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Boundary networks and Rochester’s “smart” lead law: The use of multidisciplinary information in a collaborative policy process

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Abstract

The Rochester, New York Coalition to Prevent Lead Poisoning formed in 2001 with the goal of eliminating childhood lead poisoning by 2010. The Coalition recruited diverse community stakeholders into a collaborative process. The Coalition was committed to using the best available science. The Coalition successfully infused the debate about a new lead poisoning law with local data, national analyses, and the latest medical research. We argue that this was facilitated by a “boundary network” of individuals that provided technical input throughout the process. As a result of the Coalition’s advocacy, in 2005 the Rochester City Council unanimously passed an ordinance that has been hailed as one of the nation’s “smartest” lead laws. Many communities are looking to Rochester’s new lead ordinance as a model. Both the process and outcome of this case provide valuable lessons for collaborative efforts to promote scientifically sound local environmental health policy.

Keywords

environmental health policy; collaborative environmental management; childhood lead poisoning; environmental justice; boundary networks

Introduction

Both policy makers and scientists frequently urge improved use of scientific information in decision-making.[1] However, factors such as uncertainty, insufficient resources, short time frames, and conflicting information complicate the use of scientific expertise in real-world decision making.[2,3] The use of science is particularly complex in policy processes in collaborative decision making processes.[4] Multiple approaches have been developed to support the use of science in collaborative management, including science advisory boards, adaptive management, “science shops,” co-production of science, and community-based participatory research.[1,5–12] At the local level, however, resources are seldom available to support such systematic approaches. Lack of access to technical resources is often a challenge, particularly for local community groups.[4,5,10,13,14] This is particularly common in issues of local environmental health and justice where there are complex scientific questions and limited technical resources.

Coburn[6] (p. 158) suggested that communities may in some cases compensate for their lack of technical resources by “employing intermediaries or boundary spanners.” Boundary *organizations* are groups whose primary purpose is to negotiate the relationship between science and politics, and between producers and consumers of information.[15,16] However, there may be boundary spanning *individuals* within other kinds of organizations.[1,6] This paper analyzes how community groups concerned about childhood lead poisoning in Rochester, New York were able to create a network of boundary spanning individuals despite limited financial resources. Lead poisoning has long been recognized as a threat to

children, particularly those living in deteriorated pre-1978 housing.[17] Because of lasting effects on children's brains, bones, and bodies, lead poisoning has long been recognized as the most significant environmental health threat to children in the United States. Although medical researchers were aware of the dangers of lead since the turn of the 19th century, policy responses to this knowledge were stymied by economic concerns, first by the industries (paint and gasoline) and later by owners of housing likely to contain lead paint. [18]

Several waves of public concern about this issue in the United States resulted in policy changes at the federal level, most notably removing lead from gasoline and paint in the 1970's. These steps led to the steep decrease in population-wide lead levels, which has been hailed as a major public health success.[19] Many states adopted laws related to screening children for elevated blood leads, but few (notably Massachusetts and Maryland) have adopted requirements to prevent lead exposure in housing.[20–22] A small number of cities, notably New York City, have longstanding housing-based lead laws. [23] Despite the rarity of local lead policies, many communities have initiated education and outreach activities, with varying degrees of success and sustainability.[24,25] Recently, an increasing number of municipalities that continue to be plagued with continued pockets of relatively high lead poisoning rates have pursued local policies to protect children in their high risk communities.

In December 2005, Rochester became the first city in upstate New York to adopt a local lead in housing law.[26] The passage of this law resulted from the efforts of the community-based Coalition to Prevent Lead Poisoning ("the Coalition"). Despite the Coalition's limited resources, it developed a boundary network of experts that played a key role in informing, designing, and successfully promoting a lead poisoning prevention policy appropriate to the Rochester community.

This paper draws from the author's experiences as a participant-observer in the Coalition since 2001, interviews with key participants in the process leading to the Rochester lead law, and review of related documents including meeting minutes, fact sheets, news articles and reports by the Coalition, government agencies, and consultants. Taken together, these sources reveal how the diverse boundary network of experts influenced the local lead policy process. We analyze how different technical resources were critical at different stages of the policy process - framing the issue of childhood lead poisoning, selecting the most promising policy approaches, and advocating for adoption of these strategies. We then discuss how the successful use of science by the Coalition provides guidance for other groups seeking to development effective boundary networks in environmental health policy processes.

The Rochester Coalition to Prevent Lead Poisoning

The Coalition to Prevent Lead Poisoning ("the Coalition") was formed in 2000 in response to concerns about persistently high childhood lead poisoning rates – in some cases over tenfold higher than the national average - in the poorest neighborhoods of Rochester, New York[27]. Although the county health department and health care providers had been implementing the state's policies for screening and managing children with elevated blood lead levels, there had not been widespread community concern about lead prior to 2000. The Coalition had a small staff which coordinated working committees (Housing, Membership, Outreach, Government Relations, Science, Finance, Leadership Development, and Screening/Professional Education) whose members participated either as volunteers or as part of their professional appointments.[27] The Coalition raised the community's awareness of the lead issue through public events, press releases, and meetings with community groups from low-income neighborhoods. The Coalition's committees engaged community leaders,

educators, health care providers, public interest lawyers, parents, researchers, religious leaders, and many others to pass a housing-based lead law in 2005.[28] These combined efforts contributed to a decline in the number of children with elevated blood lead levels from 1,293 children in 2000 to 363 children in 2008.[29] In 2009, the Rochester Coalition was awarded a USEPA Environmental Justice Achievement Award for its collaborative organizing, education, and policy work on lead.[30]

Research has shown that the effectiveness of collaborative management processes depends on how groups frame the relevant policy problems, what resources (human, technical, and financial) they control, and their group decision making processes.[4,14] From the outset, the Coalition recognized the importance of scientific expertise as it developed its strategy to end childhood lead poisoning. However, the Coalition directly controlled very limited technical resources. Between 2000 and 2005, the organization's budget grew from around \$10,000 to \$200,000 per year, much of which was dedicated to a public communication campaign. The Coalition never had more than two full time staff members, none of whom had technical training related to lead. Despite its lack of internal technical resources, the Coalition cultivated diverse experts, both locally and nationally, to help analyze data, summarize the best available scientific knowledge, and provide input throughout the policy process.[27,31] In addition to maintaining a standing Science Committee to review its proposals, the Coalition facilitated experts' involvement through writing fact sheets, providing interviews to local media, analyzing public health and housing data, and meeting with community leaders.

These experts formed a boundary network which evolved as the Coalition framed the issue of lead poisoning, designed policy strategies, and advocated for these policies. At each stage, the Coalition's technical resources enhanced its role in the policy process. The following sections analyze the contributions of the Coalition's boundary network throughout the policy process.

Framing the Issue: "Lead is a disease kids catch from their houses"

Childhood lead poisoning has long been recognized as one of the most important children's environmental health problems in the United States.[32] Although medical literature from the mid-1800's documented lead's threat to children, lead was not removed from gasoline household paint in the U.S. until the 1970's.[18,33] Exposure pathway studies revealed that children with elevated blood lead levels are most commonly exposed to lead from deteriorated lead-based paint, contaminated house dust and soil.[34–37] While blood lead levels have declined population-wide in the last three decades, childhood lead poisoning rates remain high in some areas, particularly in low income urban neighborhoods with older housing.[19,38] Therefore, while population-wide reductions in blood lead levels are widely hailed as a public health success, childhood lead poisoning remains a problem of environmental justice.

Rochester is typical of communities plagued by childhood lead poisoning in the 21st century. It has a large stock of "high risk" housing: 87% of Rochester's housing was built prior to 1950.[39] Due to the economic decline of the city, many of these houses are now rental units in poor condition. As a result, the prevalence of lead poisoning in the highest risk neighborhoods in the City of Rochester was 24% in 2000, compared with a statewide rate of 5.8% and a national rate of 1.6%.[39]

While high lead-risk housing is common in upstate New York cities, Rochester had several unique technical resources that helped it to move forward toward addressing the problem. The University of Rochester has conducted research on lead poisoning for many decades; this provided a base of local experts. For example, in the 1990's, the Rochester Lead in Dust

study contributed two key findings to the understanding of this problem. First, the study found that children's blood lead levels were directly correlated with the levels of lead in the dust on the floors of their homes.[40] Second, the study found negative health, learning, and behavioral effects in children with blood lead elevations below the CDC's "level of concern" of 10 µg/dL.[41,42]

This locally-conducted research caught the attention of the principal of Rochester City Elementary School 17, who partnered with the county health department to conduct a survey of his incoming students and found that 41% of them had recorded elevated blood lead levels.[27] In 2001, the principal convened a community-wide meeting at School 17 to discuss these findings and what could be done to address the problem. Presentations by researchers and doctors emphasized that lead poisoning generally cannot be treated by physicians. These statements by the medical community focused attention on housing-based prevention approaches. The School 17 meeting captured the attention of other educators, community leaders, government officials, health care providers, housing agencies, and child advocates, who then formed the Coalition as a vehicle for action.

The Coalition was committed to making sure that all of its positions were informed by the best available science. Researchers and health care providers on the Coalition's working committees helped all the members understand lead poisoning as an issue of prevention. Based on this understanding, the organization focused on shifting policy from secondary prevention (testing children, then treating their houses) to primary prevention (treating houses before children are poisoned). Thus, a combination of medical research and local health and housing data inspired the Coalition's framing of the lead poisoning issue. This information formed the basis for the Coalition's policy message: "lead is a health problem with a housing solution."

Selecting Strategies

The most significant barrier to lead poisoning policy in Rochester, as in many cities, was the perception that it was too expensive.[39,43,44] Given the weak housing market in Rochester, low profit margins for housing providers, and a cash-strapped city government, economic constraints were a critical factor in policy design. The Coalition tapped into two kinds of information to design cost-effective policy strategies: geographic analyses targeting the highest-risk housing and economic analyses of different approaches to lead hazard control.

The strategy of targeting high risk housing was informed by national housing research showing that in many cities, lead hazards are concentrated in clearly identifiable neighborhoods.[38,45–47] In 2002, the county health director commissioned a "Needs Assessment" for childhood lead poisoning prevention. The resulting report combined insights from lead poisoning prevention efforts nationwide with local data.[39] The report included maps showing high concentrations of lead poisoned children in the city's most economically distressed neighborhoods. These maps helped the Coalition focus its advocacy efforts on strategies that would efficiently target lead hazard control efforts at the highest-risk housing.

In addition to the geographic targeting, the Coalition referred to national data showing that rental housing posed a higher lead risk than owner-occupied housing.[48,49] This observation, in addition to the practical challenges of regulating owner-occupied housing, encouraged the Coalition to focus on rentals. Because rental housing was subject to the City of Rochester's existing inspection process (the Certificate of Occupancy, or "C of O" required prior to renting a unit), the Coalition chose to focus on amending the local housing code. Meanwhile, health department staff had noted anecdotally that the vast majority of

children with elevated blood lead levels received public assistance. This information guided a second policy campaign to include lead safety in the County's existing system of housing inspections for families on public assistance.

Because of the widespread concerns about costs, the Coalition's second criterion for a policy strategy was that it should enable low-cost methods for controlling lead hazards. The "Needs Assessment" report's estimate of the total cost to make the city lead-safe (between \$605 million and 5.6 billion, based on per-unit costs of \$7,556 to \$70,000, respectively) reinforced fears that lead safety would be cost-prohibitive.[39] The higher cost estimates reflected full lead abatement, which involves removing all lead hazards according to standards set by the U.S. Environmental Protection Agency (40 CFR 745.227). However, recent research on housing interventions showed that lower-cost strategies, called "interim controls," could effectively control lead hazards if combined with proper maintenance and monitoring.[50] Experts on the Coalition's housing committee cited this research in support of strategies to promote interim controls.

The Coalition combined national research on the effectiveness of interim controls with local data to develop a cost effective proposal. In 2002, the Monroe County Department of Public Health received a Lead Hazard Control grant from the U.S. Department of Housing and Urban Development (HUD) that supported interim controls in privately owned housing. Health Department staff reported that the average cost to make a unit lead safe under this program was \$3,253 per unit for interim controls (\$5,598 for interim controls with window replacement). Between 2003 and 2004, the community-based Get the Lead Out (GLO) project hired a risk assessor to estimate the per unit cost of addressing lead hazards in approximately 70 homes in one of the highest-risk neighborhoods in the city. The GLO data estimated per unit costs of \$3,366, or around half of the lowest cost estimate reported in the "Needs Assessment" report. Thus, national data on efficacy and local data on costs supported the Coalition's arguments for interim controls as a cost-effective strategy.

Based on this information, the Coalition's policy approaches targeted the highest risk housing in Rochester and promoted interim controls. This strategy vastly reduced the anticipated costs of making the city's highest risk housing lead safe. Selecting this approach was critical to addressing the largest barrier to policy change, the projected costs of lead hazard control.

Promoting the policy solution

Once the Coalition had focused its attention on a low-cost, targeted local housing policy approach, it marshaled its boundary network to help develop arguments in support of this policy solution. Six key points to the Coalition's policy argument were supported by a combination of technical experts, local data, and national studies:

1) Lead poisoning presents enormous avoidable costs to the entire community

Coalition members learned from health care providers about lead poisoning's medical costs, its negative impacts on intelligence, increased needs for special education services, and association with juvenile delinquency. The Coalition leadership realized that an estimate of these costs of lead poisoning on local government budgets could be effective in rallying support for policy change. Therefore, the Coalition asked its Government Relations committee to search the literature for cost estimates for lead poisoning. Most of the existing estimates of the costs of lead poisoning extrapolated from projections of lead's impact on IQ to reduced future earning potential.[51,52]

While these costs were enormous, the Coalition realized that local leaders were unlikely to be persuaded by predictions of lost future earning potential, since this did not affect their annual budgets. Instead, the Coalition's cost analysis focused on the immediate costs of lead-related medical treatment, special education, and the juvenile justice system. The analysis projected the annual costs of lead in Monroe County to be nearly \$500,000 for medical treatment and \$1,000,000 for special education with additional unquantified juvenile justice costs. The Coalition used this calculation to show that avoided costs of ending lead poisoning would be enough to make over 400 units lead safe each year.

This analysis helped the Coalition convince policy makers that lead poisoning was a significant problem for the entire community. In addition, the cost calculations were extrapolated to the state of New York and used to promote statewide legislation. This methodology was shared at national conferences, posted on the Alliance for Healthy Homes' website, and used by lead advocates in other communities.[53] Despite the limitations of these cost calculations they were helpful to local lead advocates in other communities' policy debates.

2) Current housing policies fail to protect children at risk for lead poisoning

One of the arguments against a new lead law was that the existing housing code already prohibited deteriorated paint. To counter this, the Coalition needed evidence that this code was not effectively protecting children. The most persuasive information came from the community based direct action project called Get the Lead Out (GLO). GLO was initiated by a family physician in the community health clinic attached to Rochester elementary School 17. Based on the "Needs Assessment" report and the School 17 principal's survey of incoming students, this physician realized that children born into his practice had a one in three chance of becoming lead poisoned. He obtained local foundation funding to have a risk assessor test the homes of patients under age three. The physician partnered with a local community group and a VISTA volunteer to help implement the project. Staff of the University of Rochester's Environmental Health Sciences Center Community Outreach and Education Core (COEC) contacted the Alliance for Healthy Housing and developed protocols based on the Children's Environmental Health Research Center program.[54] The COEC recruited medical students to educate families, follow up with property owners, and analyze data from the project.

Prior to GLO, families with concerns about lead hazards could not get information about the lead safety of their home without paying for a private risk assessment - which at around \$400 was beyond the means of most families. Between 2003 and 2004, GLO provided risk assessments to approximately 70 families, primarily renters, in a high-risk neighborhood of Rochester. GLO worked with the families to help address lead hazards, notified the property owner of the hazards, referred them to existing funding sources, coordinated with the local code enforcement office, and, when necessary, helped the families locate safer housing. Despite this support system, GLO found that less than a third of the properties they assessed were made lead safe as a result of information and education. This finding supported the Coalition's claim that a mandatory system of inspection and enforcement was essential to protect children from lead poisoning.

Qualitative information gathered through GLO included case studies of families and landlords. For example, GLO staff told the City Council about testing the house of a one-year old child with blood lead levels just above the public health level of concern (10 µg/dL). GLO's risk assessor reported the existence of lead hazards to the landlord and referred him to a local housing grant program and free lead safe work practices training. Meanwhile, the child's blood lead level continued to rise to over 20 µg/dL, at which point the Health Department was able to intervene and require repairs. Subsequent investigation by GLO

showed that city inspectors had cited 59 code violations in the house, but that deteriorated paint on windows - the most significant lead risk to the child - had not been cited. This case clearly demonstrated that neither the existing housing code system nor education to promote voluntary action were effective in preventing lead poisoning.

The initial success of GLO encouraged the City of Rochester to support the program with funding from a Lead Hazard Control grant from the US Department of Housing and Urban Development (HUD). With this funding, administration of the project was handed over to Action for a Better Community (ABC), a community-based organization. In the summer of 2005, ABC partnered with the University of Rochester COEC to have teams of local youth and medical students conduct an external survey of housing in two high-risk neighborhoods. The students observed exterior deteriorated paint on 88% of the houses they surveyed. Reporting this data in the news and to City Council provided additional impetus for the proposed lead legislation. Thus, although designed as a lead poisoning prevention project, GLO produced local data that was very influential in the policy process. The involvement of university and health care professionals insured that this data was captured and communicated effectively.

3) While education, nutrition, and cleaning are important, they are not sufficient to address the problem: therefore, a housing-based approach is needed

Opponents of a strong local lead policy argued that it was unnecessary and would be ineffective in preventing lead poisoning. Instead, they suggested educating parents about improved nutrition and housekeeping absent changed behaviors by high risk families. These arguments were repeatedly raised by stakeholders, including landlords and several City Council members. It was challenging for the Coalition to definitively counter these arguments, because past research suggested that housekeeping and nutrition can indeed be helpful in reducing the effects of lead on an individual basis. However, research also showed that housekeeping and nutrition education alone are not effective as public health interventions.

For example, the research showing that lead in dust contributes significantly to children's blood lead level is frequently interpreted to mean that proper housekeeping (frequent wet dusting, cleaning with detergents, and using a vacuum with a HEPA filter) is necessary to prevent lead poisoning. However, studies have also shown that educating families about cleaning is not effective in reducing children's blood lead levels.[55] Physicians and medical researchers from the Coalition helped interpret this apparently contradictory research. As they explained, proper housekeeping can help reduce lead levels in household dust. However, most families' normal cleaning habits cannot maintain lead safety in housing with active hazards that are rapidly shedding lead into the home environment.

Public health professionals often emphasize the role of proper nutrition in preventing lead poisoning, particularly the importance of adequate calcium and iron. High blood lead levels may cause anemia, and iron may also interfere with absorption of lead, suggesting that iron supplementation may help prevent the effects of ingested lead.[56] Calcium is also known to decrease the absorption of lead and lead competes with calcium in enzymatic processes.[57]

Therefore, public health professionals often recommend increasing calcium and iron intake in children at risk of lead poisoning. These public health messages were frequently invoked by opponents of the Rochester housing-based lead policy, who suggested that if children were fed better diets, they be harmed less by lead in their environment. As with the housekeeping issue, a policy-relevant interpretation of the nutrition research is nuanced. Scientifically trained Coalition members helped clarify that while it is important for children

to have adequate nutrition, just increasing calcium and iron intake cannot prevent health impacts on children in a high-lead environment.

Because these two issues were complex, controversial, and had the potential to undermine the housing-based policy strategy, the Coalition asked several physicians to summarize the medical literature on the significance of cleaning and nutrition with respect to lead poisoning. These short, plain-language summaries were posted on the Coalition's web site and delivered in hard copy to all City Council members. Because they were written by a health care provider and cited medical research, these summaries were credible in countering criticism of the Coalition's approach. The Coalition was thus able to argue that while education about good nutrition and housekeeping were important complements to a housing-based prevention law, educational strategies alone would not be effective in preventing lead poisoning. Indeed, the final law was accompanied by a Council resolution promoting ongoing community education about lead poisoning prevention.

4) An effective inspection protocol must address lead in dust

While landlords' biggest concern about a lead policy was the cost of lead hazard controls, city officials were also concerned about the costs, logistics, and liabilities involved in testing houses for lead. The Coalition initially proposed contracting out inspections to EPA-certified risk assessors, who would conduct a thorough assessment of each house at a cost of approximately \$400 per unit. EPA Risk Assessor training is a five-day course followed by a third party examination with recertification every three years. City officials noted that this level of training might not be possible due to agreements with its inspectors' union. They also argued it would be too expensive to have city inspectors conduct full risk assessments in all units. In addition, landlords insisted that they could not afford to pay for risk assessments privately. Instead, both city staff and landlord groups maintained that visual inspections for deteriorated paint would be sufficient.

The Coalition argued vehemently against the visual inspection proposal, noting that lead in dust is invisible. The Coalition also referred to the medical research showing that lead in dust is closely correlated with children's blood lead levels.[40] The University of Rochester COEC and the National Center for Healthy Housing (NCHH) summarized research showing that a significant percentage of homes with no observable lead hazards (bare soil or deteriorated paint) in fact had hazardous levels of lead in dust.[21,48] Based on concerns about invisible lead dust, the Coalition suggested using the EPA's clearance protocol for testing dust after lead hazard control work. Clearance testing requires a visual inspection plus at least eight dust wipe samples, which are sent to a certified laboratory for analysis. This protocol had been previously adapted for lead hazard investigations by the Children's Environmental Health Resource Center.[54] This proposal was partially adopted; the final law included a provision for dust wipe testing in homes in high risk areas that passed a visual inspection. Dust wipes were limited to high risk areas to reduce implementation costs and focus resources on the highest-need areas.

5) All lead hazards – interior and exterior paint, dust, and soil – must be addressed

Housing-based lead hazards include deteriorated leaded paint, lead in dust, and lead in bare soil. Prohibiting deteriorated paint was one of the least controversial provisions of the lead policy proposals. Indeed, as noted earlier, deteriorated paint was already a violation of the city code, albeit one that was not uniformly enforced.

Prohibiting bare soil was also generally well-accepted, although the City's proposal was limited to restricting bare soil within the "drip line" of the house. The "drip line" is the area just next to the house where the highest lead levels are found due to decades of paint chips

falling from the house and accumulating in the soil. In the HUD National Evaluation, properties with soil treatments had one-year floor dust lead loadings that were 29% lower than loadings in properties without soil treatments.[50] Based on past research connecting bare soil with children's blood lead levels, the Coalition had argued that bare soil should be cited anywhere in the yard.[37,58,59]

As noted above, City Council eventually agreed to a provision to test dust in homes in high risk areas with no visual hazards. However, there was strong opposition by landlords to testing dust on porches. Pointing out that federal regulations did not include a porch dust standard, landlords argued that it would be unfair to hold property owners responsible for high levels of lead in dust on porches. They cited a recent study by Caravanos that measured rates of deposition of ambient lead in the urban environment.[60] The existence of ambient lead, the landlords claimed, made it infeasible to keep exterior porch levels below the standards used by EPA for window wells (400 µg/sq. ft).

The Coalition's Science Committee noted that the Caravanos study suggested that it would take three months for ambient deposition alone to violate this standard. In addition, Coalition members obtained unpublished analyses that were pertinent to the policy debate from the Lead in Dust Study; for example, that homes with elevated porch dust levels were twice as likely to house EBL children.[61] This information helped persuade the Council that porch floor dust levels should be included in the inspections. Although the law initially included a requirement for clearance testing to include porch floors, within months after its passage the City removed this provision in response to protests by landlords. Thus, because the Coalition effectively presented research on various sources of lead, the final law did address lead in paint (via visual inspection), dust (interior dust wipes in high risk areas), and soil (bare soil in the dripline).

6) In order to promote cost-effective controls, an integrated system of interim controls, lead safe work practices, clearance testing, and monitoring is needed

The Coalition's policy position relied on national studies showing that interim controls are less costly than abatement and can be effective in controlling lead hazards over time. However, these studies also showed that to keep lead levels in dust low, lead hazard control work must be conducted and maintained properly. Fortunately, understanding of the essential elements of lead safety using interim controls was well-developed.

First, lead hazard control work can generate significant lead dust, creating new hazards. The solution is to use "lead safe work practices," which include protecting workers, sealing off the work area, and minimizing dust generation. The Coalition insisted that the policy should require that workers be trained in and use lead safe work practices. Lead safe work practices training is less costly than EPA lead abatement certification. The 5-day EPA lead abatement certification course cost around \$500, whereas the 8-hour lead safe work practices training course was provided for free by the City and County with support from their lead hazard control grant programs.

Second, even when lead safe work practices are used in renovating pre-1978 housing, some lead dust may be generated. Therefore, workers must carefully clean up after lead hazard control work is completed using lead-specific approaches (for example, wet cleaning rather than dry-sweeping, using detergents rather than just water, and using HEPA-filtered vacuums rather than regular shop vacuum cleaners). The effectiveness of this cleaning can be checked by clearance testing, as described above.

Third, interim controls must be monitored for maintenance over time. HUD regulations require monitoring every two years for most interim controls. Therefore, the Coalition was

very concerned about the City's proposal to incorporate lead inspections into the Certificate of Occupancy inspections, which are on either a three- or six-year cycle, depending on the type of housing. However, the Coalition recognized that simultaneously incorporating lead into the County's Quality Home Inspections process would result in more frequent visits to the highest-risk units, because families on public assistance tend to move often. In addition, the Coalition recognized that setting up an inspection system separate from the Certificate of Occupancy cycle was not feasible. Instead, the Coalition argued for a "self-referral" provision in the ordinance under which any tenant, health care provider, or concerned community group could ask for a lead inspection at any time. Coalition members familiar with federal lead hazard control regulations cited HUD's requirement of biannual inspection of interim controls in support for this proposal.

Thus, the Coalition's efforts to balance cost and effectiveness relied on a combination of federal regulations, evaluation of HUD grant programs, and knowledge of local housing programs. Requiring abatement would have been simpler because there are clear federal standards, workers must be EPA-certified, and there is no need for ongoing monitoring (since lead has been removed or permanently encapsulated) – but more expensive. However, by integrating recent housing research and federal guidelines, the Coalition designed a much less costly system of inspection, lead safe work practices, interim controls, and monitoring.

Lessons learned

At each stage of the policy process, the Coalition was able to integrate local data, national housing experiences, and medical information to inform its positions and influence the policy process. Through the process of seeking, interpreting, and communicating technical information, the Coalition developed an extensive boundary network of individuals with diverse expertise. As the policy process evolved, different members of the boundary network contributed in new ways to enhancing the technical soundness and credibility of the Coalition's positions. As a result, the community-based Coalition had more comprehensive technical expertise than the other actors in the policy process, including opposing interest groups (primarily landlords) and government agencies.

The Coalition accessed extensive and diverse technical resources despite a limited budget. Because the Coalition insisted that all its positions be informed by the best available science, its leaders were particularly attentive to recruiting members with a wide variety of relevant expertise, including housing, medical, education, legal, economic, etc. The Coalition refrained from expending its limited financial and human (staff) resources on new data collection, consultants, or extensive analyses. Rather, it relied on its members to analyze, interpret, and apply existing information to local conditions, resulting in an extensive boundary network of individuals who provided technical advice as needed throughout the policy process. The Coalition employed three primary strategies to develop its boundary network:

1) Developing relationships with boundary network members

Developing robust relationships among members is important to coalitions' decision-making ability and sustainability over time.[4] This analysis suggests that such relationships are also important in developing an effective boundary network. The Coalition's boundary network was similar to an "epistemic community," a group of scientists with a shared understanding of a natural system who promote policy based on this understanding.[62,63] However, the Coalition's boundary network did not necessarily interact directly with each other. The changing nature of the information needs over time, professional diversity of members (academics, government agencies, non-profits, etc.), variable scale (local and national), and

multidisciplinarity of the problem (encompassing health, housing, economics, education, etc.) limited direct interaction between the boundary network members.

Instead, the Coalition staff and leadership served as the hub of the boundary network. Staff and committee members sustained relationships with the various boundary network members, which helped the Coalition quickly access technical resources when they were needed. Several participants noted that the Coalition's commitment to basing its positions on the best available information may have helped boundary network members feel comfortable working with this group. The Coalition also was careful to make sure specific requests for assistance were compatible with each technical expert's interests, expertise, and capacity. For example, Coalition staff helped busy physicians write short newspaper editorials on the impacts of lead on their patients. The Coalition regularly credited technical experts for contributing information and gave them feedback on its impact; being able to see their impact may have encouraged boundary network members to stay involved. As one Coalition member said, "maybe the lesson is it is worth the time and effort to recruit experts...and part of recruiting them is convincing them it will make a difference." More research is needed on the factors that encourage - or discourage - technical experts to be involved in local environmental health policy issues.

2) Working the network

The Coalition leadership excelled at "asking the right questions" and working through its network of members to find the best answers. For example, no local experts had information that could credibly support the importance of dust wipes for initial hazard identification. However, by working with the National Center for Healthy Housing, the Coalition was able to access a then-unpublished evaluation of the Maryland lead law showing that a significant number of houses that passed visual inspection failed dust wipes.[21] These interactions, in turn, emphasized the importance of publishing and nationally disseminating results of such applied housing research. In addition to working with national organizations, Coalition members connected directly with other community groups through attending regional and national lead conferences, participating in on-line list-serves, and contacting colleagues in other states. This informal networking was particularly important because much of the needed information was not published in the peer-reviewed literature. Because the Coalition had access to such diverse expertise – both at the local and national level – they had better technical resources than the other policy actors. As a result, according to one City Council member, this was the first local policy issue in which Council relied more on community groups than on City staff for information and analysis.

3) Leveraging existing resources

As noted above, much of the information needed to support the decision-making process was not published in journals. In addition, information in medical journals was generally too complex for the Coalition's audience. Boundary network members helped interpret existing studies in a way that was relevant to the local decision making context. Most of the new analyses that were conducted by boundary network members, such as the geographic distribution of children with blood lead levels over time, relied on pre-existing health department data. Perhaps the most persuasive new information simply involved presenting illustrative stories, such as the GLO partners' description of their inability to protect a particular child from lead under the existing policy system. While the Coalition generated little if any "new science," it mobilized its boundary network to make maximum use of existing research, interpret existing data, and capture lay knowledge through case studies with minimal financial resources. As one Coalition board member recalled, "the more thoughtful politicians and their staff kept coming to us with more questions. Being able to get back to them with information that showed that there were answers, that we had done

our homework, and that the data supported our positions really helped us.” Further investigation of approaches that increase the accessibility, credibility, and use of existing information could improve local environmental health decision making.

Conclusions

Community-based organizations typically face many challenges when participating in policy processes, particularly in technically complex issues such as environmental health. They frequently lack the technical resources of private sector or government groups. The Coalition to Prevent Lead Poisoning overcame these challenges by developing a boundary network of technical experts. The boundary network was key to the Coalition’s success in promoting a local policy change.

The Coalition’s boundary network included individuals from numerous institutions including health, housing, and legal groups, academia, local government, and national nongovernmental organizations. The Coalition developed relationships with technically-trained individuals, consistently sought scientific input on its positions, and leveraged existing research throughout the policy process. By drawing on experts who had high credibility with its target audiences, the Coalition was able to enhance support for its positions. The Coalition also played a critical role in making experts’ information meaningful. As one Council members said, “Understanding can’t become wisdom without context...So the experts need to be embedded in the community to help them gain this understanding.” The Coalition helped provide the context that made boundary network members’ knowledge useful in the policy process.

This case demonstrates the potential of boundary networks to bring scientific information into local decision-making processes where dedicated boundary organizations do not exist. Science shops, collaborative analysis, and community based participatory research are promising innovations to support communities’ needs for information. However, these approaches require dedicated technical resources, generally procured by researchers, government agencies, or externally-funded groups. Such resources may not be accessible to community groups involved in local environmental health issues. For example, when a policy process is initiated by local advocates, it is seldom clear at the outset what information will be needed or how to obtain technical resources. Therefore, many of the structures that have been advocated to improve the use of science in collaborative policy processes may not be feasible in typical local environmental health debates. In such cases, boundary networks may be an effective strategy for bringing technical information into policy processes.

Given the increasingly recognized role of communities in complex environmental and health policy issues such as climate change, hazardous waste management, obesity prevention, and water and air quality protection, further research on how to promote effective use of science in such situations is important. In particular, this analysis suggests that we need better understanding of how to encourage researchers and other technical experts to engage in local policy efforts, how to connect national organizations with local communities, and how to apply existing knowledge effectively in local policy processes.

As collaborative decision making for local environmental health continues to develop, it may be increasingly important to build on the potential of boundary networks. This case demonstrates that a boundary network can effectively bring technical resources into a local environmental health policy process despite limited financial resources. It also suggests that boundary networks may enhance the effectiveness of community groups in policy processes.

Therefore, better understanding of and support for boundary networks may promote community-based solutions to local environmental health problems.

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Biography

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