomonitoring studies, EWG found two hundred chemicals in the umbilical cord blood of newborn babies (EWG 2006). In another study, Mount Sinai School of Medicine in New York, in collaboration with two nongovernmental organizations (Commonweal and Environmental Working Group) found an average of 91 industrial compounds, pollutants, and other chemicals in nine study volunteers. Seventy-six carcinogens were found among the participants, 94 nervous system toxicants, and 70 reproductive toxicants. A total of 167 separate chemicals, including dioxins, were found in the group. A companion website lists the chemicals found in each participant, which companies make or use those chemicals, and the products that contain them (EWG 2003).

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United States chemical companies hold licenses to make or import more than 75,000 chemicals for commercial use with approximately 1,500 newly synthesized chemicals annually registered by the federal government (EPA 2006c, Oleskey and

McCally 2001). Chemical production is rising and the resulting waste is mounting. According to the EPA, US industries reported manufacturing 6.5 trillion pounds of 9,000 different chemicals in 1998. In 2004, major US industries reported dumping 4.2 billion pounds of 650 industrial chemicals into our air and water (EPA 2004). This represents less than 9 percent of total toxic releases, since most toxic releases are not reported (NET 2004).

As a result of toxic products and pollution, every child born today already carries toxic chemicals in his/her body that have passed through the mother's placenta. We have minimal to no toxicological data on most of these chemicals. Additionally, there is almost no scientific research about the synergistic effects of exposing human beings to this complex cocktail of toxic compounds. And we also do not know how this body burden of chemicals interacts with ongoing exposure to emissions from factories, incinerators, food, air pollutants, and other sources, as well as other environmental stressors and genetic dispositions.

Healthcare's contribution to chemical contamination

Dioxin and mercury are two chemicals that new environmental health science has shown to be unsafe at levels previously thought benign (Mahaffey 2000; Keitt, Fagan, and Marts 2004).

According to the US Environmental Protection Agency (EPA), in 1995, medical waste incinerators were the largest source of dioxin air emissions and contributed 10 percent of the mercury air emissions in the United States (EPA 1995). Processes such as combustion, chlorine bleaching of pulp and paper, certain types of chemical manufacturing, and other industrial procedures that include the combustion of chlorine produce dioxin as a byproduct.

The EPA estimates that humans receive more than 95 percent of their dioxin intake through food (FDA 2006). People eat dairy products, meat, and fish and take the dioxin into their bodies, where it is stored in fatty tissue for years and builds up over time. Dioxin's global distribution means that every member of the human population is exposed. This is especially problematic for childbearing women, who pass dioxin to a child in utero and when breastfeeding. The EPA also estimated, in its 2003 Dioxin Reassessment draft, that the average levels of dioxin in all Americans is "at or approaching levels" where we can expect to see a variety of adverse health effects (EPA 2003). Health effects linked to dioxin exposure in humans and/or animals include cancer, endometriosis, testicular atrophy, increased miscarriages and birth defects, damage to the immune system, neurological damage, and alterations in hormone function. Dioxin is one of the most infamous of the persistent bioaccumulative toxins (PBTs), one of the most potent carcinogens known to science, and one of the few targeted by international treaty for elimination.

Intimately linked to the dioxin issue is polyvinyl chloride (PVC), used widely in the production of IV and blood bags, plastic tubing, and an array of other hospital products. PVC (because of its high chlorine content) contributes to dioxin formation when it is manufactured and incinerated. Flexible PVC often contains a chemical, DEHP (Di(2-ethylhexyl)phthalate) that can leach out of products and enter the bodies of patients receiving fluids through PVC tubing. In 2000, new environmental health science led the National Toxicology Program to conclude that DEHP is a reproductive toxicant and that infants in hospitals are at risk from exposure to this chemical (NTP 2000). The Food and Drug Administration followed with a health advisory to hospitals, urging healthcare facilities to seek safer alternatives, especially for vulnerable patient populations (FDA 2002).

Medical waste incinerators are also a source of mercury and other heavy metal emissions into the environment, although their numbers have been drastically reduced (EPA 1995). Mercury is a toxic metal that affects the human nervous system, liver, and kidneys; mercury-contaminated fish eaten by pregnant women can affect fetal development. In the United States, forty-two state departments of health have issued warnings against eating fish caught in all or some of their states' water bodies because of mercury contamination. The EPA estimates that 1.6 million pregnant women, children, and women of childbear-

ing age are exposed to unsafe levels of mercury from eating contaminated fish (EWG 1997). An estimated 630,000 newborns are threatened with neurological impairment due to in utero mercury exposure, or one in six children born in the United States (CDC 2003, Mahaffey 2004).

In addition to dioxin and mercury contamination, there are a variety of other environmental exposures in the hospital environment that can lead to compromised health for both healthcare workers and patients. Some of these issues arise from hospital design and materials used in building healthcare facilities. For example, 75 percent of PVC is used in construction, which outgases DEHP into the air. Four studies have linked interior PVC exposure to asthma (Thorton 2002; Jaakola et al. 1999; Jaakola, Verkasalo, and Jaakola 2000; Wieslander et al. 1999). Other exposures are tied to day-to-day hospital operations, such as the use of toxic cleaners and pesticides in healthcare facilities. According to research conducted by the Massachusetts Department of Health, poor air quality has been identified as the most frequent cause of work-related asthma in healthcare workers (Pechter et al. 2005).

Hospitals are also energy-intensive institutions. After the food-service industry, the healthcare industry ranks second in energy-usage intensity (DOE 2002). In 2005, each square foot of healthcare space cost an average of $2.15 in electrical and natural gas expenses (CEE 2005). Some of these costs can be addressed by energy-efficiency upgrades and smart design. Additionally, many hospitals are located in communities where public transit either does not exist or the hospital is inaccessible to the public transit system. Until recently, hospitals paid little attention to the energy performance and efficiency of their building infrastructure.

As the environmental and health effects of global warming become more pressing, healthcare, like other major sectors, will need to reduce overall energy use and move to cleaner energy sources. Indeed, they have a responsibility to do so.

Pharmaceuticals are also emerging as another major environmental and public health threat that until recently was virtually unknown. Many pharmaceuticals contain hormone-disrupting chemicals, which migrate from hospitals and homes to water bodies, negatively impact aquatic life, and wind up in our drinking water (Fox 2005, Heinzmann 2005). Additionally, many drugs contain compounds that are persistent in the environment or bioaccumulate in the food chain. As more drugs are consumed by Americans, more of these biologically active agents are building up in our environment. More than one hundred pharmaceuticals or their metabolites have been found in water bodies in Europe and the United States, some of them in drinking water supplies (Hemminger 2005, Heberer et al. 1997).

Evolving the Hippocratic oath

Since physicians and other healthcare professionals take an oath to "First, do no harm," healthcare institutions and the industries that support them have a special responsibility to ensure that their operations are not major sources of chemical exposure and environmental harm. But, until recently, healthcare professionals and hospital administrators were unaware of their contribution to chemical contamination and broader societal disease burdens. The educational curriculum for physicians, nurses, and hospital administrators does not provide the latest scientific information on the environmental consequences of healthcare delivery.

In the last ten years, however, the information gap has begun to close. The healthcare industry has begun to expand its definition of health to include environmental health—the body of scientific evidence that links the health of the environment to the incidence of human disease. With the emergence of Health Care Without Harm (HCWH), hospital leaders have learned about their industry's contribution to chemical exposure issues and made steady progress to solving some of their environmental problems. For example, due to the rising costs of complying with dioxin emission regulations and the educational work of HCWH, more

than 5,000 medical-waste incinerators have closed since the mid-1990s. In response to the changing regulatory climate, hospital administrators chose to reduce waste and adopt safer waste-disposal and treatment technologies.

In 1998, the American Hospital Association and the EPA entered into a memorandum of understanding to eliminate mercury-containing products from the healthcare sector and reduce waste volumes by 50 percent in ten years. To accomplish these ambitious goals, these organizations joined with the American Nurses Association and HCWH to form Hospitals for a Healthy Environment (H2E). Over the last several years, H2E has grown to include more than 1,206 healthcare partners representing 6,700 healthcare facilities. During this period, virtually all the major pharmacy chains in the country eliminated the sale of mercury thermometers, while major cities and at least ten states have banned their sale as well. At the same time, the nation's largest hospital systems have adopted mercury phase-out policies in their procurement specifications. The largest group purchasing organizations (GPOs)—Premier, Novation, Consorta, Amerinet, Broadlane, and MedAssets—have committed to eliminating mercury-based products from their catalogues. Mercury elimination in the American healthcare sector, although not yet complete, is a powerful success story about how hospitals can collectively use their enormous purchasing power to reduce their environmental and public health footprint and also drive markets for safer alternatives to problematic chemicals and technologies (H2E 2005).

There are additional components to this success story. First, healthcare leaders occupy a highly respected place as trust-holders in American society. If hospitals eliminate mercury from their operations, it creates the political momentum to eliminate mercury from other sectors and other products in our economy, thus improving the safety of the food supply and public health. Since hospitals began moving to remove mercury from their operations in 1998, more than twenty-nine states have passed laws restricting mercury-based products in their states (EIA 2005).

Moreover, since leaders within the American Nurses Association and affiliated organizations learned about mercury, dioxin, and other environmental threats linked to hospital operations, they have become active in more than eight states to support policies to phase out chemicals linked to cancer, birth defects, and genetic damage. In 2005, HCWH launched a website called the Luminary Project (www.theluminaryproject.org) to honor those leaders in the nursing profession who are expanding their understanding of the Hippocratic oath and engaging in preventative medicine through environmental activities in their institutions and in society at large.

Healthcare's path to ecological medicine

Once the link between healthy people and a healthy environment is made, wonderful opportunities present themselves for hospitals that want to model environmental responsibility. A few of these opportunities are discussed below.

Design for health

Over the past twenty years, scores of studies confirm that buildings throughout their life cycles are major contributors to environmental degradation and human illness (Srinivasan, O'Fallon, and Dearry 2003; Portnoy, Flappan, and Barnes 2001). Building-related activities are responsible for 35 percent to 45 percent of carbon dioxide releases into the atmosphere, contributing to global warming and exacerbating stratospheric ozone depletion by using refrigerants and materials such as insulation manufactured with hydrochlorofluorocarbons (HCFCs) (EPA 2006b). Buildings use about 40 percent of raw stone, gravel, sand, and steel; 25 percent of virgin wood; and more than 75 percent of PVC (Roodman 1995, HBN 2006). Buildings also demand about 40 percent of energy assets and 16 percent of water resources, while building construction and demolition generates about 25 percent of municipal solid wastes. Sick building syndrome has been iden-

tified as a frequent contributor to short-term or chronic illness (EPA 2006a). This is consistent with analyses that find that, in the United States, people spend 90 percent of their time indoors and that many common materials emit dangerous compounds and harbor infectious molds, fungi, and bacteria (EPA 1993). For people confined to the indoors due to illness, the consequences are even more severe.

In response, professional associations such as the American Institute of Architects and the World Congress of Architects have issued strongly worded directives advising building professionals to acknowledge sustainable design as basic and fundamental to standard quality practice (AIA 2005). In addition, local, state, and federal public policymakers are adopting green building guidelines and corporations are establishing environmental building standards. These emerging strategies redefine the way buildings ought to be designed, built, and operated. Such policies extend the conventional notion of building performance to include human health and environmental quality as essential cornerstones of quality and value.

Four years ago, the Center for Maximum Potential Building Systems convened a group of leading architects and designers from around the country to develop a green building tool that would be appropriate for the healthcare sector. The result of that project is the *Green Guide for Healthcare* (www.gghc.org). The *Green Guide for Health Care* (GGHC) is modeled on the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) standard, but it is goes beyond LEED and includes a more robust framework based on environmental health considerations aligned with healthcare system priorities. Specific guidance on materials selection addresses the chemicals issues raised in this paper. Each recommendation in the guide is accompanied by a summary of its impact on health—either patient health, worker health, or the health of the environment.

In the first eighteen months of its existence, GGHC has attracted enormous interest from the healthcare design community. By June 2006, more than one hundred hospitals around the country, representing more than 40 million square feet of construction, had agreed to pilot the GGHC in their construction projects. Kaiser Permanente, the nation's largest nonprofit health maintenance organization (HMO), has committed to use the GGHC as a framework for its entire system's building plans. During this same period, several building materials and furniture companies that service the healthcare sector have launched new products to capture the rapidly growing interest in healthcare to build "green and healthy." At the policy level, the City of Boston has agreed to recommend the GGHC to the city's hospitals that are engaged in expansion plans.

The healthcare sector's eager acceptance of the GGHC is encouraging. If hospitals help redefine green building to include environmental health as a key component in overall building projects, this could trigger a number of important new directions in healthcare construction and design.

First, it creates the possibility that healthcare can be a leading sector in going beyond first-cost building expenses. If we account for the health and environmental "services" of the building over its entire life, we can save on life-cycle costs in designing the building. This broader way of estimating costs of new construction can help marry construction and operations expenditures in cost calculations and link construction and design teams with operations teams.

Second, if hospitals evaluate buildings along environmental health criteria, it creates the possibility of an entirely new chapter in evidence-based design research in healthcare. The healthcare sector can play a leading role in society in implementing a research agenda that documents how healthy buildings contribute to healthier people and greater productivity. Hospitals can lead society toward building schools, homes, and office buildings that also promote occupant health and consider the environmental and public health implications of the building materials and systems themselves.

Healthy food in healthcare

The dominant industrial food system in the United States is currently a leading factor in a host of preventable health and environmental problems. For example, poor nutrition is a risk factor for four of the six leading causes of death—heart disease, stroke, diabetes, and cancer. Pesticide drift, field runoff, waste burning, and diesel exhaust from transporting food long distances are all factors of food production that contribute to air and water pollution. Additionally, the expansion of large-scale animal feedlot operations has contributed significantly to the demise of independent family farms, contaminating groundwater with nitrates, hormones, and other products of untreated animal waste and creating the conditions for virulent pathogens to spread.

Rather than fresh fruits and vegetables, whole grains, and other high-fiber foods important for health, our current food system favors the production of feedlot-raised animal products and highly refined calorie-dense foods. This is not only a food system misaligned with the US dietary guidelines: it is also a food system that is largely reliant on production and distribution methods that undermine public health and the environment in which we live (Koc and Dahlberg 2004).

As places of healing, hospitals have an incentive to provide food that is healthy for people and the environment in which we live. Yet many healthcare facilities are increasingly trying to save costs by buying inexpensive and pre-processed food. Part of the reason this food is inexpensive has to do with the agricultural subsidies that have brought down the cost of certain commodities, like corn for corn syrup, soybeans for partially hydrogenated oil, and mass-produced grains that are often highly processed before they reach our plates. However, cheap production has come with a very steep price in terms of our environment and nutritional needs (IATP 2006).

For hospitals, it presents a particularly ironic position: How can we expect the larger society to understand the links between good food and human health if our "healing spaces" are filled with products that are part of the problem?

Hospital leaders are beginning to rise to this challenge. Several large healthcare systems have begun to promote better health and responsible farming practices by purchasing fresher, better tasting, and nutritious food for their patients, staff, and broader community. Both Kaiser Permanente and Catholic Healthcare West (CHW) have passed overarching food policies that clearly align their institutions with both healthy food choices for their patients and sustainable agriculture practices.

CHW's policy states: "CHW recognizes that food production and distribution systems have wide ranging impacts on the quality of ecosystems and their communities, and so; CHW recognizes that healthy food is defined not only by nutritional quality, but equally by a food system which is economically viable, environmentally sustainable and which supports human dignity and justice, and so; CHW aspires to develop a healthy food system" (CHW 2006).

From sponsoring farmers markets to adopting better procurement guidelines, hospitals can make a difference. And by supporting food production that is local, humane, and protective of the environment, healthcare providers can lead the way to more sustainable agricultural practices in their communities. These sweeping changes help redefine the term *community benefit* and allow the hospital system to expand its health promotion mission beyond the four walls of its facilities.

In the past two years, Kaiser Permanente has established farmers markets at the majority of its hospital campuses. In some locations, the Kaiser Permanente lobby is the only place to get fresh and organic produce in the community (Kaiser Permanente 2006). Large GPOs, which purchase supplies for 72 percent of the healthcare market, are developing specifications to buy meat without the use of nontherapeutic antibiotics in the production process (KnowledgeSource 2006). This one change alone could help ensure

that essential antibiotic drugs are not rendered ineffective by agricultural overuse of antibiotics (Huffling 2006, Shea 2004). Healthcare's position on this critical issue sends an important message to the marketplace that the overuse of antibiotics for meat production is a problem for healthcare providers in America.

Safer chemical policies

In the introduction to this paper, we discussed how chemicals have invaded every aspect of our lives, including our bodies. These chemicals are linked to a wide variety of preventable diseases, including cancer, birth defects, immune-related diseases, learning disabilities, and asthma (CHE 2006). Clearly, if our society could eliminate these chemical exposures, a great deal of disease could be prevented, thus avoiding the enormous burden on the healthcare system.

In 1994 and again in 2005, the US General Accounting Office reported that the US chemical policy regime does not properly assess or control the public health impacts of chemicals. In the last twenty-seven years, only five chemicals or chemical classes have been restricted due to their impact on public health via the Toxic Substances Control Act, yet thousands of new chemicals have entered the marketplace without comprehensive toxicity testing (Wilson 2006).

> "To heal their patients and safeguard the health of their employees, hospital leaders recognize they must also do their part to transform their hospitals to promote healing, while using their purchasing power to heal their community and the planet. "

To address this lack of federal leadership on chemical policy, as well as to address its own contribution to a chemical-dependent economy, healthcare systems have begun to develop their own chemical policies to purchase safer chemicals. This far-reaching framework is a powerful signal to the marketplace that healthcare is planning to use its purchasing power to drive markets for safer products. If manufacturers want to provide products within this new framework, they will need to reform their production processes and replace potentially dangerous chemicals with safer ones.

Kaiser Permanente's chemical policy states the following: "Kaiser Permanente aspires to create an environment for its workers, members, and visitors that is free from the hazards posed by chemicals that are harmful to humans, animals, and the environment. Kaiser Permanente's mission is to provide affordable, high-quality healthcare services to improve the health of our members and the communities we serve. Our concern for the health of our communities extends to the air we breathe and the water we drink" (Kaiser 2005).

Other healthcare systems and GPOs are also adopting chemical policies to guide their overall procurement. Since healthcare accounts for about 15 percent of the US gross domestic product, the impact on the overall economy could be profound (OECD 2004). Acting in unison, the healthcare sector could provide the needed leadership in its purchasing to demonstrate to other sectors that replacing dangerous chemicals with safer ones is not only good for the American economy, but good for the health of the American people.

Moreover, healthcare influentials can assume leadership as spokespeople for broader chemical policy changes in our society. Indeed, this is already occurring. Leaders from Kaiser Permanente, Consorta, the American Nurses Association, and CHW have testified before state legislatures about the need for chemical policy reform. This expanded role for healthcare reflects the growing awareness that healthcare leaders can play a role in transforming not only their own institutions, but also the society at large.

Conclusion

The hospital of the twenty-first century can promote the health of its patients, employees, the general public, and the environment in its design and operations. The hospital can support the local economy through purchasing an array of safe products and technologies and model the kind of environmentally

responsible institutions every community should have. The hospital, in essence, can situate itself in the broader ecology of its community and region and act as a healing force. In the twenty-first century, health-care leaders can understand that it is difficult to have healthy people on a sick planet. To heal their patients and safeguard the health of their employees, hospital leaders recognize they must also do their part to transform their hospitals to promote healing, while using their purchasing power to heal their community and the planet.

Author Biography

Gary Cohen has been working on environmental health issues for more than twenty years. He is a founder and co-executive director of Health Care Without Harm, the international campaign for environmentally responsible healthcare. He is also the executive director of the Environmental Health Fund, which works on domestic and global chemical safety issues. Cohen is a member of the International Advisory Board of the Sambhavna Clinic and Documentation Center in Bhopal, India, which provides free medical care to the survivors of the Union Carbide gas disaster in Bhopal.

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