NATIONAL CENTER FOR HEALTHY HOUSING

and

CENTERS FOR DISEASE CONTROL AND PREVENTION
National Center for Environmental Health/
Agency for Toxic Substances and Disease Registry

NATIONAL CENTER FOR HEALTHY HOUSING

Healthy Homes Expert Panel Meeting:
Peer Review of Intervention Studies
December 11-12, 2007
Atlanta, Georgia

Record of the Proceedings and Follow-up Activities

DOCUMENT FORMAT

The Record of the Proceedings of the December 11-12, 2007 Healthy Homes Expert Panel Meeting and Post-Meeting Activity are divided into three sections. The first section includes the Report of the Expert Panel Meeting with an Executive Summary. The second section is the result of post-meeting activities by the five expert panels and includes the revised power-point presentations of each panel's intervention buckets. The final section is a bibliography for each panel's deliberations, including intervention literature that was reviewed by the panels and "background" literature.

TABLE OF CONTENTS (Total Document = 97 pages)

Page

List of Participants i

Executive Summary iii

Report of the Expert Panel Meeting
- Opening Session 1
- Overview of the Meeting Process 3
- Panel 1 Report: Interior Biological Agents (Toxins) Interventions 4
- Panel 2 Report: Interior Chemical Agents (Toxics) Interventions 9
- Panel 3 Report: External Exposures 13
- Panel 4 Report: Structural Deficiencies 17
- Panel 5 Report: Intersection Between Housing and Community 21
- Next Steps 26
- Closing Session 28

Post-Meeting Activities
- Overview 30
- Post-Meeting Minutes of Panel 1 Meeting (February 15, 2008) 31
- Post-Meeting Recommendations (Power Points) - Panel 1 34
- Post-Meeting Recommendations (Power Points) - Panel 2 36
- Post-Meeting Recommendations (Power Points) - Panel 3 39
- Post-Meeting Recommendations (Power Points) - Panel 4 41
- Post-Meeting Panel 5 Statement on Neighborhood Effects on Health 44
- Post-Meeting Recommendations (Power Points) - Panel 5 71
- Future Conference: Project Abstract 73

Bibliography
- Panel 1 74
- Panel 2 83
- Panel 3 87
- Panel 4 88
- Panel 5 93

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EXECUTIVE SUMMARY

The National Center for Healthy Housing (NCHH) and the Centers for Disease Control and Prevention (CDC) convened a "Healthy Homes Expert Panel Meeting: Peer Review of Intervention Studies." The meeting was held at CDC's Century Center facility in Atlanta, Georgia, on December 11-12, 2007.

The sponsors of the meeting made opening remarks that provided a context for the proceedings. Keynote speakers included Dr. Mary Jean Brown, Chief of CDC's Lead Poisoning Prevention Branch, who explained the purpose of and process for the meeting; Dr. Thomas Sinks, Deputy Director of CDC's National Center for Environmental Health and the Agency for Toxic Substances and Disease Registry; Dr. David Jacobs, Director of Research, NCHH; and Ms. Rebecca Morley, Executive Director, NCHH. The opening session concluded by Dr. Brown providing the charge to the Expert Panel.

The Expert Panel was asked to compile practical and evidence-based information on housing interventions. Housing providers and others can use this information to make a difference in the lives of Americans and improve the quality of the housing stock in the United States. The Expert Panel reviewed healthy homes data and lessons learned in both the United States and other countries.

The articles reviewed by the Expert Panel were identified and compiled by CDC scientists with topical expertise. Only intervention research papers were included. The resultant literature was shared with planning committee members, who added additional intervention studies to the compilation for review. These studies were then sent to the Expert Panel members for review and feedback, based on their areas of expertise.

To fulfill the charge of evaluating the intervention studies, the Expert Panel was divided into five work groups (panels) based on the following broad topical areas:

1. Interior Biological Agents (Toxins) Interventions
2. Interior Chemical Agents (Toxics) Interventions
3. External Exposures
4. Structural Deficiencies
5. Intersection between Housing and Community

The panels placed each evidence-based study they reviewed into one of four categories or "intervention buckets" based the strength or weakness of the evidence.

- Bucket 1: interventions that currently have sufficient evidence of effectiveness to recommend immediate implementation (e.g., smoke alarms).

- Bucket 2: promising interventions that need more testing and evaluation in the field prior to recommending implementation.
- Bucket 3: interventions that need formative research to determine their effectiveness and biologic plausibility.
- Bucket 4: interventions with no demonstrated record of effectiveness.

The five panel chairs reported the findings of their respective groups. In addition to presenting evidence for the four intervention buckets, some panels also identified issues, research gaps, challenges, and concerns. Two of the panels created new intervention buckets for "studies that should be discarded" and "interventions in need of more literature or expertise." Time was allotted after each "report-out" for the Expert Panel members to make suggestions on collecting additional data and strengthening the evidence-based recommendations.

Of the four buckets, bucket 1, "interventions that currently have sufficient evidence of effectiveness to recommend immediate implementation," is the most important in implementing changes in the nation's housing stock. The following are examples of interventions that are ready for immediate implementation (see the report for a complete list):

(a) Multi-faceted tailored interventions for asthma, as exemplified by the Inner City Cooperative Asthma Study, are effective in controlling asthma symptoms and reducing asthma morbidity. The interventions include education that is based on the social learning theory; use of mattress and pillow covers; use of HEPA vacuums and air filters; smoking cessation; cockroach extermination; and bedroom cleaning.

(b) Integrated pest management studies show that household cleaning and tool dispensing, professional cleaning, education of residents, use of baits, use of low-toxicity pesticides and structural repairs are effective in lowering pests.

(c) A study on radon mitigation demonstrates the efficacy of active post-construction systems placed in homes in high-risk areas.

(d) Four studies demonstrate the efficacy of non-residential smoking bans to reduce exposure to environmental tobacco smoke.

(e) A study on working smoke alarms demonstrates their effectiveness in reducing the risk of death and injury from fires.

(f) A study on four-sided isolation fencing around pools demonstrates that such fencing reduces the risk of children drowning.

(g) A study on pre-set and safe water heater temperatures shows that setting thermostats at the manufacturer's recommendation of 125 degrees is effective in reducing the risk of scalds.

At the conclusion of the five panel "report-outs," all of the Expert Panel members made suggestions on actions that NCHH and CDC should consider to improve or advance the healthy homes peer review process in the future.

The Expert Panel was informed that the output from the meeting is expected to lead to development of a white paper that will be useful in the effort to establish a policy base for housing interventions for which the evidence shows that health gains will be achieved.

NCHH and CDC plan to compile a complete list of the key outcomes and findings from the meeting and access the strength of evidence to support health-based housing interventions. The Expert Panel and others will be asked to independently review these papers, as well as identify papers that have not been found during the initial literature search.

Post-meeting activities will include identifying missing literature; making decisions to incorporate new evidence; revising criteria for the intervention buckets, if necessary; discussing other documents and outcomes from the meeting; and clarifying and addressing any remaining issues.

There are plans for a policy meeting to be held in late spring 2008 for groups outside the research community for input on applying the Expert Panel's evidence-based guidance into actual practice. Participants of the policy meeting would include policymakers, housing advocates, home builders, architects, engineers, housing providers, medical and public health officials, and other practitioners in the field.

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HEALTHY HOMES EXPERT PANEL MEETING:
PEER REVIEW OF INTERVENTION STUDIES
December 11-12, 2007
Atlanta, Georgia

Report of the Meeting

The National Center for Healthy Housing (NCHH) and the Centers for Disease Control and Prevention (CDC) convened the "Healthy Homes Expert Panel Meeting: Peer Review of Intervention Studies." The proceedings were held at CDC's Century Center facility in Atlanta, Georgia on December 11-12, 2007.

Opening Session

Dr. Mary Jean Brown, Chief of the CDC Lead Poisoning Prevention Branch, welcomed the participants and outlined the purpose of and process for the meeting. The Expert Panel would be charged with reviewing the state of science and evidence base of housing interventions that support and improve health and prevent certain diseases and conditions. For purposes of the meeting, the Expert Panel would determine the degree of evidence between housing factors and health conditions.

Dr. Brown noted that the output from the meeting would lead to development of a white paper to assist in establishing a policy base for housing interventions. A second meeting would be held in late spring 2008 for advocates and decision-makers to develop a strategy plan to put the Expert Panel's evidence-based recommendations into actual practice.

Dr. Brown explained that the Expert Panel Planning Committee developed a template with four "intervention buckets" in five major categories for the Expert Panel to provide input to NCHH and CDC.

- For Bucket 1, the Expert Panel would identify interventions that currently have sufficient evidence to recommend immediate implementation, such as smoke alarms.
- For Bucket 2, the Expert Panel would identify promising interventions that need more testing and evaluation in the field prior to recommending implementation.
- For Bucket 3, the Expert Panel would identify interventions that need formative research to determine their effectiveness and biologic plausibility.
- For Bucket 4, the Expert Panel would identify interventions with no demonstrated record of effectiveness.

Dr. Brown conveyed that NCHH and CDC would compile key outcomes and findings from the meeting and assess linkages between health and housing conditions. The Expert Panel and others would be asked to independently review these papers.

Dr. Thomas Sinks, Deputy Director, CDC's National Center for Environmental Health and Agency for Toxic Substances and Disease Registry (NCEH/ATSDR), provided a historical perspective of CDC's healthy homes activities. CDC began to focus on healthy housing around 1993 with an expansion of its childhood lead poisoning prevention efforts. Dr. Julie Gerberding, Director of CDC, initiated an agency-wide goals management process with goals that focus on each stage of life rather than on specific diseases. A "healthy homes" goal was established as one of CDC's "healthy places" goals. This goal provided NCEH/ATSDR with an opportunity to directly communicate with CDC leadership about the importance of housing as a health issue.

Dr. Sinks described CDC's more recent activities related to healthy homes. CDC held a National Environmental Public Health Conference in November 2006 attended by 1,700 people. Keynote speakers made a number of presentations on healthy housing and health literacy. He also stated that on December 12, 2007, CDC would publicly announce the initiation of a large study to analyze the effect of formaldehyde in temporary housing units deployed to Louisiana and Mississippi following Hurricane Katrina.

Dr. Sinks concluded his opening remarks by thanking the Expert Panel members for committing their valuable time to providing NCHH and CDC with solid guidance for each of the four intervention buckets.

Dr. David Jacobs, of NCHH, announced that the meeting was dedicated to the late Mr. Xavier Bonnefoy of the World Health Organization. Mr. Bonnefoy was primarily responsible

for launching the global healthy homes initiative and was responsible for implementing the stellar report "Environmental Burden of Disease Related to Inadequate Housing."

Dr. Jacobs noted that CDC will present a certificate posthumously to Dr. Bonnefoy's family in recognition of his many years of leadership, service and commitment to improve environmental health throughout the world. The certificate also honored Dr. Bonnefoy's lifelong commitment and leadership to improve the living and social environment that supports the health, safety and quality of life for all citizens worldwide.

Ms. Rebecca Morley, Executive Director of NCHH, explained the objective of the meeting from NCHH's perspective. The Expert Panel would be charged with compiling practical and evidence-based information to provide to practitioners. Providers would use this information to make a difference in the lives of Americans by improving U.S. housing stock. The Expert Panel also would be asked to review healthy homes experiences and lessons learned in the United Kingdom to avoid duplicating efforts in the United States.

Ms. Morley thanked CDC for funding the meeting and supporting all of NCHH's healthy housing activities.

Overview of the Meeting Process

Dr. Brown reviewed the process for the Expert Panel to provide guidance to NCHH and CDC. The Expert Panel members would be divided into five panels to compile information for the four intervention buckets, each covering a major healthy homes category (i.e., interior biological agents; interior chemical agents; external exposure – water and sewage; structural deficiencies; and intersection between house and community). Each panel would operate with a chair and a rappateur. The rappateurs would capture key outcomes from the panels' discussions, and the chairs would present the findings of their respective panels to all panel members in attendance on the following day, with time for discussion.

Mr. Tom Chapel, of CDC's Office of Workforce and Career Development, served as the facilitator and reviewed the process for the five panels to present their findings. Each panel would be allotted 15 minutes for its presentation and 45 minutes for discussion with the entire Expert Panel. He asked the panel members to submit any missing literature to Ms. Andrea Bader of CDC at gve1@cdc.gov within two weeks following the meeting. The panel chairs and planning committee, following the meeting, would decide on the review process for the missing literature and how it should be incorporated.

Mr. Chapel asked the panel members to point out any research gaps, issues, concerns or challenges for their respective topics. He emphasized that the panel members should feel

free to identify interventions for healthy households during the presentations. Following the meeting, the panel chairs would participate in decision making about the content of the white paper. The panels also agreed to provide NCHH and CDC with notes of their respective literature reviews, references, and discussions during the breakout sessions.

Overall, Mr. Chapel assured the Expert Panel that the meeting would not serve as the last opportunity to provide input on healthy homes intervention studies. In addition to participating in follow-up review processes, the meeting report and other documents that were developed from the meeting would be distributed to all Expert Panel members for review and feedback.

Panel 1 Report: Interior Biological Agents (Toxins) Interventions

Dr. James Krieger, of the Seattle and King County Public Health Department, chaired Panel 1 and presented the findings of the group. Panel 1 discussed several topics in its literature review, including multi-component tailored interventions, such as home visits and assessments; education; moisture control, ventilation and structural remediation; vacuuming; one-time professional cleaning; carpet interventions, such as steam cleaning, removal and replacement; integrated pest management (IPM), acaracides, and other agents to eliminate dust mites; air cleaners; and bedding treatments.

Bucket 1: "Clinical" Interventions That Are Ready for Implementation

- Multi-faceted tailored interventions for asthma, as exemplified by the Inner City Cooperative Asthma Study, have been shown to be effective in controlling asthma symptoms and reducing asthma morbidity. These interventions include education based on the social learning theory; use of mattress and pillow covers; use of HEPA vacuums and air filters; smoking cessation; cockroach extermination; and bedroom cleaning.

Bucket 1: "Exposure" Interventions That Are Ready for Implementation

- A strong body of evidence has been built to support the implementation of cockroach management.
- IPM is an evidence-based approach that includes household cleaning and tool dispensing, professional cleaning, education of residents, baits and structural repairs.
- Intensive pesticide application is noted in the literature as a second evidence-based approach.

Bucket 2: Promising Interventions In Need of More Field Testing

- Moisture control interventions that require additional field testing include water intrusion, dehumidification and removal of moldy items. Panel 1 will attempt to locate more publications on mold remediation and its impact on health.
- Ventilation interventions that require more rigorous evaluation include heat recovery ventilation, general mechanical ventilation and local exhaust.
- Air cleaners, particularly non-ionizing cleaners that use HEPA filters, require more field testing before these interventions can be translated into practice.

Bucket 3: Interventions In Need of Formative Research

- Moisture control needs more basic research to determine the most promising interventions that can reduce humidity in specific climates, in certain homes, and at particular levels.
- Additional studies should be conducted to determine the efficacy of carpet treatments, such as vacuuming, carpet composition, allergen accumulation and release from the carpet reservoir, steam cleaning, and carpet removal.
- No studies have been conducted to date that solely focus on education.
- The strength of evidence on one-time professional cleaning as an individual intervention is unclear at this point.
- Data have been gathered on the efficacy of acaracides in reducing dust mite populations, but these declines are somewhat transient without reapplying acaracides. Moreover, acaracides are not well tolerated or used by homeowners due to their ability to stain carpet and furniture. Concerns regarding long-term toxicity and low-dose exposure with acaracides, particularly in households with young children, have not been sufficiently addressed to date.

Bucket 4: Interventions Shown To Be Ineffective

- Bedding encasements, sheet washing, upholstery cleaning, and mattress and box spring covers have not been demonstrated to be effective in reducing and controlling asthma symptoms and episodes.

Issues, Research Gaps, Challenges and Concerns

- Additional intervention studies should be performed because prior research typically focused on high-risk families rather than the general population. Moreover, families with children who had less severe asthma symptoms were more likely to discontinue their participation in studies. These outcomes have limited capacity to generalize data.
- Interventions should be multi-faceted and holistic because homes contain multiple allergens and other biological contaminants.

- New studies should be designed to focus on both exposure measures and health outcomes. A number of studies in the past showed environmental or health improvements, but this research rarely captured both of these outcomes.
- Standardized methods should be developed to assess housing-related health hazards and allergen sampling or analysis.
- A clear distinction should be made between "home" and "housing" interventions. The definition of "home" should include behaviors of the occupants and social conditions in addition to the structural components of the building.
- Regional and climate differences should be considered as critical factors in recommending interior biological agent interventions.
- A clear distinction should be made between "new construction" and "rehabilitation" in recommending interior biological agent interventions.
- Missing research should be identified and reviewed for the white position paper to corroborate the findings on interior biological agent interventions.
- A "placebo" or "attention" impact should be considered in the context of asthma interventions because these effects could influence behaviors, exposures, triggers or health outcomes. These effects also emphasize the need to design studies of home interventions with comparison groups. Social support, social interaction, recognition and validation of the experiences of families could serve as generic rather than content-specific interventions.
- A correlation should be established between observational measurements and self-reports versus laboratory measurements, such as environmental sampling versus visual assessments. Home auditors, community health workers, sanitarians, and residents of homes could be engaged in this effort.
- Standard outcome measures should be developed and applied across studies, such as asthma control, quality of life, and lung function. These measures could be used to enhance cross-study interpretation and pooling of data in the future.
- More multivariate analyses should be performed to address potential interaction and confounding effects. This approach could assist in clarifying the robustness of findings.
- Reference standards for allergens and other exposures should be further developed and clarified. Existing reference standards in the literature are based on fairly old evidence and need further scrutiny and more recent data.

The Expert Panel applauded panel 1 on its exhaustive literature review and comprehensive guidance. Several members made suggestions for panel 1 to consider in collecting additional data and strengthening its evidence-based recommendations.

- Water or moisture intrusion and mold removal are primary principles that should be placed in bucket 1. However, more regional studies are needed in these areas from a climate-related basis to develop and deliver proper tools that can be generalized.
- The decision to place all moisture, dampness and humidity control interventions in bucket 2 for more field testing should be reconsidered. The Institute of Medicine report and other studies have provided a preponderance of evidence on adverse effects from wet structures and the efficacy of dampness and wetness interventions in keeping buildings dry. Specific moisture and humidity control methods that have not been shown to be effective should be identified and placed in bucket 2, but evidence-based moisture control approaches that have been demonstrated to have a health impact should be placed in bucket 1. Panel 1 should review pre-/post-evaluations or intervention studies that made homes drier and healthier.
- Moisture control, leak control, and dampness control should be included in the multi-faceted tailored interventions for asthma in bucket 1. These issues have been studied in public buildings in the United States and also in schools and homes outside the United States.
- The substantial amount of epidemiological data linking moisture and damp housing conditions to a range of adverse health outcomes should be reviewed. Interventions with a demonstrated track record of correcting conditions that lead to dampness in U.S. homes in the most cost-effective manner should be evaluated as well.
- Individual housing interventions should be tailored to specific areas of the country due to climactic variations within regions of the United States.
- Standardized definitions should be developed for “damp” and “dry” houses.
- Consideration should be given to linking viral spread of influenza and other infectious diseases to dry and cold conditions in the home.
- The bucket 1 interventions that are ready for implementation should be placed in the context of time of sale during home inspections. Collaborations should be established with professional associations and other groups in this effort, such as the National Home Builders Association, National Association of Home Builders Research Council, and the broader time of sale community.
- The follow-up policy meeting should be structured by compiling and distributing a list of questions prior to the meeting and encouraging the participants to locate evidence to address the questions. A more diverse and multi-disciplinary panel of home builders, insurers, engineers and other groups should be invited to attend the follow-up policy meeting to provide broader perspectives.
- Extreme caution should be taken in framing and delivering healthy homes messages. For example, landlords might take the position that environmental

health problems in a building do not need to be corrected because a CDC expert panel did not find sufficient evidence to support remediation.

- Evidence that is not science based should be considered in addition to research-based evidence, such as recommendations to clinicians, guidance to families with allergic children, lessons learned, traditional experiences and best practices.
- Specific aspects of the Cleveland study that might limit some of the findings to the geographical area of Cleveland should be acknowledged.
- American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) Standard 62.2 and other operation and maintenance standards for mechanical ventilation systems in the home should be placed in bucket 1. The body of evidence in this area has been well published in the literature.
- Data should be extracted from consensus-based literature on regional outcomes, such as moisture problems in the home from air handling units placed in unconditioned garages in the Gulf Coast, Florida or Hawaii.
- The literature on multi-component interventions regarding moisture should be extensively reviewed. For example, the Healthy Homes 1 study showed moisture and condensation control and the use of ventilation fans as the most effective environmental interventions.
- Rodent control of mice should be placed in bucket 3.
- Efforts should be made to locate data in the literature on pet feces as a source of infectious disease in the home.
- Caution should be taken in characterizing the *New England Journal of Medicine* studies on encasements as "ineffective" for the prevention or exacerbation of asthma because this research focused on adults rather than children. The occupational literature has shown a very different biology of asthma between these two populations.

In response to the Expert Panel's discussion and suggestions, Ms. Morley acknowledged that the Expert Panel was given a narrow focus and charge to evaluate the available scientific evidence base. She also related that Home Depot plans to allocate ~$100 million to build 100,000 housing units over the next ten years. This initiative would be consistent with NCHH's strong interest in developing a labeling program to designate units as "healthy homes." In addition to compiling best practices and lessons learned in the field, NCHH plans to work with Home Depot to gather solid evidence that shows that certain healthy homes interventions should be included in rehabilitated units.

Ms. Morley confirmed that NCHH is aware of the need to bring additional studies and perspectives to bear before the position paper is developed. As a result, home builders, architects, engineers and other practitioners in the field would be invited to attend the follow-up policy meeting to provide input on translating the Expert Panel's evidence-based guidance into practice.

Dr. Brown supported the Expert Panel's suggestion for NCHH and CDC to develop and distribute questions to participants in advance of the follow-up policy meeting. She asked the Expert Panel members to submit potential questions to Ms. Bader at gve1@cdc.gov. NCHH and CDC would compile and distribute the questions to builders, practitioners and other participants of the follow-up policy meeting.

Dr. Brown also agreed that the Expert Panel was given a narrow charge to peer review the existing evidence on housing interventions. However, opportunities would be available in the future to evaluate best practices, experiences, and other softer forms of evidence. She confirmed that building durability in the context of moisture would be a focus of the follow-up policy meeting. She acknowledged that NCHH and CDC would need to make decisions on applying solid non-housing interventions for schools, noise, and other areas into practice.

Dr. Brown clarified that a final product from the meeting has not been determined at this point. Dr. Jacobs further explained that NCHH and CDC are more interested in a review of the evidence for housing-based packages rather than single interventions.

Panel 2 Report: Interior Chemical Agents (Toxics) Interventions

Dr. Megan Sandel, of the Boston University School of Medicine, chaired Panel 2 and presented the findings of the group. Panel 2 discussed several topics in its literature review, including radon, integrated pest management (IPM) for pesticide reduction, environmental tobacco smoke (ETS), particulates and ventilation, volatile organic compounds (VOCs), and particulate intrusion from the outside into the home.

Panel 2 acknowledged several caveats in its literature review. Several studies that might be relevant were not reviewed. Some panels addressed overlapping issues, such as IPM and ventilation by panels 1 and 2; temperature control and particulate intrusion by Panels 2 and 4; and water source interventions by Panels 2 and 3. Panel 2 was instructed to disregard lead, but this issue will be covered in the position paper. All of the radon studies focused on radon levels only and did not analyze health outcomes. However, a promising study of stay-at-home women in Iowa demonstrated long-term outcomes on lung cancer.

Bucket 1: Interventions That Are Ready for Implementation

- A study on radon demonstrated the efficacy of active post-construction systems placed in homes in high-risk areas. (Groves-Kirkby)
- A study on IPM for pesticide reduction used biomarkers of pesticides in maternal and cord blood. Professional cleaning, sealing of entryways, low

toxicity pesticides with 2.15% of hydramethylnon, indoor air samples and limited biomonitoring were found to be effective. (Williams)

- Four studies demonstrated the efficacy of non-residential smoking bans in reducing exposure to ETS. (Fong, Allwright, Farrelly, Haw)
- Studies on ventilation, VOCs, and particulate intrusion reduction were not available for review. However, Panel 2 will continue to search the literature to place these topics in bucket 1.

Bucket 2: Promising Interventions In Need of More Field Testing

- A study on radon in water, particularly wells, focused on activated charcoal and aeration. This promising intervention might result in multiple benefits, but more field testing is needed because 45 million persons use well water. (Mose)
- Several IPM studies are based on self-reports of pesticide reduction and were not designed with solid pesticide biomarkers.
  - The Brenner study focused on sealing of cracks and crevices, education, plumbing repairs, and bait and traps at exits of the home. Pesticide reduction was self-reported.
  - The Levy study had no controls, while the Rhona Julien study had no measurement of pesticides or exposures.
  - The Peters study had no measurement of pesticides or exposures.
- HEPA air cleaners are promising interventions, but need more field testing.
- Garage sealing to reduce benzene is a promising intervention for VOCs.
- Promising evidence has emerged on air conditioning as an intervention to reduce particulate intrusion.

Bucket 3: Interventions In Need of Formative Research

- Several radon studies that have analyzed passive systems, particularly those placed in new construction, need ongoing testing and active interventions over time. These approaches will assist in ensuring that radon was reduced below the level of concern and will not degrade in the future. However, Panel 2 did not reach a definitive conclusion on placing this evidence in bucket 2 or 3 because the studies have demonstrated some benefit.
  - The Marley study focused on air conditioning and heating in hospitals and schools.
  - The Huber study focused on mechanical ventilation, fans, and multi-layer floors with fans.
  - The LaFollette study focused on membrane sealing and ducting in passive new construction.
- Panel 2 minimized its focus on ETS and placed stronger emphasis on administrative and legal smoke-free home policies.

- Different types and operations of central systems as ventilation interventions need more study. The ability to extrapolate these data from schools and office building to homes is limited.
- Local ventilation in bathrooms and kitchen need more formative research.
- Source control is the primary intervention for VOC reduction, but several methods are available. For example, low VOC products can be substituted in homes. Fragrances and other VOCs can be entirely avoided. New products in new homes can be "baked out." The ability to extrapolate this method from offices to homes is limited, but the Thorax study in 2004 and other home studies have been conducted.
- Existing interventions for particulate intrusion reduction need further study, including central HVAC with HEPA air cleaners, building envelope sealing, and passive or active ventilation from the Green Building Guidance.

Bucket 4: Interventions Shown To Be Ineffective

- Air cleaning as an intervention to reduce ETS should not be pursued. Panel 2 will locate additional studies to support its position.
- An ionizer as a form of ventilation is an inappropriate approach. Panel 2 will locate additional studies to support its position.

Panel 2 created the following fifth bucket:

Bucket 5: Studies That Should Be Discarded

- EPA will distribute additional evidence on radon because some of these studies were poorly designed and should not be placed in any bucket.
- The Najafi Enkavent Mat Study has inconclusive evidence for interventions.
- The Cavallo Existing Construction Passive Ventilation and Subslab Depressurization Study on active ventilation was only conducted in one experimental home.
- The Coskeran New Construction Study focused on membranes in a passive system. The cost effectiveness study was not designed as an intervention study.

Issues, Research Gaps, Challenges and Concerns

- More resources should be targeted to studies on active and passive ventilation as a radon intervention. Panel 2 was surprised by the lack of solid research in this area, particularly given the health impacts.
- Integrated Pest Management (IPM) should be clearly defined. For example, the critical elements of a solid IPM program should include the elimination of entry, shelter, food and water for pests. A strategy of using the least toxic pesticides should be adopted, such as boric acid, gels and non-aerosolized products.

- To reduce VOCs, more research should be performed with urinary biomarkers and airborne testing when possible.
- VOC studies should not be necessarily linked to health. Instead, exposure should serve as the main outcome.
- The published literature should be reviewed to identify and focus on the top five VOC culprits and sources, including benzene, dichlorobenzene, and formaldehyde.
- "Common sense" studies with certain materials and air testing should be conducted and evaluated: (1) the pre-testing building materials study in Europe; (2) the formaldehyde study in prefabricated homes in the United States; and (3) the Vivian Loftness study on healthy building elements.
- Green Building Guidance and the "Leadership in Energy and Environmental Design Green Building Rating System" should be studied as interventions for reducing particulate intrusion. Research is necessary to quantify the level of fresh air that would be needed for health. These studies also should be designed to identify appropriate markers, such as carbon monoxide levels.
- More evidence is needed on outdoor air infiltrates as an intervention for reducing particulate intrusion. Data have been collected on particulate matter 2.5 and 10 as well as the ozone, but specific interventions to study in this area have not been identified to date.

<u>Parking Lot Issues</u>

- Is a clinical outcome that is difficult to measure actually needed?
- Is exposure reduction sufficient or should other outcomes be targeted?
- What level of exposure needs to be reduced to have a clinical benefit?
- What are appropriate environmental and biological indicators to measure exposure reduction?
- What vulnerable populations are most impacted by exposure disparities?
- Studies should be designed with control groups whenever possible, but ethical issues must be considered due to the complexity of this topic.

The Expert Panel applauded Panel 2 on its exhaustive literature review and comprehensive guidance. Several members made suggestions for Panel 2 to consider in collecting additional data and strengthening its evidence-based recommendations.

- The proposed "IPM" definition should be expanded to include a cleaning component, allergens, and dust.
- The McAuley, Meek and Liu studies should be included in the literature review to support IPM as interventions. This research showed significant reductions in the amount of pesticides applied.

- Cleaning products, phthalates and other personal care products should be included in the literature review because these products are a major source of VOCs and also are associated with health end points.
- Data on the use of sanitizers in duct cleaning should be reviewed.
- Indoor air quality should be considered as a strategy to establish boundaries for cleaning product interventions.
- The literature should be evaluated to determine whether the use of certain cleaning products in homes is actually necessary. This issue should be placed in bucket 3 to promote more formative research on easy approaches to clean the home.
- Impressive studies conducted in Europe and Asia on keeping VOC and particulate levels low in ventilation and the ozone should be assessed.
- A public health basis for ventilation in homes should be established. Older data in the literature should be reviewed to support this effort.
- Data on emerging contaminants, such as pharmaceuticals and personal care products and new cleaning products, should be evaluated and placed in bucket 3. These products need more formative research and product testing. The European literature should be reviewed in this effort.
- Caution should be taken in targeting all interior chemical agent interventions to the home. Although some of these toxics begin in the home, the route of exposure is related to persistence in the environment rather than the home.

Dr. Brown provided additional guidance to assist Panel 2 in the post-meeting review process. Recommendations should not be made on the use of asbestos in homes because this guidance has been codified and is standard practice. A literature review on mercury switches should be considered. VOCs should be considered as a class of activities in terms of limiting the amount of these toxics up-front. Strong efforts should be made to avoid overlapping with the panel 5 charge to address the intersection between housing and the community. For example, “cleaning products” should be defined as those used on the home, while “personal care products” should be defined as those used on the individual.

Panel 3 Report: External Exposures

Dr. Philip Morey, of Boelter and Associates, presented the findings of Panel 3. Panel 3 focused on drinking water safety and onsite wastewater treatment strategies during its literature review. Panel 3 noted that its literature review was largely based on expert opinion and experience rather than evidence-based research.

Bucket 1: Interventions That Are Ready for Implementation

- National voluntary treatment standards for drinking water and wastewater should be established for decentralized and unregulated systems.
- National voluntary standards for drinking water and wastewater treatment should be implemented for decentralized systems.
- Training centers for water and wastewater should be enhanced with staff, physical facilities and onsite hands-on training. The content for this intervention currently exists to a large degree.
- Professional training for users of land-based technologies should be improved. These users include practicing professionals, planning and zoning commissions, and sewage enforcement officers for decentralized systems.
- Guidelines should be developed based on existing knowledge of exposure to enteric bacteria in drinking water, Legionella in water, or mold on interior surfaces among immunocompromised occupants of the home.
- Stakeholders should be extensively engaged in implementing the bucket 1 interventions, including Underwriters Laboratories, the National Sanitary Foundation, and the International Association of Plumbing and Mechanical Officials.
- An information clearinghouse should be developed to maintain evidence-based studies on safe drinking water and wastewater treatment. The goal of this initiative would be to transfer knowledge and provide guidance to stakeholders.
- Environmental health rapid response teams should be established for emergency or urgent scenarios. Technology should be used as a bridge in the event of a failure of central systems.
- Easily accessible information about the frequency of pumping septic tanks should be provided.

Bucket 2: Promising Interventions In Need of More Field Testing

- Technologies that are currently being used should be tested and verified at national or regional test centers to determine their actual effectiveness in the field and ensure standards are met. This approach should be particularly implemented for decentralized systems. Existing regional test centers should be engaged in this effort.
- Ultraviolet and filtration point-of-use devices should be tested to improve drinking water quality in highly contaminated and decentralized systems.
- DNA technology should be used to track the transmission of pathogens, particularly in decentralized systems.
- Geographic information system (GIS) techniques should be used to determine the location of wells and septic systems during field inspections and also to identify failed systems.

- CDC should address the social justice issue of “privies” or homes without sanitation facilities. To support this effort, census data for 2010 should be collected and field inspections should be performed. Innovations should be identified to ensure that basic sanitation occurs in U.S. homes.

Bucket 3: Interventions In Need of Formative Research

- More formative research should be performed to identify social marketing and outreach strategies that can be implemented by users, zoning and planning commissions, stakeholders and other target audiences.
- Education, economics and enforcement activities should be coordinated.
- Endocrine disruptors and drugs should be used to identify the degree of water contamination and determine potential health impact.
- The positive impacts of education and enforcement on drinking water and wastewater quality should be verified.
- Studies should be performed on socioeconomic, demographic and other ecological factors to identify gaps in providing basic drinking water and wastewater services.
- Surveillance studies on Legionellosis should be designed to determine the magnitude of cases and mortality in residential buildings. Regional surveillance should be performed in warm climate areas.
- System failure rates should be assessed under various operating conditions and linked to health effects.
- More formative research should be performed in the following areas: water reuse, a risk index for emergency response and public health incidents.
- Studies should be performed to determine the impact of siting and locating HUD-funded housing projects in Indian country. There is evidence that shows housing projects have been located on or near former landfills and dumps as well as in areas with high water tables.
- The CDC study, “A Survey of the Quality of Water Drawn from Domestic Wells in Nine States,” should be updated. The study was completed in 1998.

Bucket 4: Interventions Shown To Be Ineffective

- No additional studies are needed in systems that meet safe drinking water standards, particularly ultraviolet and filtration point-of-use devices.
- Less research is needed on large community systems, but more studies are needed on small systems.

The Expert Panel applauded panel 3 on its exhaustive literature review and comprehensive guidance. Several members made suggestions for panel 3 to consider in collecting additional data and strengthening its evidence-based recommendations.

- The white paper should encourage research to address a challenging issue. Linkages between drinking water and adverse health effects are difficult to make. For example, gastrointestinal conditions or other diseases are under-reported and generally linked to food rather than contaminated well water or a non-functioning septic system.
- Caution should be taken in attempting to translate interventions for large water supplies to small water supplies.
- The white paper should recommend the development of methods, standards, and research to predict whether microbiologically unsafe water or other compromised groundwater could be used in a point-of-use treatment device.
- An integrated approach should be promoted to focus on both water quality and quantity. This strategy could serve as a solid policy in the future in terms of sustainability and community development.
- A public health response should be planned for decentralized systems because some homes and small communities will have periods without water. The planning process should include the development and implementation of testing interventions in these settings.
- Applied research should be performed to test, improve and validate whether technologies related to the use of composting toilets for waste treatments would provide an adequate level of treatment long term. The public health community at state and local levels should be extensively engaged in developing voluntary standards and reviewing testing interventions for this effort. Federal standards for these technologies most likely would not be established.
- The white paper should recommend administering a national survey or performing a hazard assessment to determine areas where standards need to be developed, such as VOCs and drinking water. This initiative could be designed as a participatory research project involving local public health practitioners.
- The white paper should be structured to advance the development of drinking water and wastewater standards or guidelines to inform decision-making.
- The white paper should recommend administering a regional or local survey to obtain a more comprehensive view on various housing exposures.
- CDC should strongly emphasize the need to place questions back into the U.S. Bureau of Census Survey on drinking water sources and wastewater treatment methods.
- Existing training centers for both water and wastewater should be expanded. Additional resources could increase participation by more environmental health practitioners and individual homeowners.
- Data from the National Children's Study site in New Mexico should be reviewed in the future to identify strategies to measure environmental home exposures. The study is designed to follow 100,000 children for 20 years.

Dr. Brown provided additional guidance to assist panel 3 in the post-meeting review process. Panel 3 is charged with addressing lead, arsenic and other contaminants in unregulated water supplies. However, data from studies on large water systems can be extrapolated to small systems and do not need to be replicated.

Panel 4 Report: Structural Deficiencies

Dr. Carolyn DiGuiseppi, of the University of Colorado Health Science Center, chaired Panel 4 and presented the findings of the group. Panel 4 discussed several topics in its literature review, including burn, fall and fire prevention; noise reduction; injury prevention in hazardous areas; and temperature control. Panel 4 noted that its literature review was primarily based on large and systematic analyses of data rather than individual studies. Specific interventions that had been evaluated in multiple high-quality observational studies were included in the literature review.

Bucket 1: Interventions That Are Ready for Implementation

- Working smoke alarms reduce the risk of death and injury in a fire.
- Four-sided isolation fencing around pools reduces the risk of children drowning.
- A study analyzed legislation on pre-set and safe water heater temperature at the manufacturer's recommendation of 125 degrees. Observational data and other research showed that the implementation of this legislation was an effective intervention in reducing the risk of scalds.

Bucket 2: Promising Interventions In Need of More Field Testing

- Home safety education to families with children to promote stair gates, window guards and other types of safety equipment was found to reduce hazards in the home. However, the studies showed no evidence of being able to reduce injuries.
- Home modifications to prevent falls in children and adults, including handrails, grab bars and lighting, were found to be effective in reducing hazards. However, the studies could not be linked to a reduction in injuries from falls. Home modifications also might need to be placed in the context of multi-factorial interventions for older adults.
- A number of building code interventions were found to be promising, such as stair and balcony designs and window guards. However, specific design requirements that should be implemented and the effectiveness of these designs have not been established in the research literature to date. Panel 4 placed this part of the intervention in bucket 5.

- Community-based smoke alarm installation programs coupled with education to high-risk homes were found to increase the prevalence of smoke alarms. However, the question of whether installed smoke alarms were maintained as working smoke alarms has not been answered to date.
- Several building codes and other legislation should be evaluated to determine their appropriateness as fire prevention interventions, such as smoke alarms; electrical systems, heating systems, and other ignition sources; and access windows, fire escapes, protected stairways and other safe escape exits.
- Ordinances and legislation were found to be promising interventions in encouraging installation of four-sided isolation fencing around pools. However, a study on three- and four-sided fencing did not show that ordinances were beneficial in reducing drowning rates.
- A study showed that community-based education could be used to increase isolation pool fencing. However, this research was conducted in New Zealand and should be replicated to analyze cultural differences in other populations in the United States and United Kingdom.
- Home-based education was found to change behaviors, but was not shown to play a role in increasing isolation fencing around pools.
- Temperature controlled mixer faucets were found to be effective in reducing scalds in the United Kingdom. However, this intervention has not been explored in the United States.
- Voluntary compliance to pre-set water heater temperatures to a safe level might be a promising intervention based on positive effects from legislation. However, the degree to which manufacturers would adhere to this standard is unclear.
- Home safety education to families with children was found to modestly reduce hot water heater temperatures. However, this research could not be linked to reductions in injury rates.

<u>Bucket 3: Interventions In Need of Formative Research</u>

- Formative research is needed on the design of smoke alarms to optimize efficacy, reliability, and long-term function.
- Formative research is needed on home- and community-based education and distribution programs to reduce ignition sources. This guidance should include updating wiring, cleaning chimneys, and using safe space heaters.
- Formative research is needed to explore behaviors to escape fires.
- Formative research is needed on the acceptability, promotion, and adverse effects of automatic fire sprinkler systems.
- Formative research is needed to determine specific home modifications that are most effective in reducing older adult falls.
- Formative research is needed to answer two key questions related to drowning: (1) Are pool covers or alarms effective alternatives to pool

fencing? (2) Do pool covers or alarms add benefit to pool fencing? Studies are also needed on better bathtub designs to protect persons of all ages.

- Formative research is needed to address and better evaluate several issues related to scalds and burns, such as the use and acceptability of anti-scald technology; the effectiveness of community-based education for safe hot water temperatures; and the design of stoves and controls.
- Formative research is needed to address behavioral, legislative, design, and engineering issues to reduce carbon monoxide exposure.
- Formative research is needed to determine the effectiveness of enforcement, incentives or specific language or a combination of these interventions in safety-related building codes and legislation.
- Formative research is needed to determine interactions among a range of structural hazards, such as the relationship between falls and low-level carbon monoxide.
- Formative research is needed to analyze innovation around experimental design and evaluate residential hazards, such as laboratory testing of electrical wire coating.

Bucket 4: Interventions Shown To Be Ineffective

- Advice and recommendations on home modifications alone were not found to be effective in preventing older adult falls.
- Two interventions were not found to be effective in fire prevention: community-based smoke alarm "giveaway" programs and home safety education to store matches or lighters out of the reach of children.
- Three-sided fencing around pools was found to be less effective and potentially harmful compared to four-sided isolation pool fencing.

[Editor's Note: Bucket 5 appears to be a subset of Bucket 4]

Bucket 5: Interventions In Need of More Literature or Expertise

- More evidence is needed to make recommendations on adverse effects from noise and temperature control.
- Guidance is needed from engineering and consumer product safety experts to make recommendations on fire ignition and spread.
- Guidance is needed from architects, builders, and engineers to make recommendations on structural designs to prevent falls and scalds, such as safe kitchen layouts.

Issues, Research Gaps, Challenges and Concerns

- More studies should be conducted with larger cohorts to evaluate injury outcomes. Panel 4 was challenged in drawing strong conclusions due to the lack of data.

- Standardized tools and measures of home hazards, interventions and outcomes should be developed and used to facilitate cross-study comparisons and pooling of data.
- Multi-factorial interventions with a factorial design should be evaluated to assess specific interventions.
- Federal support should be targeted to small business innovation research, such as the anti-scald technology, to increase the development and evaluation of interventions.
- Cost-effectiveness studies and cost benefit analyses of home safety interventions should be performed.
- Insurers and other third parties with potential economic interests should be included in the development and implementation of interventions to reduce injuries and death.

The Expert Panel applauded panel 4 on its exhaustive literature review and comprehensive guidance. Several members made suggestions for panel 4 to consider in collecting additional data and strengthening its evidence-based recommendations.

- Studies conducted in Boston public housing on clutter and lack of storage should be reviewed because these issues have implications for pests, dust mites, fire and fall risks. In support of this research, consideration is being given to using a home designer to design storage capacity for small spaces. Panel 4 should combine these efforts with its structural design interventions in bucket 5.
- Evidence-based studies and practical tips on hoarding and clutter should be reviewed to support structural deficiency interventions for older adults.
- Data should be collected for bucket 3 to determine whether raising the hot water heater temperature to wash bedding is an effective intervention in reducing dust mites.
- The literature on poisoning prevention should be reviewed as a household intervention.
- Studies on lighting and crowding should be evaluated because these interventions have been shown to have an impact on mental health, transmission of communicable diseases, injury hazards, and asthma episodes.
- The white paper should use “density” rather than “crowding” because this word has cultural implications.
- Papers on firearm safety and gun locks should be evaluated because these interventions are useful for gun control in the home.
- The white paper should recommend randomized controlled clinical trials to evaluate “common sense” interventions.

- The white paper should describe anecdotal data for healthy homes in addition to evidence-based research. For example, some federal healthy homes grants are being used to focus more on elderly persons than infants. Significant housing problems most likely will not be corrected if an elderly homeowner lives on a fixed income. However, Medicare should pay for simple interventions to protect elderly persons in their homes, such as power strips to eliminate the use of extension cords and remote controls to turn on lights.
- Strategies should be developed to ensure that conflicting guidance is not released. For example, CDC recommends a higher water temperature to eliminate Legionella in water, while the studies reviewed by panel 4 recommend a lower water temperature to reduce the risk of scalds.
- The white paper should explicitly focus on medically vulnerable populations due to the significant increase of these groups over the past few years.
- Data on potential responses to heat events, particularly in low-income housing, should be reviewed to identify interventions for structural deficiencies.
- Unlocked Lock boxes for guns and unlocked medicine cabinets should be considered as structural deficiencies in the home.

Panel 5 Report: Intersection Between Housing and Community

Dr. Edmond Shenassa, of the Brown Medical School and Centers for Behavioral & Preventive Medicine, chaired Panel 5 and presented the findings of the group. Panel 5 discussed several topics in its literature review, including policy; connectivity, density, mixed use, and green space related to urban design; noise and safety related to housing; and community-based issues, such as safety, poverty, and residential segregation.

Panel 5 also considered several principles to guide its literature review. The context in which housing is nested and physical aspects of the neighborhood immediately adjoining the house are important factors. Parks, playgrounds, and other structures or resources that are within walking distance of homes in the community are relevant to the neighborhood, but should be distinguished from “city” parks and playgrounds outside of the community.

Concepts from sociology, psychology, and other non-public health fields were not included in discussions on the intersection between housing and the community. Hybrid designs as well as people-based and place-based interventions were considered. Racial and socioeconomic disparities are underlying issues for all housing interventions and should be explicitly framed in the white paper. Some of the bucket 1 interventions will be best

practices and policies at some level of government, such as zoning laws, rather than approaches supported by evidence-based research or large-scale randomized trials.

Panel 5 determined that a number of the important articles for the intersection between housing and the community were not provided prior to the meeting. As a result, Panel 5 will include additional literature to produce a more detailed analysis and clarify methodologies. Overall, Panel 5 requested clear guidance on specific interventions to evaluate on the intersection between housing and the community.

[Editor's Note: Panel 5 divided Bucket 1 into two groups]

Bucket 1a: Interventions That Are Ready for Implementation (Federal Policy)

- A legal framework and evidence exists for a number of policy interventions at the federal level.
- Several zoning policies are relevant to housing, such as inclusionary zoning, repeal of ordinances to keep out small lots in communities, and mixed use land.
- Financial incentives can be given to builders or bankers to develop mixed income housing or promote inclusionary mortgage practices. Density bonuses can be awarded to avoid sprawl and encourage the development of green housing and planned communities. Housing subsidies can be given to individuals for both buying and renting homes.
- Cities and municipalities can be required to use health and environmental impact assessment as criteria for housing developments.

Bucket 1b: Interventions That Are Ready for Implementation (Precedent)

- Several interventions are not supported by federal policy, but they have a precedent at the local or state level.
- Policies related to smart growth include planning of the entire community, public transportation, and promotion of accessibility and density.
- Universal design criteria and building standards promote access to the home for all persons, including at least one entrance with no stairs, one bathroom on the first floor, and increased width of doors for wheelchair entry.

Bucket 2: Promising Interventions In Need of More Field Testing

- Interventions related to the safety of the neighborhood and its residents need more field testing. For example, "Hope VI Demolition Grants" fund the demolition and revitalization of poor or distressed public housing throughout the country. This initiative involves relocating residents during revitalization and moving residents back to a mixed income community. Hope VI is considered to be a gold standard because its experimental design makes accurate assessments of the efficacy of interventions possible for reducing

crime and implementing community-based safety interventions. Emphasis is placed on both the individual and place, such as increasing visibility at night with more lighting or widening streets. However, Hope VI might not be adequate in extremely poor neighborhoods with high rates of crime.

- The "Moving to Opportunity Demonstration Project" and "Housing Choice Voucher Program" are evidence-based policy interventions that have made an impact on safety. Qualified residents are allowed to rent a unit in the private market and pay only 30 percent of their income. Panel 5 characterized these interventions as high priorities, but their positive health impacts on boys need further study. Deleterious or mental health effects were observed among men and boys who participated in this program. Moreover, some families are not benefiting from this program because they are moving to other public housing. Popkin is assessing families over time to determine what happened to them in this program.
- A supervised playground is a fairly cost-effective intervention that might make good use of available resources. Evidence has shown that supervised playgrounds can be effective in increasing exercise.
- Neighborhood noise is an example of an intersection between the house and environment. Evidence has shown window replacement to be an effective solution to noise reduction. Panel 5 members have not reviewed any papers on this topic. Window replacement is a specific and practical intervention that links with multiple outcomes and is the intersection of house and community. For example, window replacement can lower noise levels and the risk of lead poisoning and falls.
- Connectivity designs, such as in smart growth areas, are important in allowing people to easily access services and community resources without driving. Connectivity is one of the issues considered in schools of thought known as "new urbanism" and "smart growth," which are concerned with the design of housing communities. Urban planning strategies balanced with transportation considerations have been implemented to develop mixed use of land and promote walking, access, and mixed demographics. The design of houses and accessible street grids are other components of connectivity. However, assessments of connectivity designs that have been performed in the United States have not been complete to date. Smart growth strategies suggest: (1) development of housing with heterogeneous designs in the same neighborhoods that are also close to transport and retail areas; (2) promotion of the development of neighborhoods that are racially and demographically diverse; and (3) promotion of mix use of land, higher density,

sidewalks, and building of public areas. The purpose of these strategies is to promote walking and decrease traffic congestion.

- Programs to reduce poverty and residential segregation suggest the need to reduce pockets of concentrated poverty. This makes it necessary at times to assist individuals in relocating from high poverty and less developed neighborhoods to lower poverty and well-integrated communities. Some of these person-based programs have had mixed results, such as improved health for girls and women and poor outcomes for boys.
- Placed-based [Editor's Note: Should "place-based" be replaced by "relocation-based"?] interventions that improve conditions of poor neighborhoods need more field testing.

Bucket 3: Interventions In Need of Formative Research

- Formative research of fair housing policies to emphasize disparities and racial segregation in a number of U.S. communities.
- Research that provides evidence of structural inequalities using GIS techniques.
- Evidence demonstrating the effects of providing green space around the home.

The Expert Panel applauded panel 5 on its exhaustive literature review and comprehensive guidance. Several members made suggestions for panel 5 to consider in collecting additional data and strengthening its evidence-based recommendations.

- The public health community should endorse the implementation of policies that currently have a legal framework, such as the Section 8 program and poverty concentration objectives within housing assistance programs. This support should be particularly emphasized in the development of housing mobility programs.
- Voucher programs should be placed in bucket 1. Numerous studies on the Section 8 program and other evidence-based research have shown several benefits with the use of vouchers. Most notably, relocating individuals to areas with lower poverty resulted in safer and less poor neighborhoods and also addressed housing affordability issues.
- Caution should be taken on the definition of "evidence-based" interventions to include in bucket 1. A weight of scientific evidence can be applied in decision-making, but no scientific certainty exists.
- Evidence from the United Kingdom on relocation housing for medical reasons should be reviewed. These studies show beneficial health outcomes after individuals were relocated from adverse housing conditions to better housing by order of a medical or health professional.

- Transportation, park spaces, travel, urban design, and other characteristics of a healthy community should not serve as a major focus of housing interventions. Other groups are currently addressing these issues and recently reviewed the literature and best practices on the effectiveness of urban design. For example, the "Active Living by Design Program" at the Robert Wood Johnson Foundation is convening numerous workshops on community design. Moreover, the Robert Wood Johnson Foundation, Kellogg Foundation, and CDC are partnering on a similar project. These studies should be referenced in the white paper.
- Data should be reviewed on the health impacts of density and walkability in the community in terms of reducing carbon monoxide.
- The growing body of evidence on biological changes related to stress should be evaluated. Data have shown that stress triggers inflammatory responses and can be measured by cytokines or C reactive protein.
- Interventions to assess neighborhood quality should be reviewed and placed in bucket 3. For example, the Los Angeles Family and Neighborhood Survey and other assessment tools need more formative research and evaluation in order to be validated.
- Data on the effect of uncontrolled sprawl and its relationship to quality of life issues should be reviewed. Land conservancy organizations, open space, smart development, agricultural land preservation and recreational spaces should be thoroughly considered in this effort.
- The University of Chicago studies and measures of social capital developed in the United Kingdom should be included as data sources because these interventions can be argeted to either the individual or community.
- Social capital and connectedness should be considered as critical and measurable components in people-based and place-based policies.
- The Section 8 "Rent Versus Eat" studies on housing affordability and the Children's Sentinel Nutrition Assessment Program should be evaluated in the context of protecting health.
- Data on energy policies, such as supporting weatherization programs and investing in energy, should be included in the panel 2 literature review.
- The literature on community policing should be reviewed to determine whether strategies other than lighting and siting of housing can enhance community safety.
- Missing articles on neighborhood effects should be collected and included in the panel 5 literature review.
- Social justice issues should be placed in bucket 3 because this area needs more formative research.
- A number of studies on green space interventions should be evaluated and considered for bucket 1.

- Several studies demonstrated a higher prevalence of asthma among children in schools sited near highways compared to children in schools sited away from highways. This research could be used to evaluate an environmental factor of housing with a health impact.
- The University of Illinois studies focused on the presence of trees and nearby nature in Chicago public housing. This research also examined specific aspects of social, mental or relational health, such as children playing and adult interaction.
- The literature contains several studies on habitat housing, its effect on nearby nature versus housing, and the overall impact of nearby versus remote nature.

The meeting sponsors made several clarifying remarks in response to the Expert Panel's discussion and suggestions. Ms. Morley was aware that some panels expressed concern about the rigorous definition of "evidence-based" interventions to include in bucket 1. She recognized the need to make a decision on whether interventions that are codified in law, included in building practice, or integrated into guidelines should be defined as "evidence." She confirmed that the planning committee and chairs would discuss and attempt to resolve this issue during the post-meeting review process.

Dr. Brown explained that "healthy communities" are included in CDC's healthy places goals along with healthy homes. She noted that the CDC team for this goal area is focusing on universal design and other topics being addressed by Panel 5. She confirmed that the panel's guidance and recommendations would be distributed to CDC's healthy communities goal team.

Next Steps

Ms. Morley asked each Expert Panel member to recommend actions that NCHH and CDC should consider to improve or advance the healthy homes peer review process in the future. Suggestions by the Expert Panel are outlined below.

- Policymakers and persons in disciplines outside the research community should be engaged in future efforts. Detailed guidance on specific aspects that constitute evidence for policymaking in the healthy homes arena should be distributed to these groups. A graded evidence scale also should be developed for these groups to endorse prior to the follow-up meeting.
- Evidence for "best practices" should be clearly defined, such as moisture control.

- The added value of bucket 1 interventions should be considered, such as interventions that contribute to reducing global warming and a reduction in energy use.
- Tangible products other than the white paper should be generated from future healthy homes meetings, such as a monograph or meeting summary in a peer-reviewed journal.
- Federal agencies should solicit applications for funding to support studies on some of the healthy homes topics that were raised during the meeting.
- Strong efforts should be made to address issues and answer questions in bucket 3 that need formative research. Bucket 3 should not serve as an obstacle to shifting interventions to bucket 1 or 2.
- More emphasis should be placed on healthy and safe housing for the elderly to promote economic progress and maintain the strong political will that has been generated in this area.
- The white paper should emphasize the need to advance studies to actual implementation. CDC and the broader public health community should partner with community-based organizations and academic institutions to translate solid innovation to the field.
- Links to papers that were reviewed should be posted on a web site for access by each of the five panels.
- Interventions that enhance adaptive capacity should be considered, along with climate change and greenhouse gas mitigation.
- Unregulated home workplaces should be addressed, particularly occupational hazards caused by printing and painting.
- More emphasis should be placed on take-home occupational exposures that have been well studied and documented by the National Institute for Occupational Safety and Health.
- Attention should be paid to dust-free heating and ventilation systems in the home.
- Healthy homes experiences and lessons learned in Europe and Asia should be thoroughly reviewed in the United States.
- New interventions should be consistent with existing rubrics and constructs in other parts of the world to make progress on global population health.
- Strategies should be developed to appropriately frame “risk” across different perspectives, including engineers, public health practitioners, and regulators.
- Consideration should be given to renaming the healthy homes effort to “Healthier People in Healthier Housing.” The new name would engage a broader range of expertise and also broaden the scope to include human behavior, environmental change, advocacy and legislation.
- Efforts should be made to overcome barriers to differences in languages among disciplines, such as the public health community versus engineers.

- Representatives of community-based organizations should be extensively engaged in the healthy homes initiative to provide input on the actual feasibility of implement the proposed housing interventions.
- CDC should widely publicize its infrastructure and support capability to develop comprehensive and informative documents from the healthy homes meeting.
- Cost-related issues and economic implications should be identified to support and prioritize some of the housing interventions.
- A process should be developed to ensure divergent or conflicting guidance is not issued.

Closing Session

The meeting sponsors thanked the Expert Panel members for taking time from their busy schedules to provide NCHH and CDC with valuable recommendations, feedback, and insight.

Ms. Morley acknowledged the tremendous efforts of several persons who were responsible for making logistical arrangements and other preparations for the meeting: Ms. Baeder, Public Health Prevention Specialist; Dr. Stephen Margolis and Mr. Jerry Hershovitz, consultants to NCHH; and Ms. Laura Titus, Events Planner, NCHH. Ms. Morley also thanked the planning committee members for developing the agenda and identifying clear goals and objectives for the meeting.

Dr. Brown related that the deliberations of the Expert Panel would be extremely helpful in advancing CDC's healthy housing and healthy community agendas. She emphasized that the Expert Panel's guidance also would be important to other efforts, such as the CDC/ U.S. Environmental Protection Agency Water Safety Group. Dr. Brown reiterated that other opportunities would be available in the future for the Expert Panel to discuss additional issues and in more depth.

In response to an Expert Panel member's question, Dr. Brown stated that her preference would be to simultaneously release the healthy homes papers as both NCHH/CDC documents and peer-reviewed articles. However, NCHH and CDC would make a decision on the most appropriate formats and venues to release the papers in the future. The Expert Panel members were encouraged to submit suggestions on options NCHH and CDC should consider.

Dr. Jacobs commended the Expert Panel members for their individual contributions to the growth and expansion of the healthy homes field. He urged the Expert Panel to continue to focus on the international health homes agenda.

Post-Meeting Activities

All panel members and chairpersons agreed at the end of the December 11-12 meeting that they would reconvene via telephone conference call and group e-mail to: 1) review and discuss any intervention literature that was not analyzed during the meeting; and 2) "fine-tune" their power point recommendations. All of the panels met during the months of February and March, 2008 and the following presentations are the results of those activities.

Participants: Peter Ashley, Ginger Chew, Dorr Dearborne, David Jacobs, Jim Krieger, David Miller, Rebecca Morley, Felicia Rabito

The purpose of the telephone call is to determine whether the additional literature that was reviewed following the December meeting changed the categorization of interventions in the buckets.

Participants identified the following issues for discussions and possible re-categorization:

1. Multifactorial asthma interventions
2. Mold control
3. Steam cleaning for mites
4. Air cleaners

1. Multifactorial asthma interventions

For bucket 1 "Interventions ready for implementation (Exposure)," we should include multi-factorial measures to reduce asthma triggers. The study that Ginger reviewed[1] showed an effect on Fel d1, Can f1, and dust mite. The PREVASC study showed that hot wash and mattress covers resulted in a decrease in allergens.

A suggestion was made to look through the multi-factorial asthma studies and pull out the components that are used in these studies. Note: Rebecca did a brief review of these and found the following common interventions: Steam cleaning or intense vacuuming, bedding treatment, professional laundry or in-home laundry. ETS and pet avoidance are also referenced.

2. Mold Control

The Lignell paper[2] shows that there was an improvement in school children following mold remediation. There were both clinical and microbial improvements. Another paper by Burr showed a clinical decrease in asthma symptoms as a result of moisture reduction.
There is a broad body of evidence linking the presence of mold and moisture to poor health outcomes. From a public health perspective these clinical findings point to the need for interventions that reduce the sources of dampness and mold. However, we don't know how much we need to intervene. We don't know how clean a home has to be.

[1] Schonberger, H. J., Dompeling, E., Knottnerus, J. A., Maas, T., Muris, J. W., van Weel, C., et al. (2005). The PREVASC study: the clinical effect of a multifaceted educational intervention to prevent childhood asthma. *European Respiratory Journal, 25*(4), 660-670.

[2] Lignell, U., Meklin, T., Putus, T., Rintala, H., Vepsalainen, A., Kalliokoski, P., et al. (2007). Effects of moisture damage and renovation on microbial conditions and pupils' health in two schools--a longitudinal analysis of five years. *Journal of Environmental Monitoring, 9*(3), 225-233.

There is a broad body of epidemiologic and laboratory evidence linking the presence of mold and moisture to poor health outcomes. National and international expert panels have reviewed the evidence, finding consistently that both mold and moisture are associated with a wide variety of adverse health effects in both the general population and in specific vulnerable segments of the population. From a public health and prevention perspective these clinical findings point to the importance of controlling moisture sources within the home, correcting water damage as soon as it occurs, and safely cleaning or removing mold-contaminated materials promptly. There are a number of challenges that remain demanding further study. The United States comprises a very large geographic area with diverse climates, building systems and ages of the building stock. Although removal of contamination is normally not difficult, correcting the underlying faults can be (and often is) expensive. There is an important opportunity to better define –on a regional basis- the level of intervention that can be justified on public health grounds.

The consensus was that based on the evidence, "elimination of water intrusion and visible mold should go in bucket 1."

3. Steam cleaning

The articles did find significant reductions in exposure and symptoms. Both are small studies.[3] It was noted that the reductions are transient and need to be repeated. The consensus was to include steam cleaning under "Bucket 2: Promising Interventions Needing More Field Testing (Exposure)."

4. Air cleaners

Wood's study[4] showed an effect on airborne allergens. A review article also showed an effect on airborne allergens. VanderHeide showed that the HEPA filters compared to non-HEPA filtered.[5] Hyper-responsiveness and peak flow improved more for people with HEPA filters. Reisman[6] saw an effect on airborne particulates but the population was a mix of smokers and non-smoker and pets in both groups. It was agreed that based on the work of Expert Panel 2, HEPA air cleaners work for PM1-10. One could speculate that they would work for cat, mice and rat, but may not work as well for roach and dust mites. There was agreement that ozone producing air cleaners should not be used.

Next Steps:

[3] Colloff, M. J., Taylor, C., Merrett, T. G., Colloff, M. J., Taylor, C., & Merrett, T. G. (1995). The use of domestic steam cleaning for the control of house dust mites. *Clinical & Experimental Allergy, 25*(11), 1061-1066.

[4] Wood, R. A., & Wood, R. A. (2002). Air filtration devices in the control of indoor allergens. *Current Allergy & Asthma Reports, 2*(5), 397-400.

[5] van der Heide, S., van Aalderen, W. M., Kauffman, H. F., Dubois, A. E., de Monchy, J. G., van der Heide, S., et al. (1999). Clinical effects of air cleaners in homes of asthmatic children sensitized to pet allergens. *Journal of Allergy & Clinical Immunology, 104*(2 Pt 1), 447-451.

[6] Reisman, R. E., & Reisman, R. E. (2001). Do air cleaners make a difference in treating allergic disease in homes? *Annals of Allergy, Asthma, & Immunology, 87*(6 Suppl 3), 41-43.

Rebecca stated that there is an implementation summit/meeting being planned for September – the meeting will be to inform a research and policy agenda.

Rebecca queried the participants regarding what they would find as the most useful output of the expert panel. All agreed that research direction is a critical outcome of the work. The suggestion was made for a set of mini-monographs in EHP (see for example, Healthy Children Mini-monograph) Volume 112, Number 1, January 2004). There was also support for one paper that outlines current best practice and research needs.

POWER POINT PRESENTATION WITH INTERVENTION "BUCKETS"

PANEL 1 - INTERIOR BIOLOGICAL EXPOSURES

Healthy Homes Expert Panel Meeting: December 11-12, 2007

Report Out of Findings— Panel 1 – Biologic Agents

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Our Topics

- Multi-component tailored*
- Education
- Moisture Control, Ventilation, Structural remediation
- Vacuuming
- One-time professional cleaning
- Carpet intervention (steam cleaning, removal, replacement)
- Integrated pest management
- Acaracides
- Air Cleaners
- Bedding Treatments

1

"Bucket 1": Interventions Ready for Implementation (Clinical)

- Multi-faceted tailored interventions for asthma
  - Education (Social learning theory)
  - Mattress and pillow covers
  - HEPA Vacuum
  - HEPA Air Filter (subset)
  - Smoking Cessation
  - Cockroach Extermination
  - Bedroom cleaning

2

"Bucket 1": Interventions Ready for Implementation (Exposure)

- Cockroach Mgt
  - Integrated pest management
    - Household cleaning and tool dispensing
    - Professional cleaning
    - Resident education
    - Baits
    - Structural repairs
  - Intensive pesticide application
- Interventions to reduce asthma triggers
  - Mattress encasements
  - Hot wash
  - HEPA filter air cleaners
  - Eliminating water intrusion (limited evidence)
  - Removal of moldy items and/or visible mold (limited evidence)

3

"Bucket 2": Promising Interventions Needing More Field Testing (Clinical)

- Moisture control
  - Dehumidification
- Ventilation
  - Heat recovery ventilation (mechanical ventilation)
  - Local exhaust

4

"Bucket 2": Promising Interventions Needing More Field Testing (Exposure)

- Repeated Dry-Steam Cleaning (results are transient but the action needs to be repeated)
- Repeated Vacuuming (results are transient but the action needs to be repeated)
- HEPA Air Cleaners (per work of Panel 2 these work for PM 1-10). You can speculate that they would work for cat, mice, and rat but may not as well for roach and dust mite. Ozone producing air cleaners should not be used.

5

"Bucket 3": Interventions in Need of Formative Research

- Moisture – what are the most promising interventions to reduce humidity in specific climates and to what levels?
- Carpet Treatments
  - Carpet composition
  - Carpet removal
- Education
- One-time Professional Cleaning? (check Robert Woods – Hopkins)
- Acaracides

6

"Bucket 4": Interventions Shown to be Ineffective on Clinical Outcomes

- Bedding Encasement/Washing

  (sheet washing, upholstery cleaning, mattress and box spring covers) – not effective in isolation.

7

Issues, Research Gaps, Challenges, Concerns…

- Intervention studies generally included high-risk families, not the general population, which limits generalizability. Also, families with children that have less severe symptoms are more likely to drop from studies.
- Because homes contain multiple biological contaminants, interventions must be multi-faceted/holistic.
- Some studies show environmental improvements or health improvements, seldom both.
- Standardized methods for assessing housing-related health hazards and allergen sampling/analysis/(dampness– RH vs moisture content) and allergen sampling.

8

Issues, Research Gaps, Challenges, Concerns…

- Need to distinguish between "home" and "housing" interventions.
- Regional/climate differences are critical factors for making recommendations.
- Need to distinguish between new construction and rehabilitation in making recommendations.
- Some research is missing and should be reviewed for the white paper to corroborate the findings.

9

Issues, Research Gaps, Challenges, Concerns…

- In the context of asthma interventions, there is a placebo effect that needs to be considered.
- The correlation between observation measurements and self-reports versus lab measurements (e.g. visual assessments vs. environmental sampling).
- Standard outcome measures should be established (e.g. asthma control, quality life, and lung function).
- More multivariate analyses are needed to address interaction effects.
- Reference standards need to be developed.

10

Healthy Homes Expert Panel Meeting: December 11-12, 2007

Report Out of Findings—Panel 2

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Our Topics

- Topic A Radon
- Topic B IPM as pesticide reduction
- Topic C ETS
- Topic D Particulates and Ventilation
- Topic E VOC
- Topic F Particulate Intrusion from Outside

1

Our Panel

- Asa Bradman
- Jack Hughes
- Dave Jacobs
- Cliff Mitchell
- Megan Sandel
- Richard Shaughnessy
- Tim Takaro

2

Caveats

- We think that there may be studies that we did not review that may be relevant
- Some overlap between Panels
  - Panel 1 and 2 over IPM and Ventilation
  - Panel 4 and 2 over temp control, particulate intrusion
  - Panel 3 and 2 over water source interventions
- other

3

"Bucket 1": Interventions Ready for Implementation

- Topic A Radon
  - Intervention A Groves-Kirkby Active post construction systems in high risk areas
- Topic B IPM as pesticide reduction
  - Intervention A Williams, professional cleaning, sealing of entry, low toxicity pesticide (2.15% hydramethylnon) indoor air samples & limited biomonitoring
- Topic C ETS
  - Intervention A Fong, Allwright, Farrelly, Haw – non-residential smoking bans are effective in reducing exposure to ETS

4

"Bucket 1": Interventions Ready for Implementation

- Topic D Ventilation
- Topic E VOC
  - Detached Garages are important ways to reduce VOC emissions **(Batterman, S., Jia, C., & Hatzivasilis, G. (2007). Migration of volatile organic compounds from attached garages to residences: A major exposure source. *Environmental Research, 104*(2), 224-240.)**
- Topic F Particulate Intrusion reduction

5

"Bucket 2": Promising Interventions Needing More Field Testing

- Topic A Radon
  - Intervention A Mose Radon in Water – activated charcoal & aerration
- Topic B IPM- Panel 1 , self report pesticide reduction
  - Intervention A IPM Brenner, sealing crack & crevice, education, plumbing repair, bait + traps (small n (9) at exit) – self report reduced pesticide
  - Intervention B Levy no controls, pre post (n=50) no measurement of pesticides/exposure (Rhona Julien study)
  - Intervention C Peters (same study as Levy) no measurement of pesticides/exposure
  - Cleaning- McCauley, L. A., Travers, R., Lasarev, M., Muniz, J., Nailon, R., McCauley, L. A., et al. (2006). Effectiveness of cleaning practices in removing pesticides from home environments. *Journal of Agromedicine, 11*(2), 81-88

6

"Bucket 2": Promising Interventions Needing More Field Testing

- Topic C ETS
- Topic D Ventilation/ Particulate inside homes
  - Intervention A- HEPA air cleaners
  - Intervention B- HEPA Vacuums (Yiin LM, Yu CH, Ashley P, & G., R. (2008). Cleaning Efficacy of High-Efficiency Particulate Air-Filtered Vacuuming and "Dry Stream" Cleaning on Carpet. *Journal of Occupational & Environmental Hygiene, 5*, 94-99.)
- Topic E VOC
  - Intervention A- Garage sealing for Benzene
- Topic F Particulate Intrusion reduction
  - Intervention A- air conditioning

7

"Bucket 3": Interventions in Need of Formative Research

- Topic A Radon – Passive systems with testing and adding active if needed (between Bucket 2 + 3, EPA)
  - Intervention A Marley AC & Heat (Hospital & School)
  - Intervention B Huber Mechanical Ventilation, Fan, Multilayer Floor w/fan
  - Intervention C LaFollette Passive New Construction – Membrane Sealing & Ducting
- Topic B IPM as pesticide reduction

8

"Bucket 3": Interventions are formative and need more study

- Topic C ETS
  - Intervention – Administrative/legal smoke free homes policies
- Topic D Ventilation
  - Intervention A- Central systems (types vs operational)
    - Limited extrapolation from schools/office buildings to homes
  - Intervention B- Local (bathroom, kitchen)

9

"Bucket 3": Interventions are formative and need more study

- Topic E VOC
  - Intervention A- Source Control
    - Low VOC product substitution
    - Avoidance
    - "Baking out" new product (Few home studies- Thorax 2004 and limited extrapolation from offices to homes)
- Topic F Particulate Intrusion reduction
  - Intervention A- Central HVAC with HEPA
  - Intervention B- Building envelope sealing, ventilation passive or active (i.e. Green)

10

"Bucket 4": Interventions Well studied, Not Effective, No more study

- Topic A Radon
- Topic B IPM as pesticide reduction
- Topic C ETS
  - Issue A Engineering Controls/Air Cleaning – not effective? (finding the studies) Batterman, S., Godwin, C., Jia, C., Batterman, S., Godwin, C., & Jia, C. (2005). Long duration tests of room air filters in cigarette smokers' homes. *Environmental Science & Technology, 39*(18), 7260-7268. –

11

"Bucket 4": Interventions Well studied, Not Effective, No more study

- Topic D Ventilation
  - Issue A Ionizers
  - Issue B- construction standards (CHMC, Sherman- not helpful studies)
- Topic E VOC
- Topic F Particulate Intrusion Reduction

12

Studies we would jettison ? Bucket 5

- All Radon studies- EPA send more literature?
- Najafi Enkavent Mat Study – inconclusive evidence for intervention –
- Cavallo Existing Construction Passive Ventilation + Subslab Depressurization, active ventilation (1 experimental home)
- Coskeran New Contruction – membranes (passive system) Cost Effectiveness Study – not intervention study

13

Issues, Challenges, Concerns…

- A Radon
  - Surprise there is not more good research into active and passive ventilation
- B IPM – Clear definition is needed
  - Eliminate entry
  - Eliminate shelter
  - Eliminate food & water
  - Adopt targeted least toxic pesticide use (boric acid, gels, non-aerosolized)
- C ETS
- D Home Ventilation

14

Issues, Challenges, Concerns…

- E VOC
  - urinary biomarkers when possible, though possibly not
  - airborne testing when possible
  - SHOULD NOT NECESSARILY HAVE TO TIE TO HEALTH BUT DO TO EXPOSURE
  - Top 5 VOC culprit + sources (published literature for which ones)
    - Benzene, Dichlorobenzene, formaldehyde
  - Do a study with certain materials, air test and show reduction, has implications, even though common sense, we should still evaluate
    - pre testing building materials (Europe) separate study
    - US only formaldehyde in pre fab
    - Vivian Loftness Elements healthy building EHP

15

Issues, Challenges, Concerns…

- F Particulate Intrusion Reduction
  - GREEN building guidance/ LEED
  - depends on how you bring fresh air for health
  - need the research to quantify how much fresh air is needed
  - ?CO2 600-700ppm
  - More literature needed Outdoor air infiltrates
    - PM 2.5 higher indoors than outdoors
    - PM 10? Less so infiltrating
    - ozone
    - no intervention yet identified

16

Parking Lot Issues

- Do you need a clinical outcome when it is hard to measure ??
  - Is reducing exposure enough? THAT IS AN OUTCOME
    - Need to know how much exposure reduction will have a clinical benefit?
  - Measuring reduction of exposure
    - Environmental measures
    - Biologic measures
  - Exposure disparities, vulnerable populations
- Need a control whenever possible, important to think about ethically design a good one

17


Healthy Homes Expert Panel Meeting: December 11-12, 2007
Draft Report Out of Findings— Panel 3 - External Exposures
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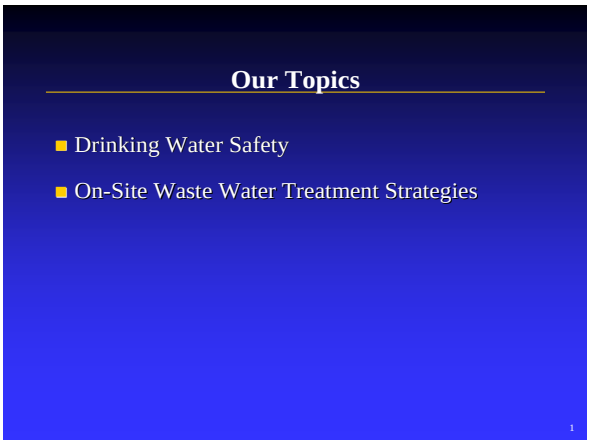
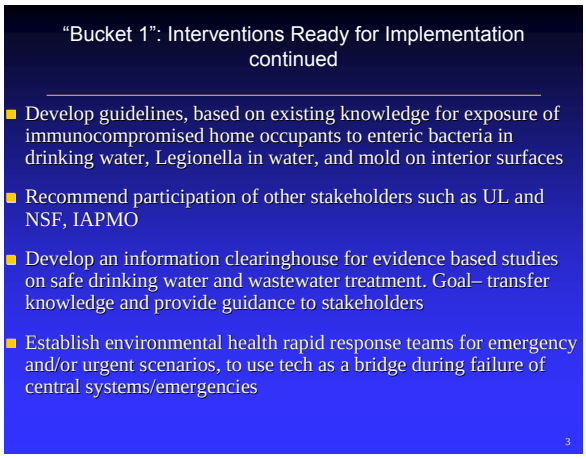
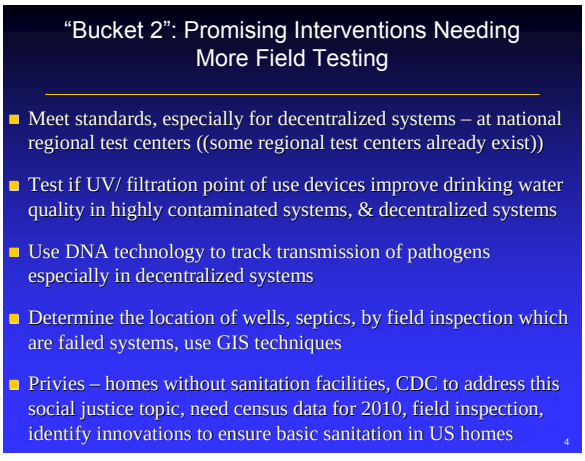

Our Topics
Drinking Water Safety
On-Site Waste Water Treatment Strategies
1


"Bucket 1": Interventions Ready for Implementation
Establish national voluntary treatment standards for drinking water and wastewater (decentralized systems, unregulated systems)
Implement a national voluntary standards for drinking water and waste water treatment (decentralized systems)
Enhance training centers (staffing and physical facilities), with onsite hands-on training (content already exists to a large extent)
Improve professional training for technology users on land based tech. including planning and zoning commissions, practicing professionals, sewage enforcement officers (decentralized)
2


"Bucket 1": Interventions Ready for Implementation continued
Develop guidelines, based on existing knowledge for exposure of immunocompromised home occupants to enteric bacteria in drinking water, Legionella in water, and mold on interior surfaces
Recommend participation of other stakeholders such as UL and NSF, IAPMO
Develop an information clearinghouse for evidence based studies on safe drinking water and wastewater treatment. Goal– transfer knowledge and provide guidance to stakeholders
Establish environmental health rapid response teams for emergency and/or urgent scenarios, to use tech as a bridge during failure of central systems/emergencies
3


"Bucket 2": Promising Interventions Needing More Field Testing
Meet standards, especially for decentralized systems – at national regional test centers ((some regional test centers already exist))
Test if UV/ filtration point of use devices improve drinking water quality in highly contaminated systems, & decentralized systems
Use DNA technology to track transmission of pathogens especially in decentralized systems
Determine the location of wells, septics, by field inspection which are failed systems, use GIS techniques
Privies – homes without sanitation facilities, CDC to address this social justice topic, need census data for 2010, field inspection, identify innovations to ensure basic sanitation in US homes
4


"Bucket 3": Interventions in Need of Formative Research
Social marketing and outreach strategy for stakeholders and various target audiences, zoning and planning commission, end users, etc.
Determine degree of water contamination with endocrine disruptors, drugs etc., and potential health impact thereof
Verify that improvements in education and enforcement have a positive effect on drinking water quality and wastewater quality
Study influences for socio-economic and demographic and other ecological factors to identify gaps in providing basic drinking water and waster water services
5

"Bucket 3": Interventions in Need of Formative Research continued

- Legionellosis: design surveillance studies to determine the magnitude of cases and mortality in residential buildings, carry out regional surveillance in warm climate areas
- Assess systems failure rates under various operating conditions, tie to health effects
- Study water reuse
- Study the risk index for emergency response, public health incidents etc

6

"Bucket 4": Interventions Shown to be Ineffective

- UV/filter point of use devices – no more studies needed in systems which meet safe drinking water standards
- Less research on large community systems and more on small systems

7

Issues, Research Gaps, Challenges, Concerns…

- Current enforcement structure is ineffective
- Update the CDC study "A Survey of the Quality of Water Drawn from Domestic Wells in Nine States". It was completed 1998
- Provide easily accessible information about the frequency pumping septic tank

8

Healthy Homes Expert Panel Meeting: December 11-12, 2007

Report Out of Findings—Panel 4 – Structural Deficiencies

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Our Topics

- Burn Prevention
- Fall Prevention
- Noise Reduction
- Fire Prevention
- Injury Prevention in Hazardous Areas
- Temperature Control

1

Structural Deficiencies

- Structural deficiencies are conceptualized to encompass those deficiencies for which a builder or landlord (or owner) would take responsibility (design, construction, installation, repair). It thus excludes behaviors of household residents such as safely storing poisons, affixing loose rugs, and purchasing non-slip bathmats.
- The scope of this panel was determined to include structural deficiencies, as well as monitoring of structural deficiencies and behavior to correct or monitor structural deficiencies.

2

"Bucket 1": Interventions Effective for Reducing Injury

- Fire Prevention
  - Working smoke alarms
- Drowning Prevention
  - Isolation (4-sided) fencing around pools
- Scalds
  - Legislation for pre-set safe temperatures for water heaters
  - Use of water heaters with pre-set safe temperatures

3

"Bucket 2": Promising Interventions Needing More Field Testing

- Fall Prevention
  - Home safety education to promote stair gates and window guards to prevent child falls
  - Home modification to prevent falls in children and older adults, e.g., handrails, grab bars, lighting, window guards
  - Building codes, e.g., stair & balcony design, window guards
    - Building codes are promising but the specific design requirements are included in bucket 5

4

"Bucket 2": Promising Interventions Needing More Field Testing

- Fall Prevention (continued)
  - Community-based, coordinated, multi-strategy initiatives that include home hazard reduction, targeting older adults

5

"Bucket 2": Promising Interventions Needing More Field Testing

- Fire Prevention
  - Community-based installation of smoke alarms, with education, in high-risk homes
  - Building codes and legislation
    - Smoke alarms
    - Safe ignition sources (e.g., electrical and heating systems)
    - Exits for safe escape, e.g., access windows, fire escapes, protected stairways

6

"Bucket 2": Promising Interventions Needing More Field Testing

- Drowning
  - Isolation (4-sided) pool fencing
    - Ordinances, legislation, building codes to require use
    - Home- and community-based education/promotion to promote use
- Scalds
  - Temperature-controlled mixer faucets
  - Voluntary compliance by manufacturers with preset safe temperature on water heaters
  - Home education to reduce temperature of hot water heaters

7

"Bucket 3": Interventions in Need of Formative Research

- Fire Prevention
  - Design of smoke alarms to optimize efficacy, reliability and long-term function
  - Home- and community-based education / distribution programs to reduce ignition sources (e.g., update wiring, clean chimneys, safe space heaters)
  - Exploration of behaviors to escape fires (in order to inform building design)
  - Acceptability, promotion and adverse effects of automatic fire sprinkler systems

8

"Bucket 3": Interventions in Need of Formative Research

- Fall Prevention
  - What specific home modifications are most effective for reducing older adult falls
  - Effects of community-based, coordinated, multi-strategy initiatives that include home hazard reduction, targeting children
- Drowning
  - Are pool covers or alarms effective alternatives to pool fencing
  - Do pool covers or alarms add benefit to pool fencing
  - Better designs for bathtubs to protect all ages

9

"Bucket 3": Interventions in Need of Formative Research

- Scalds/burns
  - Use and acceptability of anti-scald technology
  - Community-based education for safe hot water temperature
  - Community-based, coordinated, multi-strategy initiatives targeted to families with children aged <14 years
  - Design of stoves and stove controls
- CO
  - Behavioral, legislative, design and engineering interventions to reduce CO exposure

10

"Bucket 3": Interventions in Need of Formative Research

- General injuries
  - Safety-related building codes and legislation: effect of enforcement and/or incentives and/or specific language
  - Interactions among range of structural hazards, e.g., falls & CO
  - Innovation around experimental design and evaluation of residential hazards, e.g., lab testing of electrical wire coating

11

"Bucket 4": Interventions Shown to be Ineffective

- Older Adult Falls
  - Advice/recommendations alone for home modification
- Fires
  - Community-based smoke alarm give-away programs
- Drowning
  - Three-sided pool fencing is less effective than four sided (isolation) pool fencing and may be harmful

12

"Bucket 5": Need more literature or expertise to make recommendations

- Noise
- Temperature
- Fire ignition and spread (engineering, consumer product safety)
- Structural design to prevent falls & scalds (kitchen)
  - Need architects, builders, engineers

13

Issues, Research Gaps, Challenges, Concerns…

- Methodologic issues:
  - Few studies evaluated injury outcomes and many had a small sample size, making it difficult to draw strong conclusions
  - Investigators should develop and use standardized tools and measures of home hazards, interventions and outcomes to allow cross-study comparisons and pooling of data
  - Multi-factorial interventions should be evaluated using a factorial design to assess specific interventions. However, if a multi-factorial intervention is shown to be effective in reducing injuries, it is not essential that the individual components be evaluated separately before the intervention can be recommended for implementation.

14

Issues, Research Gaps, Challenges, Concerns…

- Methodologic issues (continued):
  - Hazard reduction studies should measure:
    - all applicable outcomes relevant to morbidity and mortality (e.g., stress resulting from loss of property in a house fire; risk of Legionnaires' disease with lower hot water heater temperature)
    - injury outcomes that are directly relevant to the particular hazards being prevented (e.g., effects of reducing hot water temperature on scald burns rather than on total injuries)

15

Issues, Research Gaps, Challenges, Concerns…

- Federal support of small business innovation research may be a useful approach for intervention development and evaluation
- Cost effectiveness and cost benefits analyses of home safety interventions (e.g., hard-wired smoke detection systems versus automatic sprinkler systems) are needed
- Insurers and other third parties with potential economic interests should be included in development and implementation of interventions to reduce injuries & deaths

16

PANEL 5 POST MEETING ACTIVITY: STATEMENT ON "NEIGHBORHOOD EFFECTS ON HEALTH"

by Dolores Acevedo-Garcia, PhD, MPA-URP
with references

There is empirical evidence that after taking into account individual level factors, disadvantaged neighborhood environments (e.g. poverty concentration) have a detrimental effect on health outcomes, including mortality, child and adult physical and mental health, and health behaviors (Macintyre & Ellaway, 2000; Ellen, Mijanovich & Dillman, 2001; Pickett & Pearl, 2001; Macintyre, Ellaway et al., 2002; Ellen & Turner, 2003; Kawachi & Berkman, 2003; Macintyre & Ellaway, 2003).

However, research reviews have noted that despite compelling empirical results, the evidence on neighborhood effects on health is not conclusive due to important methodological limitations (Macintyre & Ellaway, 2000; Ellen, Mijanovich et al., 2001; Macintyre, Ellaway et al., 2002; Ellen & Turner, 2003; Kawachi & Berkman, 2003; Macintyre & Ellaway, 2003). Since the vast majority of studies have used non-experimental, cross-sectional research designs, it is not possible to rule out selection bias as a possible explanation for neighborhood effects (Oakes, 2004). Unmeasured factors that affect both neighborhood choice and health outcomes could potentially account for the association between e.g. neighborhood poverty level and health. A high incidence of health problems in high-poverty, distressed neighborhoods does not necessarily mean that the neighborhood environment actually caused those problems. It may mean instead that many families with problems end up living in the same neighborhood, perhaps because housing was more

affordable there or discrimination closed the door to other neighborhoods. Non-experimental studies have tried to minimize selection bias by utilizing multilevel statistical analysis to distinguish the effect of individual and family characteristics from the independent effect of neighborhood conditions on health outcomes.[7]

The Moving to Opportunity (MTO) policy demonstration constitutes a notable exception due to its experimental longitudinal design. Since experimental studies assign families to poor and non-poor neighborhoods randomly (i.e. independently of family and individual characteristics), reported effects on health can be attributed to differences in neighborhood environment (Leventhal & Brooks-Gunn, 2001; Goering, Feins & Richardson, 2002; Goering, 2003; Goering & Feins, 2003; Leventhal & Brooks-Gunn, 2003; Acevedo-Garcia, Osypuk, Werbel, Meara, Cutler & Berkman, 2004).

EVIDENCE OF EFFECTS OF HOUSING MOBILITY POLICY ON HEALTH

Sponsored by the Department of Housing and Urban Development and begun in 1994, MTO was conceived as a housing mobility policy experiment. Eligible participants from central-city public housing located in high-poverty neighborhoods (i.e. poverty rate≥40%) in five metropolitan areas[8] were randomly assigned to one of three groups:

[7] Some studies have also used propensity scores. The propensity score is used primarily in observational studies for reducing bias and increasing precision. The propensity score is a summary from all observed background covariates, which seeks to balance observed covariates across the two (theoretical) treatment groups, to simulate the balanced distribution of confounders achieved through experimental design (D'Agostino, 1998).

1. The treatment group (also referred to as the experimental or MTO group) was offered both a Section 8 housing voucher that could be redeemed only in a low-poverty neighborhood (i.e. poverty rate≤10%) and housing search counseling.
2. The Section 8 group was offered a geographically unrestricted Section 8 housing voucher.
3. The in-place control group did not receive a voucher, but remained eligible for public housing.

All of the participants consisted of low-income families, and most were racial/ethnic minorities (Goering, 2003; Goering & Feins, 2003).

To date, the MTO demonstration has shown better health in the MTO group, and in some instances also in the health of the regular Section 8 voucher group vis-à-vis the control group of families that stayed in their public housing developments.[9] The most recent follow-up study indicated a lower rate of adult obesity (body mass index (BMI) ≥ 30[10]) in the MTO

[8] The five metropolitan areas are Baltimore, Boston, Chicago, Los Angeles, and New York.
[9] Findings from the Gautreaux study suggest that enhancing minority access to suburban neighborhoods may improve outcomes (Popkin, Rosenbaum, McCurdy & Rusin, 1989; Rosenbaum & Popkin, 1990; Rosenbaum & Popkin, 1991; Rosenbaum, 1994; Rosenbaum, 1995). Although the Gautreaux study did not measure health outcomes, we may hypothesize that the improvement in social determinants of health such as education, employment and earnings could have led to an improvement in health outcomes. Also, improvements in health, for instance mental health, could have contributed to improvements in employment status.
[10] The BMI evaluates an individual's weight status in relation to height. BMI is generally used as the first indicator in assessing body fat and has been the most common method of tracking weight problems and obesity among adults. BMI is a mathematical formula in which a person's body weight in kilograms is divided by the square of his or her height in meters. The BMI is highly correlated with body fat. The

group (US Department of Housing and Urban Development, Office of Policy Development and Research, Orr, Feins, Jacob, Beecroft et al., 2003). In the MTO demonstration, lower obesity rates in adults may be partly due to healthier diets, as the MTO group showed increased consumption of fruits and vegetables (US Department of Housing and Urban Development, Office of Policy Development and Research et al., 2003).

MTO adults also showed significant improvements in mental health, including reductions in psychological distress and depression, and increasing feelings of calm and peacefulness. Improved mental health was also shown in the first MTO follow-up study in two of the five sites, New York (Leventhal & Brooks-Gunn, 2003; Leventhal & Brooks-Gunn, 2003) and Boston (Katz, Kling & Liebman, 2001), as well as in the Yonkers study of scattered-site public housing (Briggs & Yonkers Family and Community Project, 1997). The consistency of these results across different studies is encouraging.

Improvements in mental health are not surprising given that fear of crime was the main reason why MTO participants wanted to move out of their neighborhoods. Adults and children moving to low-poverty neighborhoods reported increases in their perception of safety and reductions in the likelihood of observing and being victims of crime (US Department of Housing and Urban Development, Office of Policy Development and Research et al., 2003). Considerable stress in the neighborhoods of origin may have also

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criterion for obesity is the same for men and women (National Center for Health Statistics & Centers for Disease Control and Prevention, 2004).

resulted from chronic exposure to poor-quality housing and schools, two additional reasons why participants looked forward to moving out of those neighborhoods (US Department of Housing and Urban Development, Office of Policy Development and Research et al., 2003). In addition to improvements in adult mental health, girls in the MTO group, and in some instances also girls in the Section 8 voucher group, reported improvements in their mental health, including reductions in psychological distress, depression and generalized anxiety disorder (US Department of Housing and Urban Development, Office of Policy Development and Research et al., 2003). Girls aged 15-19 in the MTO group also had better health behaviors than their counterparts in public housing, e.g., lower rates of smoking and marijuana use (US Department of Housing and Urban Development, Office of Policy Development and Research et al., 2003).

Non-experimental studies also indicate that residents of higher SES neighborhoods show a lower prevalence of mental health problems. The Yonkers Scattered-Site Public Housing evaluation team documented recent violent victimization, depression and anxiety symptoms, and substance use among mothers (Briggs & Yonkers Family and Community Project, 1997; Briggs, Darden & Aidala, 1999). The group that moved to neighborhoods with new scattered-site public housing reported lower prevalence of depression symptoms, problem drinking, marijuana use, and experience of violent or traumatic events compared with those who stayed in the segregated Yonkers public housing neighborhoods (Briggs & Yonkers Family and Community Project, 1997).

Ironically, although health improvements were not among the stated goals of MTO, they are currently among the most apparent gains realized by participating families. MTO has provided some of the most compelling and methodologically sound evidence to date that neighborhoods matter for health.[11] In the long run, the positive effects of housing mobility on health may lead to improvements in other areas over the life course. For instance, healthier children may do better in school, and healthier adults may be able to hold better and more stable jobs.

Although the reductions in obesity and mental health problems are promising, we should also note that at the latest follow-up, the MTO demonstration did not find significant improvements in other health outcomes such as asthma, blood pressure, and alcohol use, all of which could also be influenced by neighborhood conditions.[12] [13]

[11] While the Moving to Opportunity experimental design eliminates selection – one of the most serious threats to internal validity in observational neighborhood studies, some threats to validity remain, including the Hawthorne effect, compensatory rivalry and compensatory equalization (Orr, 1999). For a methodological discussion of validity threats with respect to MTO and other housing mobility research, please see (Acevedo-Garcia, Osypuk et al., 2004).

[12] For a complete review of the MTO health effects see (Acevedo-Garcia, Osypuk et al., 2004).

[13] Mixed-income housing is another type of housing intervention that may improve health outcomes.A 2003 review in the *American Journal of Preventive Medicine* examined research on the health effects of mixed-income housing (Anderson, Charles, Fullilove, Scrimshaw, Fielding, Normand et al., 2003). According to the authors' conceptual framework, mixed-income housing may have a beneficial effect on health because it would lead to an increase in social capital by reducing the isolation experienced in high-poverty neighborhoods; help to raise expectations of community norms; and increase the quality of public services, as well as access to private goods and safety. However, this research review found insufficient empirical evidence that mixed-income housing programs have improved health outcomes.

Increasingly there is consensus that, in addition to addressing affordability, housing rental assistance should improve access to better neighborhoods. This approach is consistent with tackling both household socioeconomic factors and neighborhood environment factors that influence health outcomes.

> id 1970s, the US has pursued housing vouchers, instead of public housing, as the primary means of providing housing assistance to low-income families, as it became clear that public housing had promoted racial residential segregation and poverty concentration There is evidence that the health of public housing residents, who are disproportionately racial/ethnic minorities[14], is considerably worse than the health of the average American. The HOPE VI Panel Study conducted by the Urban Institute examined the living conditions of residents of severely distressed public housing at five sites both at baseline and after housing redevelopment. At baseline, HOPE VI adults reported
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> "excellent" or "very good" physical health was much lower (38%) than the overall national average (68%) and than the minority national average (60%) in the 2001 National Health Interview Survey. Similarly, 29% reported poor mental health, compared to 20% in the 1999 National Survey of American Families. Furthermore, 39% reported having a chronic health condition such as high blood pressure, diabetes, or arthritis; and 22% reported having been diagnosed with asthma (versus 10% nationally).
>
> HOPE VI children faced substandard housing (e.g. lead paint, mold, inadequate heat, and pest infestations) and extremely dangerous neighborhood conditions (e.g. shootings and drug related crime) (Popkin, Levy et al., 2002). Accordingly, they had higher rates of health problems than those of low-income children in national surveys. HOPE VI parents reported substantially lower health ratings for their children than those reported for children in national samples. Twenty five percent of children aged 0-5 had been diagnosed with asthma, more than three times the national average (Popkin, Levy et al., 2002).

Research on HOPE VI by the Urban Institute has clearly documented that health problems

[14] According to the 1997 *Picture of Subsidized Housing* data (HUD), 58% of Section 8, 68% of public housing, 37% of new and rehabilitated Section 8, and 53 % of Section 236 households belonged to racial/ethnic minority groups.

are highly prevalent in the public housing population. Housing assistance policy cannot ignore this reality. Some housing revitalization and mobility programs may improve health outcomes but to learn whether they do, changes in health status should be a standard benchmark in the evaluation of housing assistance programs.

Because of the ills associated with public housing, rental assistance is increasingly given primarily through housing subsidies, i.e. Section 8 vouchers. In theory, vouchers allow households to find housing in any neighborhood of their metropolitan area where affordable units exist, instead of having to reside in deprived, racially segregated neighborhoods where many public housing projects are located. Data from the Department of Housing and Urban Development show that, indeed, while on average public housing residents live in neighborhoods that are 59% minority, households receiving Section 8 vouchers live in neighborhoods that are 39% minority (US Department of Housing and Urban Development, 1997). Similarly, individuals receiving section 8 vouchers are less likely to live in high poverty neighborhoods than individuals in public housing. In the late 1990s, 14.8% of voucher recipients lived in high-poverty neighborhoods (poverty rate>30%), compared with 53.6% of public housing residents (Turner, 1998).

The evidence that, in addition to addressing housing affordability, Section 8 may contribute to improving access to low-poverty neighborhoods, suggests that it may result in better

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The respective average proportion minority at the neighborhood level for these four types of assisted

health outcomes through these two pathways. However, although a few studies have assessed the health effects of the affordability component of Section 8 (Child Health Impact Working Group, Smith et al., 2005), there has not been a study of the health effects of its locational component, apart from the inclusion of a Section 8 group in the Moving to Opportunity study.

HOUSING POLICYYNG POLICY EXPERTS RECOGNIZE THAT ALTHOUGH, IN PRINCIPLE, HOUSING VOUCHERS OFFER MORE NEIGHBORHOOD CHOICES, IMPROVED NEIGHBORHOOD OUTCOMES ARE CONSTRAINED, ESPECIALLY FOR SOME GROUPS, E.G. RACIAL/ETHNIC MINORITIES AND CENTRAL CITY RESIDENTS (TURNER, 1998).[15] BLACK (25%) AND HISPANIC (28%) FAMILIES ON SECTION 8 ARE MORE LIKELY THAN WHITE (8%) FAMILIES TO LIVE IN NEIGHBORHOODS WHERE POVERTY IS CONCENTRATED (POVERTY RATE ≥ 30%). (DEVINE, GRAY, RUBIN & TAGHAVI, 2003) [16]

BECAUSE OF THE RACIAL DISPARITIES IN NEIGHBORHOOD OUTCOMES WITHIN THE SECTION 8 VOUCHER PROGRAM, HOUSING POLICY EXPERTS HAVE RECOMMENDED COUPLING SECTION 8 WITH FAIR HOUSING EFFORTS, AS WELL AS DEVELOPING HOUSING MOBILITY INITIATIVES (TURNER, 1998). SINCE THE MID-1990S, THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT HAS

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housing was 39%, 59%, 34%, and 40% (US Department of Housing and Urban Development, 1997).

[15] Section 8 has been successful in facilitating moves to low-poverty neighborhoods in some areas, e.g. Alameda County, California, but success has been limited in other areas, e.g. Chicago (Varady & Walker, 2003).

[16] ENCOURAGINGLY THOUGH MORE THAN 20% OF BOTH BLACK AND HISPANIC FAMILIES LIVE IN NEIGHBORHOODS WHERE THE POVERTY RATE IS LESS THAN 10%, AND MORE THAN 50% OF BOTH GROUPS LIVE IN NEIGHBORHOODS WHERE THE POVERTY RATE IS BELOW 20%.

INTRODUCED MOBILITY POLICIES AND PROGRAMS TO ENCOURAGE VOUCHER HOLDERS TO MOVE FROM HIGH-POVERTY TO LOW-POVERTY NEIGHBORHOODS BY PROVIDING HOUSING SEARCH ASSISTANCE AND CONNECTING VOUCHER HOLDERS WITH LANDLORDS IN LOW-POVERTY NEIGHBORHOODS (CUNNINGHAM & SAWYER, 2005).

As discussed earlier, the Moving to Opportunity demonstration evaluated both the regular Section program and a mobility enhanced version of Section 8 (i.e. MTO) for their impact on health—compared to housing assistance through public housing projects. To date the results of the MTO demonstration suggest that a mobility-enhanced Section 8 programs may improve the health (and quality of life) of low-income families by helping them move out of high-poverty neighborhoods. In this policy demonstration, the two treatment groups (Section 8 and MTO) and the control group (public housing) were all receiving housing assistance. Since housing affordability was addressed for all three groups, the differences in health outcomes across groups may be attributed to location (i.e. differences in neighborhood environment). Thus, MTO does not provide estimates of the health benefits associated with addressing housing affordability, i.e. MTO provides a conservative estimate of the overall health effects of housing assistance, which comprise both affordability and neighborhood effects.

Enhancing mobility programs to improve health

There is considerable room to improve housing mobility. Therefore, it is encouraging that

even a limited mobility program such as MTO has had some positive effects on health. Housing policy experts have suggested that housing mobility can be strengthened if supplemented with efforts to help the distressed neighborhoods of origin, as well as with assistance for families during and after relocation (Katz, 2004; Popkin, Katz et al., 2004). Enhanced housing mobility programs should address concerns about leaving the neighborhood of origin, which may include not having access to a known health care provider, leaving a familiar public school (system), and losing a supportive social network. Severing links with the neighborhood of origin should be followed up by information, counseling and support to help residents adapt to their new neighborhood. These services should be comprehensive, i.e. addressing the housing search process, though important, is not sufficient. Additionally, services should be offered for several months or years after the move until residents feel comfortable in their new neighborhood.

Given the high prevalence of health problems among public housing residents, mobility programs should take into account disease management issues. For example, if relocation results in severing ties with neighborhood health care providers, it may worsen health outcomes. Additionally, evidence from the Gautreaux mobility program indicated that those moving to the suburbs may be less satisfied with medical care, possibly because in those neighborhoods there are fewer health care providers serving low-income families, or former residents of public housing may be less familiar with them. In MTO, among those eligible to move, some did not want to because they were afraid of losing access to health care in their

neighborhood. Also, families with a disabled member were less successful in moving to low-poverty neighborhoods. This suggests that although more prosperous neighborhoods may offer some better opportunities to maintain good health, residents' attachment to health care providers in disadvantaged neighborhoods may be a barrier to moving. Therefore, comprehensive mobility initiatives should assist individuals in finding alternative sources of health care in their new neighborhoods, and insuring continuity of treatment (Acevedo-Garcia, Osypuk et al., 2004).

Although housing mobility policies were not intended to affect health, it appears that they may have. Indeed, Leventhal and Brooks Gunn claim "the most significant benefits of the MTO program were non-economic" (Leventhal & Brooks-Gunn 2003b). From a public health perspective, the most important implication of the evidence on housing mobility is that housing policy has the potential of improving the health of individuals. Section 8, housing mobility and other housing assistance policies should continue to be evaluated for their impact on health. If the long-term benefits are positive as suggested thus far by the housing mobility research, such policies may promise to improve individual health and quality of life, as well as population health. Since housing mobility policies target (very) low-income families, by improving the health of these disadvantaged groups, these policies may also have the potential of reducing health disparities.

Evaluation of the health effects of the Section 8 Voucher program

Given that they target (very) low-income families, housing vouchers and housing mobility

initiatives should continue to be evaluated for their impact on the health of disadvantaged groups and their contribution to reducing health disparities. Housing vouchers are increasingly becoming the dominant strategy for providing housing assistance with potential for reaching approximately 6 million households--the estimated worst-case housing needs population (U.S. Department of Housing and Urban Development & Office of PolicyDevelopment and Research 2000). As a policy demonstration, MTO has been very limited in scope (about 1,800 experimental families) and its political viability as a large-scale program is unclear. Therefore, it will be important to evaluate further the health impact of Section 8 and some of its politically viable variations such as regional (as opposed to local) administration of the program, which has been proposed as a way to enhance its housing mobility potential (Turner 1998, Katz and Turner 2001).

Conceptual frameworks

Housing policy research constitutes a unique opportunity to explore various neighborhood effects on health through experimental designs. Conceptual frameworks should outline plausible mechanisms through which neighborhood conditions may affect specific health outcomes. The development of such conceptual frameworks will require multidisciplinary research teams that include housing policy and public health experts (Srinivasan et al. 2003).

Public health research can help inform the selection of health outcomes that are more

sensitive to certain neighborhood conditions at certain times in the life course. For instance, Macintyre discusses that fear of crime/violence may influence women and elders more than men or younger people, affecting mental but not physical health. Conversely, children may be more sensitive than adults to material conditions like damp, affecting respiratory disease (Macintyre & Ellaway 2003). In the latest MTO report (US Department of Housing and Urban Development et al. 2003), the investigators found it difficult to interpret the lower obesity rates among experimental adults. However, public health research suggests that disadvantaged neighborhoods are associated with reduced access to healthy foods via decreased availability of grocery stores (Morland, Wing, Diez-Roux, & Poole 2002), and with unsafe or "low-walkability" neighborhoods, which may not be conducive to physical activity (Saelens, Sallis, Black, & Chen 2003). In turn, those factors may be linked to higher obesity rates. Alternatively, the MTO interim finding that experimental families eat more meals together as a family may explain part of the obesity effect, e.g. parents may be preparing healthier meals more frequently.

Multilevel data and analytic methods. Future research on housing mobility should include a larger sample of individuals, neighborhoods of origin, receiving neighborhoods, and metropolitan areas, as well as more comprehensive data on housing unit characteristics. Many of the research questions that future studies should address are multilevel in nature and thus will require the application of multilevel analytic methods (Subramanian et al. 2003). For instance, given that improvements in neighborhood quality that result from

mobility policies are conceivably accompanied by improvements in the quality of housing units, it is important to determine whether mobility policies result in improved health outcomes due to housing unit effects, neighborhood effects or both. Similarly, improvements in housing and neighborhood quality may have differential effects on individuals with various demographic and socioeconomic characteristics. The health effects of improving neighborhood environment may be greater for individuals/households with fewer coping resources such as low-SES or single-headed households.

Multilevel methods may also allow us to assess whether there is significant variation in health outcomes across (experimental) neighborhoods, and if so, which factors may explain such variation. For instance, health effects may be greater if the receiving neighborhoods are low-poverty neighborhoods (i.e. poverty rate<10%) as opposed to simply less disadvantaged than the neighborhoods of origin.

Furthermore, to the extent that housing mobility demonstrations are conducted in a large cross-section of metropolitan areas, multilevel methods may allow us to determine if after controlling for neighborhood and/or household characteristics, health outcomes are affected by metropolitan area characteristics, e.g. whether health effects are greater if mobility policies are implemented in metropolitan areas characterized by higher levels of racial or economic segregation, since these movers may have more to gain than similar individuals in areas with lower levels of segregation.

Better health, housing and neighborhood data. Future studies should also include better measurement of health outcomes including baseline and follow-up measurements and triangulation of methods (i.e. biological measures, self-reported health measures, and validated scales, e.g. depression). It would also be important to link participant data to health insurance claims data or medical records, given proper ethical/confidentiality protections, especially for diagnostic-specific information. Such data linking may be feasible for policies such as MTO if substantial proportions of participants were enrolled in Medicaid or state children's health insurance programs. Linking to administrative health data seems feasible, given that the MTO follow-up study plans to link to other administrative data systems, i.e. welfare, arrest records, and schools (US Department of Housing and Urban Development et al. 2003). In addition to being uniform across all the study sites (the original survey instruments were not), the 2001-2002 follow-up MTO household survey prepared by Abt Associates partially addressed some of the above issues, e.g. it included a detailed section on injuries, one on asthma symptoms, body mass index, and blood pressure measurement. Yet additional measures may include other health outcomes that may be associated with neighborhood conditions, e.g. intimate partner violence and infectious diseases such as tuberculosis, HIV, and sexually-transmitted diseases (Acevedo-Garcia 2000; Fullilove 2003; Kawachi & Berkman 2003a; O'Campo et al. 1995).

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Healthy Homes Expert Panel Meeting: December 11-12, 2007
Panel 5 – Intersection between House and Community
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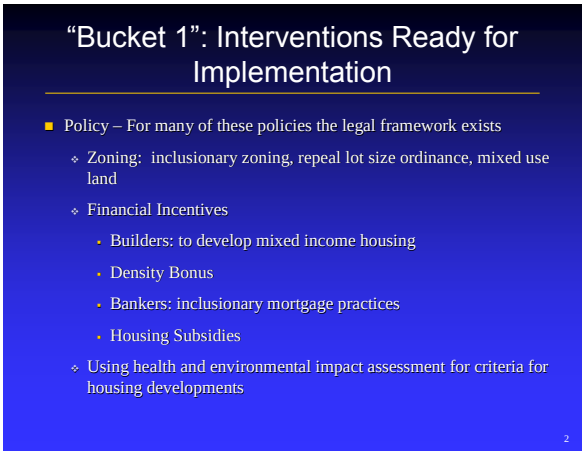
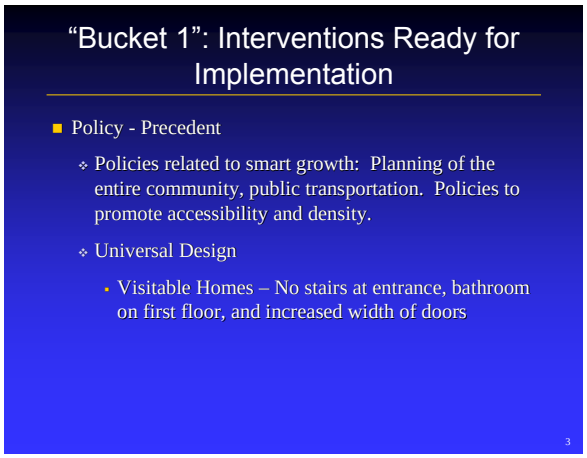
CDC


Our Topics
Policy
Urban Design: Connectivity, Density, Mixed Use, Green Space
Housing Design: Noise, Safety
Community: Safety, Poverty, Residential Segregation
1


"Bucket 1": Interventions Ready for Implementation
Policy – For many of these policies the legal framework exists
Zoning: inclusionary zoning, repeal lot size ordinance, mixed use land
Financial Incentives
Builders: to develop mixed income housing
Density Bonus
Bankers: inclusionary mortgage practices
Housing Subsidies
Using health and environmental impact assessment for criteria for housing developments
2


"Bucket 1": Interventions Ready for Implementation
Policy - Precedent
Policies related to smart growth: Planning of the entire community, public transportation. Policies to promote accessibility and density.
Universal Design
Visitable Homes – No stairs at entrance, bathroom on first floor, and increased width of doors
3

"Bucket 2": Promising Interventions Needing More Field Testing

- Safety
  - Hope VI – Hybrid
    - Person focused
    - Placed focused
  - Supervised Playground – Place focused
  - Crime Prevention through Environmental Design
- Noise
  - Window Replacement

4

"Bucket 2": Promising Interventions Needing More Field Testing

- Connectivity
  - Smart growth areas: urban planning strategies to develop mixed use of land, mixed demographics, balanced with transportation
    - Design of houses, Accessible grid of streets
- Poverty/Residential Segregation
  - Move people from high poverty neighborhoods to lower poverty neighborhoods – Person based
  - Improve conditions of the poor neighborhoods – Place based

5

"Bucket 3": Interventions in Need of Formative Research

- Residential Segregation
  - Fair housing policies
  - GIS technologies are useful tools to provide visual evidence of structural inequalities
- Green space
  - Provide green space around the housing – Place Based

6

FUTURE CONFERENCE ON SEPTEMBER 18, 2008
PROJECT ABSTRACT
EVIDENCE-BASED PRACTICE: IMPLEMENTING HEALTHY HOMES INTERVENTION

The proposed conference will translate the results of a recent evaluation of the scientific evidence supporting specific interventions in housing that have been demonstrated to improve health and safety. The evaluation was conducted by a panel of more than 30 international and national public health and housing scientists at a December 2007 meeting co-sponsored by the CDC's National Center for Environmental Health/Agency for Toxic Substances and Disease Registry and the National Center for Healthy Housing (NCHH). The proposed conference will enable the translation of the findings into practice by public health and housing programs and others at national, state and local levels.

There is now robust and emerging evidence that housing and community-based interventions and improvements can prevent or reduce the effect of serious health and safety consequences. As examples, housing and community interventions have been shown to effectively reduce asthma severity, injuries, chemical exposure, obesity, and water-borne disease. Evidence from the expert panel meeting found that integrated pest management, radon mitigation, multi-faceted asthma trigger interventions and housing assistance programs result in improved health outcomes. However, few of these interventions are implemented at the national scale. An exception is the national effort to address the childhood lead poisoning problem. The success of this is directly related to the integration of residential lead hazard control with health and housing programs.

This conference will result in the development of policy recommendations on the implementation of housing interventions, which once implemented will produce dramatic improvements in health and safety. The multi-disciplinary conference will include participants from the following stakeholders: public health, affordable housing, urban planning, energy assistance, advocacy, housing finance, and health care. This conference supports CDC's Healthy Homes and Healthy Communities Goals initiatives and the U.S. Surgeon General's commitment to healthy housing. The conference addresses CDC's topical area titled: "NCEH-500.1.6 "Build Environment /Healthy Community Design."

The conference will be held in Baltimore, MD, on September 18, 2008 at the Maryland Department of the Environment, which meets the requirements of the Americans with Disabilities Act. In addition to a panel of 30 national experts, the meeting will be open to 100 attendees. The panel will represent nationally prominent authorities in the fields of environmental public health; construction, maintenance, and rehabilitation; urban planning; code enforcement; housing policy and green building design; and community organizing. NCHH will develop the agenda for the meeting collaboratively with CDC staff. The conference will be organized to enable participants to grasp the scientific evidence, determine how to best apply the evidence in their domains, and develop practical recommendations for implementation. The product of the conference will be an Evidence-Based Action Agenda for Healthy Housing. At the close of the meeting, participants will be asked to define the resources and commitments they can provide following the conference.

INTERVENTION RESEARCH BIBLIOGRAPHY

PANEL 1 - INTERIOR BIOLOGICAL AGENTS

A. Moisture control

Mold

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B. Control/elimination of allergens

Asthma

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SECTION 3, COMPONENT 3: CONTROL OF ENVIRONMENTAL FACTORS
AND COMORBID CONDITIONS THAT AFFECT ASTHMA
http://www.nhlbi.nih.gov/guidelines/asthma/06_sec3_comp3.pdf
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E. Particulate matter (e.g., install and maintain filtration and ventilation systems

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G. Particulate intrusion (e.g., sealing and filtration of buildings)

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Oie, L., Nafstad, P., Botten, G., Magnus, P., Jaakkola, J. K., Oie, L., et al. (1999). Ventilation in homes and bronchial obstruction in young children. *Epidemiology, 10*(3), 294-299.

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PANEL 3 - EXTERNAL EXPOSURES

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Colford, J.M. Randomized, Controlled Trial of In-**Home** Drinking **Water Intervention** to Reduce Gastrointestinal Illness. http://aje.oxfordjournals.org/cgi/content/full/161/5/472

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B. On-site waste water treatment strategies

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PANEL4 - STRUCTURAL DEFICIENCIES

A. Burn prevention (e.g., shield hot surfaces, reduce hot water temperature, etc.)

Community-based education to reduce burns and scalds

Macarthur, C., & Macarthur, C. (2003). Evaluation of Safe Kids Week 2001: prevention of scald and burn injuries in young children. Injury Prevention, 9(2), 112-116.

Turner C. Spinks A. McClure R. Nixon J. Community-based interventions for the prevention of burns and scalds in children. Cochrane Database of Systematic Reviews. (3):CD004335, 2004.
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Home safety education and provision of safety equipment to reduce burns and scalds

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B. Fall prevention (e.g., repair of floor and stair surfaces, install/repair railings, ladder safety, install non-slip rugs, etc.)

Injury – falls

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C. Fire prevention (e.g., use and maintenance of smoke, heat and carbon monoxide detectors/alarms, use of fire resistant materials)

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Interventions to promote smoke alarms and fire guard
DiGuiseppi, C., Roberts, I., Wade, A., Sculpher, M., Edwards, P., Godward, C., et al. (2002). Incidence of fires and related injuries after giving out free smoke alarms: cluster randomised controlled trial.[see comment]. BMJ, 325(7371), 995.

DiGuiseppi C, Goss C, Higgins JP. Interventions for promoting smoke alarm ownership and function. Cochrane Database of Systematic Reviews. [in press]

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Home based education to promote CO detectors.
Posner J, Hawkins L, Garcia-Espana F, Durbin D. A randomized clinical trial of a home safety intervention based in an emergency department setting. Pediatrics 2004;113:1603.

Review Article
Public/Private Fire Safety Council. Home Smoke Alarms and Other Fire Detection and Alarm Equipment http://www.firesafety.gov/downloads/pdf/white-paper-alarms.pdf

D. Injury prevention in hazardous areas (e.g., drowning prevention education, retrofit bathtubs and showers to prevent falls, etc.)

Injury – General home injury
Modification of the home environment to prevent injuries
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Injury - Elderly
Modification of the home environment to reduce injuries

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Injury - Swimming pools

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Interventions to influence use of pool fences and drowning rates

Morgenstern, H., Bingham, T., Reza, A., Morgenstern, H., Bingham, T., & Reza, A. (2000). Effects of pool-fencing ordinances and other factors on childhood drowning in Los Angeles County, 1990-1995.[see comment]. American Journal of Public Health, 90(4), 595-601.

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Comparative efficacy of 3- vs. 4-sided pool fencing

Stevenson MR, Rimajova M, Edgecome D, Vickery K. Childhood drowning: barriers surrounding private swimming pools. Pediatrics 2003;111:115-9.

E. Temperature control (e.g., prevention of exposure to excessive heat and cold)

Naughton, M. P., Henderson, A., Mirabelli, M. C., Kaiser, R., Wilhelm, J. L., Kieszak, S. M., et al. (2002). Heat-related mortality during a 1999 heat wave in Chicago.[see comment]. American Journal of Preventive Medicine, 22(4), 221-227.

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PANEL5 - INTERSECTION BETWEEN HOUSE AND COMMUNITY

A. Housing location and equity (e.g., environmental justice, avoid wetlands and industrial sites, evaluate brownfields)

Interventions for low-income/minority populations that reflect on Environmental Injustice:

Clougherty, J. E., Levy, J. I., Hynes, H. P., Spengler, J. D., Clougherty, J. E., Levy, J. I., et al. (2006). A longitudinal analysis of the efficacy of environmental interventions on asthma-related quality of life and symptoms among children in urban public housing. Journal of Asthma, 43(5), 335-343.

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Poor Housing that reflect health disparities specifically for low-income populations

Environmental Justice Building

Agyeman, J., & Evans, T. (2003). Toward Just Sustainability in Urban Communities: Building Equity Rights with Sustainable Solutions. The Annals of the American Academy of Political and Social Science, 590, 35-53.

Maantay, J. (2002). Zoning law, health, and environmental justice: what's the connection? Journal of Law, Medicine & Ethics, 30(4), 572-593. http://www.blackwell-synergy.com/doi/abs/10.1111/j.1748-720X.2002.tb00427.x

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Policy

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Bhatia, R., & Bhatia, R. (2007). Protecting health using an environmental impact assessment: a case study of San Francisco land use decisionmaking. American Journal of Public Health, 97(3), 406-413. http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=17267726

Built Environment

Cummins, S. K., Jackson, R. J., Cummins, S. K., & Jackson, R. J. The built environment and children's health. Pediatric Clinics of North America, 48(5), 1241-1252.

Guite, H. F., Clark, C., Ackrill, G., Guite, H. F., Clark, C., & Ackrill, G. (2006). The impact of the physical and urban environment on mental well-being. Public Health, 120(12), 1117-1126.

Newcombe, R. G., Lyons, R. A., Jones, S. J., Patterson, J., Newcombe, R. G., Lyons, R. A., et al. (2005). Home injuries and built form--methodological issues and developments in database linkage. BMC Health Services Research, 5(1), 12.

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B. Green space (e.g., eliminate conditions that have potential mental health impacts)

Farley, T. A., Meriwether, R. A., Baker, E. T., Watkins, L. T., Johnson, C. C., Webber, L. S., et al. (2007). Safe play spaces to promote physical activity in inner-city children: results from a pilot study of an environmental intervention. American Journal of Public Health, 97(9), 1625-1631.

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C. Impact of local ordinances on housing quality

Breysse, J., Anderson, J., Dixon, S., Galke, W., Wilson, J., Breysse, J., et al. (2007). Immediate and one-year post-intervention effectiveness of Maryland's lead law treatments. *Environmental Research, 105*(2), 267-275.

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