

## ORIGINAL ARTICLE

# Human and environmental health: sustainable design for the NICU

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The 6th edition of the Recommended Standards for Newborn Intensive Care Unit (NICU) Design includes, for the first time, concerns related to sustainability. Environmental responsibility in healthcare had its beginnings in the late-1980s with an awareness of the toxic qualities of mercury and the need to remove it from hospital environments. Since that time, environmental activism in healthcare has grown to include efforts to construct 'green' buildings, incorporate sustainable practice and apply environmentally responsible purchasing. Language inserted into Standards 8 and 18–21 is intended to extend sustainable design and practice not only in the design of space in the NICU but also in the selection of materials such as floor surfaces, wall coverings, furnishings and ceiling finishes. This paper includes a number of resources that will not only assist with application of the standards, but also with expanding knowledge of issues related to the development of healthcare settings that are not harmful to either human or environmental health.

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## Introduction

The 6th edition of the Recommended Standards for Newborn Intensive Care Unit (NICU) Design addresses, for the first time, concerns related to green or sustainable design. The intention of these additions to the standards is to raise awareness of the harmful effects of some materials and substances that are typical of NICU and hospital design and practice, and to encourage the development of sustainable environments in healthcare. The ultimate goal is to eliminate from healthcare environments all substances, materials or practices that are in any way harmful to human or environmental health. This paper, intended as a supplement to the most recent edition of the Recommended Standards, provides a brief introduction to sustainable design and practice in healthcare, articulates the specific standards in which language related to sustainable concerns appears and identifies

selected resources that may be helpful in the development of sustainable healthcare environments.

## Sustainable healthcare

With the rise of industrial activity, particularly during the last half of the 20th century, came substances, materials and goods that enhanced quality of life with innovations in transportation and communication, improvements in health and hygiene, conveniences in homes and businesses and advances in information technologies.<sup>1</sup> Accompanying these achievements were unintended negative consequences such as the release of toxic substances into the air, soil and water, production of dangerous materials, deposits of valuable materials after a useful life into material graves such as landfills, regulations articulating lawful and unlawful amounts of pollution and erosion of diversity among species and cultures. McDonough and Braungart<sup>1</sup> refer to these conditions as consequences of the first industrial revolution, one characterized by 'cradle to grave' industrial activity. In this scenario, described succinctly as 'take-make-waste,' materials are pulled from the earth, forced into a product or object, and then discarded after use in a material grave such as a landfill or incinerator. In contrast to this approach is 'cradle to cradle' design in which materials used in products either biodegrade into harmless substances or are recovered at the end of one useful life to be used as 'food' for the next product. Based on the regenerative cycles of nature, cradle to cradle design utilizes solar income and emphasizes the value of being native to a place, for example, recognizing the diversity of the ecosystems, the inhabitants and the materials of a place. Cradle to cradle design provides 'an ecologically intelligent framework'<sup>2</sup> for the next industrial revolution. Fundamental to this revolution is the use of materials and substances that are harmful to neither human nor environmental health. It is especially ironic that many substances now known to negatively affect human and environmental health may be found even in healthcare environments.

Although Solomon<sup>3</sup> notes that healthcare was slow to respond to the challenges of sustainable design and practice, the industry's interest during the late-1980s in the reduction of waste and

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elimination of toxic materials such as mercury serves as an early example of environmental responsibility. Kaiser Permanente in California is a current example of a healthcare system that has taken strides towards the development of healing environments that '[protect and enhance] the environment and the health of patients, employees and the communities in which [it does] business...'.<sup>4</sup> Since the early-1960s when Rachel Carson, the author of *Silent Spring*, was invited to speak at a medical symposium, Kaiser Permanente has been committed to provide healthcare that is harmful to neither human nor environmental health. The environmental activism of Kaiser Permanente is realized today in green buildings, sustainable operations of its physical facilities and environmentally responsible purchasing which includes not only eliminating mercury from its healthcare environments but also polyvinyl chloride (PVC), a substance known to be harmful to human and environmental health<sup>5</sup> and pervasive in hospital environments. For the NICU, the purchasing committee at Kaiser Permanente identified alternatives to di(2-ethylhexyl) phthalate (DEPH), a substance used to soften PVC medical devices such as NG tubes, IV bags and catheters. DEPH is among a family of 'plasticizers' reported to suppress the immune system, damage organs and impair reproductive health, particularly in infant boys.<sup>5,6</sup>

Thus, in healthcare practice and in the design of healthcare environments, awareness of issues related to environmental responsibility is growing, and sustainable practice is increasing. In these revised Recommended Standards, language has been inserted to extend sustainable design and practice into the NICU.

### Standard 8: general support space

A designated area for collection of recyclable materials used in the NICU shall be established...

The intent of this addition to the Standards is to encourage responsible use or eventual re-use of materials by developing a designated space for recyclable materials such as batteries, newsprint and plastics. This collection area may:

- facilitate existing or initiate new hospital procedures for recycling or redistributing materials or products;
- foster collection of unused materials and medical supplies that may be redistributed to hospitals or clinics in need of such materials or
- encourage purchase of products and materials that may not be deposited in a material grave after a first useful life.

This collection area will be located outside the patient-care area, but may be available to families as well as staff to encourage recycling of materials and reduce the amount of waste. For additional information about this recommendation, see the Green Guide for Health Care<sup>7</sup> listed in the References section of this supplement and in the Recommended Standards.

### Standard 18: floor surfaces; Standard 19: wall surfaces; Standard 20: furnishings; Standard 21: ceiling finishes

... shall be free of substances known to be teratogenic, mutagenic, carcinogenic, or otherwise harmful to human health.

Volatile organic compounds that 'off-gas' and degrade indoor air quality such as formaldehyde and PVC, persistent bioaccumulative toxins including mercury and benzene, polychlorinated biphenyls used in everyday items such as paint and rubber products, and phthalates such as DEPH, are pervasive in day-to-day environments as well as in hospital settings. The effects of these substances and others range from short-term reactions such as eye irritation to chronic conditions including allergic reactions or asthma to nervous system disorders to cancer. The presence of these substances in hospital environments extends from floors (carpet, vinyl composition tile or 'VCT') to walls (wallpaper, paint and acoustical wall panels), furnishings (pressed wood products with laminated veneers), ceilings (tiles and paint) and materials, supplies and equipment used in patient care (vinyl gloves, sharps containers and IV bags).

The lists of harmful substances may be long, arduous and confusing, and a comprehensive review of detrimental compounds that may be found in flooring, furnishings or ceiling and wall finishes is not possible in these Standards. Language inserted strategically into the 6th edition of the Recommended Standards is intended to elicit consideration of potentially harmful conditions in order that environmentally responsible decisions may be made. For example, 'Standard 18: Floor Surfaces' includes a brief description of PVC, which is common in flooring materials including sheet goods, tiles and carpet. Additional information regarding PVC, for example, is available in the Glossary and Reference sections of the Recommended Standards document, in the references of this paper and through a number of print and digital resources. Further investigation of PVC and related materials will be necessary to assure selection of a floor surface that is harmful to neither human nor environmental health.

### Resources

Although no 'clearinghouse' of ecologically healthy materials and substances exists, a number of resources are available to assist with the development of environmentally responsible design and practice in healthcare. Some are sources for practical information such as Health Care Without Harm ([www.noharm.org](http://www.noharm.org)), which provides current reports on a variety of topics that may include green buildings, policy news or non-toxic alternatives to products typical of healthcare environments. Other websites offer very specific, detailed information concerned perhaps only with energy use (e.g., [www.energystar.gov](http://www.energystar.gov)) or with the qualities of particular chemicals and substances such as the Envirofacts Master Chemical Integrator ([www.epa.gov/enviro/html/emci/chemref/](http://www.epa.gov/enviro/html/emci/chemref/)).

Resources are also available to address healthcare design and practice at the level of the building and site, such as the US Green Building Council which developed a certification process, Leadership in Energy and Environmental Design (LEED; [www.usgbc.org/LEED/LEED](http://www.usgbc.org/LEED/LEED)), for the planning, design, construction, operation and maintenance of green buildings. Boulder Foothills Community Hospital, a women's and children center, became the first healthcare facility to earn a LEED certification in 2003. The Green Guide for Health Care<sup>7</sup> ([www.gghc.org](http://www.gghc.org)) is modeled after LEED and was developed specifically as a 'toolkit' by which facilities can guide and develop sustainable healing environments. The Green Guide for Health Care also provides guidance specific to materials, environmental quality and environmentally preferable purchasing.

Additional resources important to the selection and purchase of materials and products include Sustainable Hospitals ([www.sustainablehospitals.org](http://www.sustainablehospitals.org)), the Environmentally Preferable Purchasing Guide ([www.swmcb.org/EPPG](http://www.swmcb.org/EPPG)) and the Comprehensive Procurement Guidelines developed by the Environmental Protection Agency ([www.epa.gov/cpg/products.htm](http://www.epa.gov/cpg/products.htm)). A software program, 'Building for Environmental and Economic Sustainability' (BEES), which is available online, can be used not only in the selection of materials but also in life-cycle analyses of the products ([www.bfrl.nist.gov/oa/software/bees.html](http://www.bfrl.nist.gov/oa/software/bees.html)).

Another type of resource useful in the development of healthy healing environments includes third-party institutes or organizations that certify products. McDonough Braungart Design Chemistry (MBDC) Cradle to Cradle Certification evaluates a product throughout its lifecycle, determining among other criteria whether it will ultimately safely biodegrade or be used in another product ([www.mbdc.com/certified.html](http://www.mbdc.com/certified.html)). The Greenguard Environmental Institute tests and certifies products related to indoor air quality ([www.greenguard.org](http://www.greenguard.org)), whereas Green Seal not only certifies products but also works with manufacturers to 'green' their products ([www.greenseal.org](http://www.greenseal.org)). Products certified by MBDC, Greenguard or Green Seal may be viewed on their respective websites.

The number of resources that address human and environmental health grows exponentially each year, yet the development of a sustainable healthcare environment is a gradual process. The first step in this process is to identify collaborators, others who share the same convictions, and the second is to develop initial goals. Use resources such as those listed in this

paper to support and inform decisions and actions taken towards achieving set goals. Continued involvement in the development of spaces that nurture human and environmental health fosters further understanding of issues and solutions as well as growth of a network of additional collaborators and resources, thereby fueling the journey of sustainable design and practice.

## Conclusion

The 6th edition of the Recommended Standards for NICU Design includes language related to the design and practice of sustainable healthcare environments. This supplement to those standards provides a framework for sustainable healthcare as well as practical information regarding application of new language to the Standards. Many resources exist and are available to assist not only with application, but also with expanding knowledge of issues related to the development of healthcare settings that are harmful to neither human nor environmental health.

## References

- 1 McDonough W, Braungart M. *Cradle to cradle: remaking the way we make things*. North Point Press: New York, 2002.
- 2 McDonough W. Teaching design that goes from cradle to cradle. *Chronicle of Higher Education* [serial online]. 2004 Available at: <http://chronicle.com/weekly/v50/i46/46b00601.htm> Accessed 30 July 2004.
- 3 Solomon NB. Environmentally-friendly building strategies slowly make their way into medical facilities: new guidelines highlight the relationship between sustainable design and human health *Architectural Record*; August 2004; 179–188.
- 4 Bonda P. Putting the healthy back into healthcare *Green @ work*; January/February 2004; 16–23.
- 5 Ackerman F, Massey R. The economics of phasing out PVC Report presented to the Global Development and Environment Institute 2003; 1–57 Available at: <http://www.noharm.org/details.cfm?type=document&id=880> Accessed 29 September 2005.
- 6 Swan SH, Main KM, Liu F *et al*. Environmental levels of phthalates adversely affect male reproductive development in humans, study finds. *Environmental Health Perspectives* 2005 Available at: <http://www.ehp.niehs.nih.gov/press/052405.html> Accessed 6 July 2005.
- 7 Green guide for health care. Best practices for creating high performance healing environments Version 2.1 Pilot 2005 Available at: <http://www.gghc.org> Accessed 27 May 2006.