Public Health and Law Collaboration: The Philadelphia Lead Court Study

Carla Campbell, MD, MS, Ed Gracely, PhD, Sarah Pan, MPH, Curtis Cummings, MD, MPH, Peter Palermo, MS, and George Gould, Esq

Objectives. We determined whether Philadelphia Lead Court is effective in enforcing lead hazard remediation in the homes of children with elevated blood lead levels.

Methods. We created a deidentified data set for properties with an initial failed home inspection (IFHI) for lead hazards from January 1, 1998, through December 31, 2008, and compared compliance rates within the first year and time to compliance for lead hazard remediation between 1998 and 2002 (precourt period) and between 2003 and 2008 (court period). We evaluated predictors of time to compliance.

Results. Within 1 year of the IFHI, 6.6% of the precourt and 76.8% of the court cases achieved compliance ($P < .001$) for the 3764 homes with data. Four years after the IFHI, 18% had attained compliance in the precourt period compared with 83.1% for the court period ($P < .001$). A proportional hazard analysis found that compliance was 8 times more likely in the court than the precourt period ($P < .001$).

Conclusions. Lead court was more effective than precourt enforcement strategies. Most properties were remediated within 1 year of the IFHI, and time to compliance was significantly reduced. This model court could be replicated in other cities with similar enforcement problems. (*Am J Public Health.* 2013;103: 1271–1277. doi:10.2105/AJPH.2012.301076)

Lead toxicity and elevated blood lead levels (EBLLs; defined by the Centers for Disease Control and Prevention since 1991 as a blood lead level [BLL] ≥ 10 μg/dL) are among the major environmental problems affecting US children.[1] As a result of increasing evidence for the harm caused by even low-level lead exposure, the Advisory Committee on Childhood Lead Poisoning Prevention[2] recently recommended to the Centers for Disease Control and Prevention that they abandon the so-called "level of concern" previously used and instead use a reference value representing the BLLs in the 97.5th percentile for children participating in the National Health and Nutrition Examination Survey (which the data presently show to be 5 μg/dL) to identify children needing more clinical and public health follow-up. EBLLs can cause impairment of development, behavior, attention and cognition, anemia, and, rarely, death; new data have shown that intelligence and cognitive function can be affected at BLLs less than 5 micrograms per deciliter.[1–5] Children are more affected than adults because many organ systems are developing during infancy and childhood, including the nervous system, and they absorb more lead, relative to adults.

Children are exposed to lead primarily through contact with deteriorating lead-based paint and lead-contaminated house dust and soil, mostly by ingestion of dust or paint chips through routine hand-to-mouth activity practiced by most infants and toddlers.[6,7] US homes were painted with lead-based paint until 1978, when its residential use was banned by the Consumer Product Safety Commission. A recent study by the US Department of Housing and Urban Development (HUD) found that 38 million houses in the United States had lead-based paint, and 24 million had significant lead paint hazards.[8] According to the 2009 American Housing Survey data, 91.6% of the housing units in Philadelphia, Pennsylvania, were built before 1978.[9] Because 27% of Philadelphia families live in poverty, some owners may defer routine maintenance and repair, leading to property deterioration and the generation of lead hazards, mostly from peeling paint. The prevalence of EBLLs based on the results of children's screening tests reported to the Philadelphia Department of Public Health (PDPH) has always been higher than the corresponding national data. However, it has declined markedly over recent years, from 52% of screening tests in 1993[10] having a BLL of 10 micrograms per deciliter or greater to 2.3% (n = 810 tests), 2.2% (n = 797), and 2.3% (n = 824) of venous lead tests for 2009, 2010, and 2011, respectively. Percentages and numbers of venous lead tests of 5 micrograms per deciliter or greater were higher and were 15.5% (n = 5418), 14.2% (n = 5010), and 10.3% (n = 3666) for 2009, 2010, and 2011, respectively (Claire Newbern, PhD, MPH, personal communication, June 21, 2012). The trend in BLLs of 5 micrograms per deciliter or greater (the recommended reference value) is a downward one but represents a significant number of Philadelphia children for whom additional clinical and public health management would be recommended by the recent Advisory Committee on Childhood Lead Poisoning Prevention recommendations.[2] This problem requires a public health solution because lead exposure of children involves multiple stakeholders, including the child and parents, the property owner, and the local authorities who make and enforce laws, ordinances, and codes.

Workers from the PDPH inspect the homes of children with EBLLs for lead hazards. In April 2002, an inventory was prepared and resulted in the assessment that 1400 "backlog" properties housing children with EBLLs had identified lead hazards for which remediation work had been ordered by the health department but had not been conducted by the property owner, in violation of the health code and presumably because of the PDPH's lack of authority to force the owners to comply with departmental orders. The City of Philadelphia did not have any type of separate

administrative hearing conducted by either the PDPH or any other city office for those who were out of compliance with health department regulations. In short, owners faced no negative consequences if they were noncompliant with the departmental orders. The only course of action that the PDPH's Childhood Lead Poisoning Prevention Program could take was to send out its own crews into the homes to do the remediation work and send the owner an invoice, which was usually not paid. The Childhood Lead Poisoning Prevention Program has had limited staff to do this—generally 2 abatement teams—and it could only remediate 2 to 4 homes per month. In addition, before 2002, they were limited to doing paint stabilization and lead dust cleaning, so they could not do carpentry work, roof or plumbing repair, or any other basic systems work that might help decrease future peeling of old lead-based paint. Presumably, other cities may have a more formal process for issuing violations, holding administrative hearings, issuing judgments, and levying penalties or fines in situations in which remediation of lead hazards has been ordered for a particular property. Before 2002, attempts were made to bring enforcement of orders to remediate properties through the Philadelphia court system, but it usually resulted in the judge ordering the PDPH to do the remediation work, without prioritization by resident children's BLLs or other factors and without supplemental funding. Because of this typical response, the aforementioned strategy was not commonly used in the decade or 2 before the creation of Lead Court.

The Philadelphia Lead Abatement Strike Team (LAST) program was developed by the PDPH in 2002 in response to community concern about the failure to remediate identified lead hazards.[10] A number of advocacy and community-based groups expressed deep concern about this failure, and Public Citizens for Children and Youth was a leader in advocating for improvement of the lead remediation process. A LAST policy group was regularly convened by the office of the city's managing director and included staff from the PDPH, key housing agencies, and the city's Law Department for improvement of health code enforcement for lead hazards[11] and development of an infrastructure for remediation and temporary occupant relocation. Enforcement was strengthened considerably with the November 2002 creation of the Lead Court through a partnership among the PDPH, the Office of the City Solicitor, and the Court of Common Pleas. The creation of the LAST program, enabling much easier collaboration and coordination among the various city agencies, was instrumental in creating a climate in which Lead Court could be created. The Lead Court was created specifically for cases involving owner noncompliance in response to remediation orders issued by the PDPH.[10,12,13] As part of its function, PDPH staff members gave a formal presentation to the judges and Law Department staff on causes of lead exposure, information on the toxic effects of lead, and how remediation of the home is instrumental to stopping and preventing further lead exposure. On reinspection in the first month of a property with an initial failed home inspection (IFHI), cases in which remediation work has not been started are referred to the Law Department to be logged into the Lead Court system.

In this article, we report on a quantitative study of the Philadelphia Lead Court that evaluated whether the court was effective as an innovative law enforcement strategy in (1) reducing time to lead hazard remediation compliance compared with the precourt period and (2) increasing the rate of compliance within 1 year of the IFHI. A Lead Court successful on both of these measures would result in fewer properties with lead hazards (and thus fewer children exposed to them) than would otherwise be the case. In a qualitative analysis, we interviewed Lead Court staff members; results will be reported elsewhere.

METHODS

The quantitative study was a retrospective cohort study by secondary analysis of existing data for addresses with an IFHI from January 1, 1998, through December 31, 2008. We created a deidentified data set for these properties from the database of the PDPH's Childhood Lead Poisoning Prevention Program, which has been subjected to rigorous quality control measures. Lead inspection was done by a certified lead inspector who visually inspected for defects in the condition of painted areas in all rooms, using x-ray fluorescence to determine lead paint concentration when needed. Comparisons were made between the precourt (1998–2002) and court (2003–2008) periods, excluding a 7.5-month transitional period (from November 6, 2002, through June 30, 2003). Therefore, the precourt time period was 4 years, 10.5 months; the court time period was 4 years, 6 months. Before 2001, the homes of children with 1 BLL of 20 micrograms per deciliter or greater were inspected. After 2001, a BLL of 20 micrograms per deciliter or greater, or 2 levels of 15 micrograms per deciliter or greater within a 6-month period triggered an inspection; from 2005 onward, a BLL of 20 micrograms per deciliter or greater, or 2 levels of 10 micrograms per deciliter or greater triggered this inspection.

Data entered included dates on which the property had been inspected, property owner status (owner occupied, landlord owned, or public housing through the Philadelphia Housing Authority or the Section 8 voucher system), zip code and census tract, the date the property achieved compliance (when the lead violations were remediated) through dust wipe samples showing a level below the Environmental Protection Agency standards for dust at the time of reinspection, whether the agent who did the work used a lead hazard control grant from HUD (certified abatement contractors were required for HUD grant properties, and non-HUD grant work was done by certified PDPH staff or property owners), and serial BLL data for an index child whose BLLs triggered the property inspection. Data from the Law Department included the date of referral, complaint filing date, first hearing date, date the case was discontinued and ended (cleared from the court process), and disposition (mostly compliance with occasional referral to the PDPH for remediation or notation of vacancy). An Excel database (Microsoft Corp., Redmond, WA) was reviewed for irregularities, discrepancies, missing values, and out-of-range values; converted into a SPSS version 18 database (PASW, Chicago, IL); and analyzed statistically.

Study question 1 hypothesized that the Lead Court period would have (1) a higher rate of compliance attainment within 1 year of IFHI and (2) a shorter time to compliance. The rate of compliance achieved at 1 year was compared between periods by means of a χ^2 test,

using all homes failing inspection and having at least 1 year of data from the IFHI date through the censoring point as the denominator. We determined the time to compliance in months for each period by means of Kaplan–Meier curves using all data, and we compared them with a log-rank test. Data for the precourt households were censored at November 15, 2002 (start of the transitional period), and those in the court period (with IFHI by December 31, 2008) were censored at May 15, 2010, giving most precourt and all court cases more than 1 year of follow-up.

Study question 2 stated that compliance has reduced BLLs in resident children by 6 months or 1 year after compliance, regardless of when compliance was obtained. The main analysis was a repeated measures analysis of variance between the log-transformed BLL closest to 6 months before compliance and the BLL closest to 6 months and 12 months after compliance. We further stratified this analysis with the court period and age of index child with EBLL (< 2 years vs ≥ 2 years at the IFHI) serving as grouping variables.

For study question 3, we used a proportional hazards model to look at factors predicting time from IFHI to attainment of compliance, or time to compliance. Potential predictors included Lead Court status (precourt or court), occupancy status (owner or tenant), age of index child with EBLL (< 2 years vs ≥ 2 years) at the IFHI, and first BLL of the index child.

Using descriptive statistics, we also examined whether a HUD grant was used and how many inspections were needed to attain compliance (which served as a proxy for number of court hearings required). Sample size allowed for comparison of compliance rates (precourt vs court) with a difference as small as 5% with more than 80% power.

RESULTS

We created a database with a total of 4530 entries. We excluded 117 cases with missing data and 206 cases whose IFHI date was in the transition period, which left 4207 cases: 1987 precourt cases (January 1, 1998–November 15, 2002), including those with less than 1 year of follow-up data from the IFHI date, and 2220 court cases (July 1, 2003–December 31, 2008).

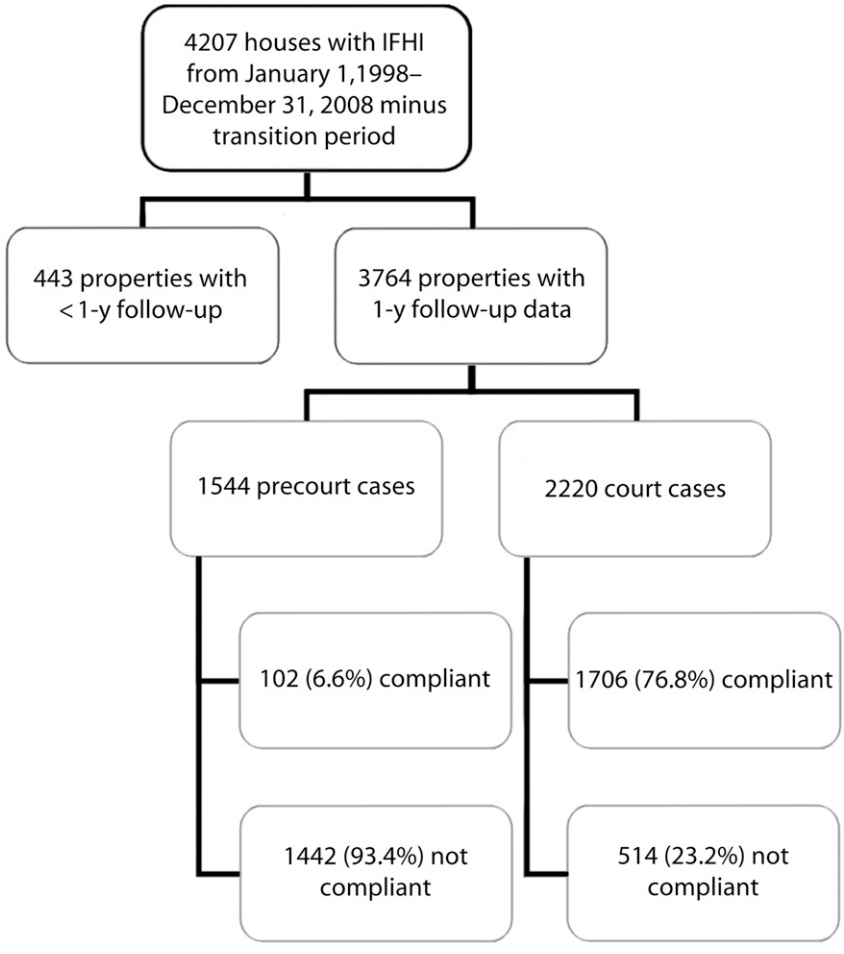
Within the first year of the IFHI date, a significantly ($P < .001$) higher rate of compliance was attained in the court period cases (1706 cases; 76.8%) than in the precourt period cases (102; 6.6%), leading to a total of 1808 compliant properties (Figure 1). The total number of cases was 3764 and was limited to homes with at least 1 year of data from the IFHI date through the censoring point as the denominator (1544 precourt and 2220 court cases).

Compliance was attained rapidly in the court period (Figure 2); the increase in percentage of homes compliant was much slower for precourt cases ($P < .001$). Even 4 years after IFHI, only 18% of precourt properties had attained compliance, compared with 83.1% of court properties.

Blood Lead Level Patterns in Relation to Compliance

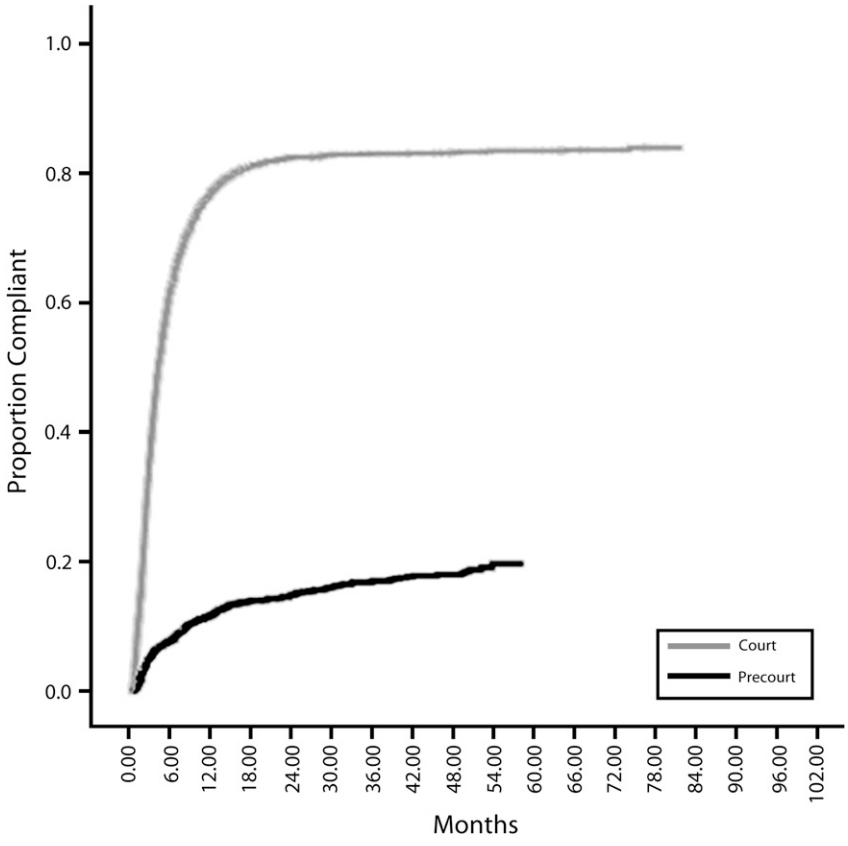
Study question 2 addressed the relationship of BLLs to compliance, regardless of the interval needed to achieve this and whether the case went through Lead Court or not. We analyzed BLLs for the properties that had an index child with a BLL 6 months before and 6 months after compliance; some had levels 12 and 18 months out.

In general, geometric mean BLLs were higher in the precourt period than in the court period (group main effect $P = .018$) and in children aged 2 years and older than in children younger than 2 years at the IFHI (age group main effect $P = .007$; Figure 3; see also Tables A and B, available as a supplement to the online version of this article at



Note. IFHI = initial failed home inspection. $P < .001$ for comparison of compliance rates.

FIGURE 1—Flow diagram of rate of compliance within 1 year of IFHI: Philadelphia, PA, January 1, 1998–December 31, 2008.



Note. $P < .001$ by log-rank test.

FIGURE 2—Time to compliance with lead remediation by precourt group (1998–2002) and court group (2003–2008): Philadelphia, PA, January 1, 1998–December 31, 2008.

http://www.ajph.org). BLLs decreased over time (time main effect $P < .001$) from 6 months before compliance versus 6 and 12 months after compliance. We found a trend toward a court group × time interaction ($P = .09$) and a significant age group × time interaction ($P = .018$), the latter indicating more change over time in younger children.

Factors Predictive of Attainment of Compliance

Study question 3 addressed factors that predict time from the IFHI date to compliance, or time to compliance. Occupancy status differed between the periods ($P < .001$). Specifically, the precourt properties included more owners (865; 48.4%) and fewer tenants (818; 45.8%) than the court properties (owners = 899 [43.2%]; tenants = 1151 [55.4%]). Both groups had a small percentage in Section 8 housing (4.9% and 1.3%, respectively) and public housing (0.9% and 0.1%, respectively). Occupancy status data was available for 1786 precourt and 2079 court cases (out of a total of 4207 cases). The mean age of the index child at the IFHI date was 36.3 months (SD = 18.3) for the precourt group and 34.1 months (SD = 19.2) for the court group ($P < .001$). Of the precourt children, 486 (28.6%) were aged 2 years or younger at the IFHI date, compared with 590 (31.8%) of the court children ($P = .037$). Age data was available for 1702 precourt and 1857 court cases (out of a total of 4207 cases). The mean for the first BLL was 18.1 (SD = 11.4) for the precourt children and 14.2 (SD = 10.0) for the court children; geometric means were 14.0 and 10.9, respectively ($P < .001$).

A Cox proportional hazards model, looking for predictors of time from IFHI to compliance while controlling potential confounding variables, found a hazard ratio of 8 (95% confidence interval = 6.992, 9.200) comparing court to precourt, indicating that compliance across time was an average 8 times more likely in the former ($P < .001$). Additionally, none of the confounders such as occupancy status, age of child at IFHI, and first BLL were significant predictors of compliance in the court group (Table 1).

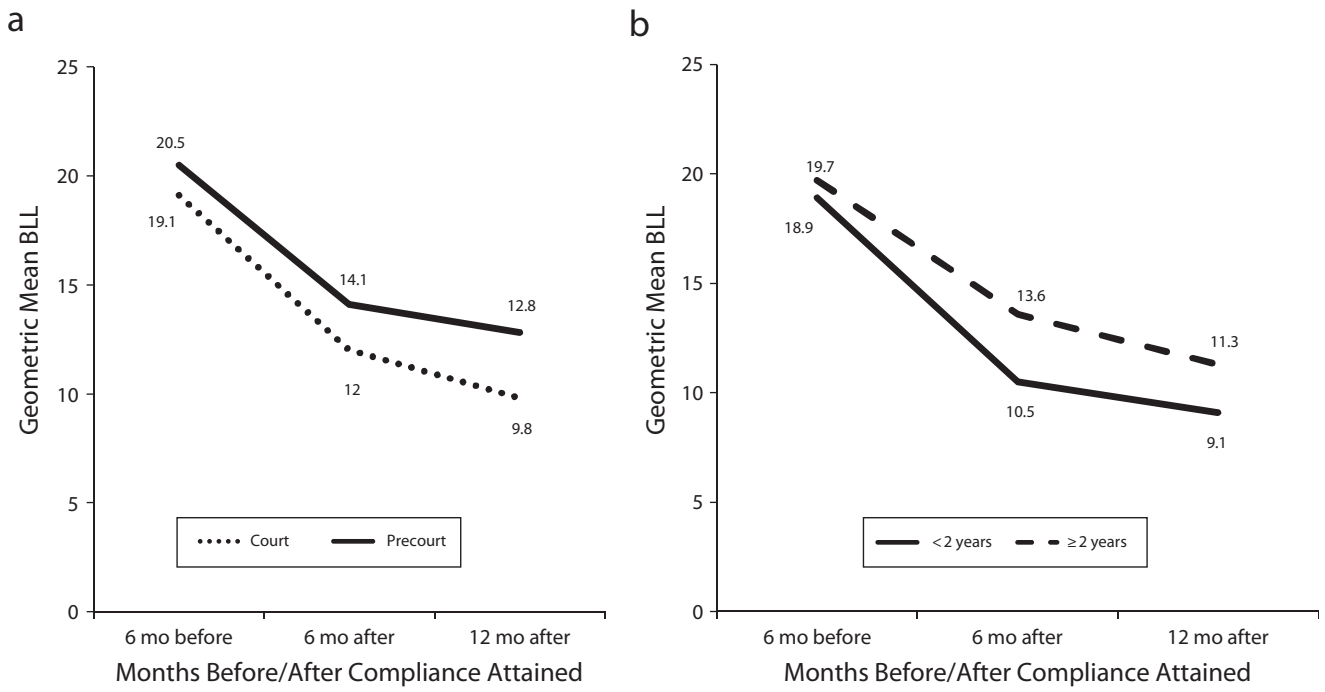
Other Analyses

Table C (available as a supplement to the online version of this article at http://www.ajph.org) compares the time to compliance for work done with and without HUD grants, with the HUD grant work taking significantly longer. Precourt compliance took an average of 12.5 months with an HUD grant versus 9.4 months without a grant. Corresponding figures in the court period were 5.6 and 4.8 months, respectively. Both comparisons were significant ($P < .001$). HUD grants were much more utilized in the court period; a total of 767 grants constituting 41.5% of the properties were obtained in the court period, as contrasted with 71 grants representing 24.1% of the properties in the precourt period.

The number of reinspections (which followed the IFHI) and court hearings needed to attain compliance were tracked for court properties. If the first reinspection did not result in compliance, the case was referred to Lead Court. Seven (0.4%) required 1 reinspection, presumably because the property came into compliance before the date of the first court hearing; 1548 (87.3%) had 2 reinspections (1 court hearing); 120 (6.8%) had 3 reinspections (2 court hearings); and 98 (5.5%) had 4 or more reinspections (≥ 3 court hearings) for the 1773 properties tabulated. A total of 4167 cases were filed for a first court hearing between September 2, 2002, and December 31, 2010, with 1668 cases filed by December 31, 2003. Therefore, the court initially handled a large volume of cases that has slowed down over time, with 177 cases filed in 2010.

DISCUSSION

The development of a specialized court as an innovative law enforcement strategy has been very effective in Philadelphia, markedly



Note. BLL = blood lead level.

FIGURE 3—Geometric mean blood levels by (a) time and court period and (b) time and age group: Philadelphia, PA, January 1, 1998–December 31, 2008.

increasing the number of properties with lead hazards that became compliant after remediation work. We have demonstrated that the precourt enforcement strategy was not effective, based on the rate of properties becoming compliant within the first year and over a 4-year follow-up period. The act of appearing before a judge in a court of law seems to have served as an incentive for many owners.

Cities that already have a formal process in place for enforcement of orders to remediate lead hazards from properties might not need to consider a specialized court process, but it was very good solution for Philadelphia under the conditions present in the city when Lead Court was created in 2002. We also think that educating judges hearing cases in Lead Court regarding how children get exposed to lead and what measures need to be taken to prevent further lead exposure was helpful in having them understand the consequences of giving the owner more time to remediate a given property.

To our knowledge, no other study has analyzed this type of enforcement strategy, and only 2 other similar courts exist nationally. A lead court in Chicago, Illinois, is run within the Housing Court division,[14] and the Mahoning County (Ohio) Common Pleas Court hears cases against owners of rental units that were not remediated of lead hazards.[15] By comparison, the Philadelphia Lead Court has operated out of both the municipal and the common pleas courts, but not through housing court. A literature search found several references discussing various aspects of enforcement of housing policies.[14,16–18] A common theme is that stricter laws and housing codes may lead to healthier homes with fewer subsequent cases of children with EBLLs and lower societal costs.

One practical question raised is how well the court might have worked without the provision

TABLE 1—Multivariate Predictors of Time to Compliance Using a Cox Proportional Hazards Model: Philadelphia, PA, January 1, 1998–December 31, 2008

Predictor	HR (95% CI)	*P*
Occupancy		.38
Tenant (Ref)	1.000	
Section 8	1.277 (0.905, 1.803)	.163
Owner	1.016 (0.919, 1.123)	.751
Age at IFHI	1.000 (0.996, 1.004)	.825
First BLL	0.999 (0.995, 1.003)	.594
Court group	8.020 (6.992, 9.200)	< .001

Note. BLL = blood lead level; CI = confidence interval; HR = hazard ratio; IFHI = initial failed home inspection.

of HUD grants and without the LAST program serving as a catalyst to create Lead Court. Time to compliance was increased when a HUD grant was used to fund the remediation work, particularly in the precourt period. However, for the court period, the mean number of months to compliance was much lower for properties both receiving and not receiving grants, a much higher number of properties achieved compliance (767 vs 71), and a higher percentage secured HUD grant funding (41.5% vs 24.1%). The shorter time to compliance for property owners not using HUD grant funding may be attributable to an ability to immediately pay to get the work done. The HUD grant application requires the deed to the property and verification of low-income status as well as PDPH inspection. It took time in 2002–2003 for an infrastructure (including hiring of lead abatement contractors and temporary resident relocation) to be developed, which then streamlined the process thereafter; this work was facilitated by the LAST program. The HUD grant properties may also have had more work done relative to non-HUD properties. Therefore, if the court process had been created without the LAST program and HUD grant funding for at least some of the owners, compliance times and rates might have been different. Also, central to the formation of the LAST program was active input from Philadelphia's children's advocacy group and other community-based groups. The LAST group has not met recently, and Lead Court continues to run well, but the LAST group definitely facilitated the creation of Lead Court.

An important question raised by the study is this: "Does an indicator of positive environmental change, such as achieving compliance, necessarily correspond to a genuine health improvement?" We assumed that if a property was remediated, it did not contain housing-based lead hazards that could further expose resident children to lead (although lead-contaminated toys, food, and other items might have added to the sum total of lead exposure). Therefore, by counting compliant properties, we were able to document an improvement in home environments in the city. However, the lead safety of a property is time specific, and proper maintenance is needed to retain it over time.

No specific health indicators are available for decreased lead exposure. We used BLLs as a proxy for lead exposure to determine whether compliance in a property had a direct and positive impact on a child's lead status; in general, BLLs measure acute or subacute exposure and decline as children outgrow the hand-to-mouth activity that leads to ingestion of lead. The national and Philadelphia trends have been toward declining BLLs in recent years. Most lead is stored in the bones and eliminated from the body over many years. However, some studies have found a prolonged half-life of lead in the blood in chronically exposed children as compared with more acutely exposed individuals.[19] We followed trends in BLLs before and at intervals after compliance. These results indicated that BLLs declined after compliance and further declined over time, regardless of whether compliance was achieved through Lead Court or in the precourt period. Because Lead Court produced many more compliant properties than in the precourt era, Lead Court had an indirect influence on lowering BLLs for those children who lived in properties achieving compliance.

Strengths and Limitations

Strengths of this study include the analysis of a large number of properties over a long time period and the clear and strong association between time period and time to compliance, with the latter being much shorter for court period cases. Results may be generalized to other populations of children living in similar older housing where local governments are working on attaining compliance for properties with identified lead hazards through lead hazard remediation work. Limitations of this study include varying total sample sizes depending on the analysis because of missing or incomplete data (as indicated in the results) and having no other similar studies with which to compare our results.

Conclusions

We found this specialized court process to be very effective in resolving exposure of children to property-based lead hazards by mandating compliance with orders to remediate them. It could be used as a model by other cities that have difficulty in enforcing remediation of housing violations. Cities that have an effective enforcement system built into their city infrastructure, through either the health or housing department or other city agency, would presumably not need to resort to the creation of a specialized court to achieve compliance with orders to remediate lead hazards. Elements that would increase the likelihood of successful replication would be to include collaboration among public health, law, and judicial officials and staff through a multidepartmental citywide task force similar to the LAST program; input from advocates and community-based organizations; and identification of a source of remediation funding for low-income property owners. Use of this model in other cities might ultimately lead to fewer children being exposed to housing-based lead hazards. ■

About the Authors

Carla Campbell and Curtis Cummings are with the Department of Environmental and Occupational Health, Drexel University School of Public Health, Philadelphia, PA. Ed Gracely is with the Department of Epidemiology and Biostatistics, Drexel University School of Public Health and with the Department of Family, Community and Preventive Medicine, Drexel University College of Medicine. Sarah Pan is with the Department of Pathology and Laboratory Medicine, University of Pennsylvania Perelman School of Medicine, Philadelphia. Peter Palermo was with the Childhood Lead Poisoning Prevention Program, Philadelphia Department of Public Health, Philadelphia, PA. George Gould is with the Housing and Energy Units, Community Legal Services, Philadelphia, PA.

Correspondence should be sent to Carla Campbell, MD, MS, Department of Environmental and Occupational Health, Drexel University School of Public Health, 1505 Race Street, MS 1034, Philadelphia, PA 19102-1192 (e-mail: ccc57@drexel.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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Contributors

C. Campbell initiated the study, wrote the first draft of the article, and coordinated revisions. E. Gracely and S. Pan analyzed the study results. All authors helped conceptualize the study, helped with oversight of the study and interpretation of results, and critically reviewed the article and its revision.

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Human Participant Protection

This study was approved by the institutional review boards of the Philadelphia Department of Public Health and Drexel University.

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