Lead Poisoning and Asthma

An Examination of Comorbidity

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Objectives: To determine the comorbidity of lead poisoning and asthma in urban children, and to examine associated clinical factors.

Methods: One-hundred-one patients at an inner-city clinic with blood lead levels (BLLs) of 25 µg/dL or higher (≥1.2 µmol/L) (BLL25 group) were randomly selected from a tracking lead database and matched on age, sex, and primary language to 101 randomly selected patients with a first BLL recorded in the database of lower than 5 µg/dL (<0.2 µmol/L) (BLL5 group) and no subsequent BLLs of 10 µg/dL or higher (≥0.5 µmol/L). Medical records were reviewed to determine diagnosis or symptoms of asthma or wheezing at any visit, immunization status, and number of visits. Analyses for matched pairs were conducted.

Results: The BLL25 and BLL5 groups did not differ on age at diagnostic BLL (26.6 months vs 24.2 months), sex (54% male), or language (12% Spanish). The BLL25 and BLL5 groups had a similar number of subjects with a diagnosis of asthma (6% vs 11%; odds ratio, 0.5; 95% confidence interval, 0.2-1.6); 26% of BLL25 and 34% of BLL5 subjects had either a diagnosis or symptoms of asthma or wheezing (odds ratio, 0.7; 95% confidence interval, 0.4-1.3). Subjects with BLL25 were more likely to have delayed immunization and a first clinic visit when older than subjects with BLL5.

Conclusions: There was no increased likelihood of asthma diagnosis or symptoms among young children with lead poisoning. Children with lead poisoning also had delayed medical care. These data may help guide interventions aimed at preventing or reducing the impact of lead poisoning and asthma.


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EAD POISONING and asthma are common pediatric health problems. Both diseases have environmental mechanisms. Lead paint hazards are a primary source for lead poisoning, and there is evidence that exposure to household allergens increases asthma morbidity. Household dust is an important vector for both lead and allergens. Risk factors for both diseases are similar. Urban, low-income, and minority children are at highest risk for lead poisoning and asthma. Age and condition of housing are risk factors for lead poisoning and asthma.

Home repair has been used for prevention and intervention efforts for both diseases. Lead poisoning prevention efforts target repair of lead-based paint hazards. Efforts to reduce household allergen exposure target focused home remediation, particularly related to dust, mold, and moisture control. There has been a recent increase in funding to create environmentally “safe” homes, an approach that encompasses control of both lead and allergen or asthma hazards. From 1993 through 2000, the US Department of Housing and Urban Development (which recently changed its name to the Office of Healthy Homes and Lead Hazard Control) awarded a total of $552 million in lead hazard control grants under the Lead-Based Paint Hazard Control Grant Program. In 1999 and 2000, the office also allocated grants of $10 million per fiscal year for projects that address a broader concept of home safety, titled the Healthy Homes Initiatives. Determining the degree of comorbidity between lead poisoning and asthma may provide information to guide interventions aimed at preventing or reducing the severity or impact of lead poisoning and asthma.

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Chicago, Ill, has high rates of both lead poisoning and asthma, making it an ideal location to examine the relationship between these 2 diseases. In 1999, 18% of Chicago children tested had a blood lead level (BLL) of 10 µg/dL or higher (≥0.5 µmol/L). A recent study of Chicago kindergarten students reported that 10.8% of children had diagnosed asthma, and there was a 30.1% prevalence of asthma symptoms unassociated with the
diagnosis of asthma. Asthma hospitalizations and mortality in Chicago are high and rising.
We hypothesized that, because of the high likelihood of exposure to environmental risk factors, children with lead poisoning would experience higher rates of asthma or wheezing than those without lead poisoning. This study examines that hypothesis.

SUBJECTS AND METHODS
A matched case-control study was conducted, involving retrospective review of BLLs and medical records. A goal of 100 subjects in each group was set to provide 80% power and 95% confidence of detecting a difference in the occurrence of asthma symptoms between groups of 20% and 40%.

SUBJECTS
The medical records of children receiving pediatric care at a single Chicago inner-city health center were selected for review based on BLLs recorded in a tracking database initially established in December 1996 and continually updated. Variables in the database included child’s name, medical record number, sex, date of birth, address, and primary language and the dates and results of blood lead analyses performed since December 1996. In November 1998, the tracking database was reviewed, and 2 groups of subjects with BLLs obtained at younger than 8 years were determined. First, subjects with any BLL of 25 µg/dL or higher (≥1.2 µmol/L) (BLL25 group) since December 1996 were determined, and their medical records were reviewed. This BLL was chosen because it is the action level for environmental investigation in Illinois. The first BLL25 in the child’s medical record was defined as the diagnostic BLL. The child’s age at the diagnostic BLL was computed and used in the matching process. Data were extracted if the complete medical record was available and the child had received follow-up after the BLL25 was obtained. Twelve potential subjects with BLL25 did not meet these criteria. Data from 101 subjects with BLL25 were reviewed and included.

Next, subjects with an initial tracking database BLL lower than 5 µg/dL (<0.2 µmol/L) (BLL5 group) and no subsequent BLLs of 10 µg/dL or more (≥0.5 µmol/L) were determined. The initial tracking database BLL5 was defined as the diagnostic BLL for this group. Children were ranked by age at diagnostic BLL within sex and primary-language groups. Subjects with BLL5 were randomly matched 1-to-1 to subjects in the BLL25 group on sex, primary language, and age at diagnostic BLL (within 6 months for subjects <2 years or within 12 months for subjects ≥2 years). Among potentially eligible subjects, 13 with BLL5 selected during randomization were eliminated owing to an unavailable record. In these cases, a second record was selected and reviewed. This study was approved by the Children’s Memorial Hospital Institutional Review Board, Chicago.

The health center has a patient population that is 55% African American and 42% Hispanic. About 68% of its patients are from families with an income that is less than 100% of the poverty level. Approximately one third (33%) of pediatric patients are uninsured, 61% have Medicaid coverage, and 4% have private insurance. All blood lead specimens obtained at the clinic are obtained by venous draw. During the first part of the study period, the health center routinely checked BLLs annually. Since fall 1999, BLL screening at the center has been conducted at 9, 15, 24, 36, and 48 months of age and as indicated by risk.

Health center patients are primarily from 2 Chicago neighborhoods, North and South Lawndale. North Lawndale is 96% non-Hispanic black and South Lawndale is 85% Hispanic (1990 US census). Chicago Department of Public Health statistics for 1998 reported that 36% of North Lawndale tested and 17% of South Lawndale children tested had a BLL of 10 µg/dL or higher (≥0.5 µmol/L). Blood lead analyses were conducted by the Illinois Department of Public Health Laboratory using atomic absorption spectrophotometry.

MEDICAL RECORD REVIEW
One of us (S.N.M.) reviewed medical records. The following computer database variables were verified from the medical record: sex, date of birth, primary language, and BLLs. The medical records were reviewed for child address obtained at the time of the diagnostic BLL. The entire record was reviewed for race, diagnosis of asthma, and history of asthma symptoms (defined as a diagnosis of asthma, a clinical diagnosis of bronchiolitis, or a symptom report of wheezing).

Health care use was determined by visit counts and immunization status. Immunization status for each child at the current age was reviewed and compared with the following schedule, which is based on Centers for Disease Control and Prevention and Illinois Department of Public Health recommendations.
Children were considered not delayed if they met the following schedule: aged 9 to 11 months with 3:3:3 (diphtheria and tetanus toxoids and pertussis, Haemophilus influenzae type B, and inactivated polio vaccines); aged 12 to 23 months with 3:3:3; aged 24 to 71 months with 4:3:1:3 (diphtheria and tetanus toxoids and pertussis, Haemophilus influenzae type B, measles-mumps-rubella, and inactivated polio vaccines); and 6 years or older with 5:4:3:2. Additionally, older children were considered delayed if their immunization status when they were 24 months old was delayed. Coding decisions on unclear record notations were reached by consensus opinion with a health center physician (B.R.). Data from primary care visits at other sites were not available.

The year homes were built was determined from 1999 tax records released by the Cook County (Illinois) Tax Assessor. Records are available at the Web site, http://www.newschicago.org (accessed April 2, 2001).

ANALYSIS
Data were analyzed using SAS statistical software (SAS Institute, Cary, NC). Matched-pairs analyses were conducted and the significance of results tested using odds ratios (ORs), 95% confidence intervals (CIs),31 and Wilcoxon signed rank tests. P < .05 was considered significant.

RESULTS
There were 101 subjects with BLL25 and 101 with BLL5 included. As shown in the Table, groups did not differ on age at diagnostic BLL, sex, or use of Spanish as their primary language. These variables were used in the matching process. Child’s age at medical record review was significantly older for the BLL25 group.

Race was determined for 101 subjects with BLL25 and 90 subjects with BLL5. Of those whose race was known, the majority of children in both groups were African American (BLL25, 89 [88%] of 101 vs BLL5, 74 [82%] of 90).

There was no significant between-group difference on diagnosis of asthma or history of asthma symptoms; 6% of subjects with BLL25 and 11% of subjects with BLL5 had a diagnosis of asthma (OR, 0.5; 95% CI, 0.2-1.4), and 26% of subjects with BLL25 and 34% of subjects with BLL5 had a history of asthma or asthma symptoms (OR, 0.7, 95% CI, 0.4-1.3) documented in the medical record at the time of review.
Subjects with BLL25 had delayed health care but did not differ on total number of clinic visits. Of subjects with BLL25, 53% had delayed immunization vs only 20% of subjects with BLL5 (n=97 matched pairs; OR, 5.0; 95% CI, 2.5-9.9). Children with BLL5 were more likely than subjects with BLL25 to initiate care at the clinic as a newborn (median age [range], months, at first clinic visit: BLL25, 5 [0-91]; BLL5, 0 [0-64]; Wilcoxon P = .003). However, the groups had a similar total number of visits (median [range], No. of visits: BLL25, 15 [3-54]; BLL5, 15 [3-73]; Wilcoxon P = .09).

The ages of 88 BLL25 homes and 71 BLL5 homes were identified from city and county tax records. Distribution of the year homes were built is shown in the Figure. Of BLL25 homes, 30%, 66%, 2%, and 2% were built before 1900, from 1900 through 1929, from 1930 through 1949, or from 1950 through 1979, respectively. For the BLL5 group, these percentages were 24%, 61%, 6%, and 10%, respectively. In an analysis restricted to matched pairs in which both subjects had the year their home was built identified, BLL25 homes were significantly older than the BLL5 homes (n=68 matched pairs; Wilcoxon P = .04).

**COMMENT**

We found no increased likelihood of asthma diagnosis or symptoms among young children with lead poisoning compared with age-, sex-, and language-matched children with low BLLs who were attending the same clinic. In both groups, the prevalence of asthma symptoms among preschool-aged children was high, as is commonly found in Chicago.

These findings have implications for strategies used to target homes in the US Department of Housing and Urban Development–funded Healthy Homes Initiatives. Strategies that target homes based on the presence of children with lead poisoning are likely to encounter preschool-aged children with asthma at the expected rate, as determined for that area, and provide services or repair to older buildings. Strategies that focus on “case” identification by identifying preschool-aged children with asthma will include more recently built homes among the group selected for repair. We cannot speculate on whether lead poisoning is more prevalent among children with asthma because our sample was not selected to answer that question.

The significance of the lack of comorbidity between lead poisoning and asthma in this study may be limited by the disparate peak incidences of these diseases. Other studies report that lead poisoning peaks among preschool-aged children' and asthma peaks among school-aged children. Further, asthma symptoms among preschool-aged children are predictive of ongoing asthma in fewer than 50% of patients. Nevertheless, efforts to provide home remediation to prevent asthma progression may need to focus on young children at a time when the certainty of asthma progression is not clear but the certainty of lead poisoning has been established.

A longitudinal prospective study in diverse sites, following subjects from preschool through school age, may be more effective at demonstrating a comorbidity between lead poisoning and asthma and would define longer-term relationships between these diseases. Such a study would overcome limitations of our study related to retrospective medical record review methods and single-site enrollment. Confounding variables, including family history of asthma, breastfeeding history, and exposure to smoking, would also be important to consider. Although children were matched on age at diagnostic BLL, children in the BLL25 group were somewhat older than children in the BLL5 group at record review. This bias would have given children with BLL25 extra opportunities to receive care for asthma symptoms, something that we did not find to occur.

Children with lead poisoning received less optimal health care than children with low BLLs and were more likely to have delayed immunizations and began their care at this clinic at a later age. However, because the numbers of clinic visits were similar, we do not feel that an underreporting bias for asthma or asthma symptoms because of lack of access to care at this site contributed significantly to our inability to detect a significant between-group difference for these variables. The finding of delayed care reinforces the difficulty in identifying children with lead poisoning because those who do not seek care.
Asthma and lead poisoning are common in urban areas, and both diseases have an environmental mechanism. There has been a recent increase in funding to create environmentally “safe” homes. Determining lead and asthma comorbidity may contribute to our understanding of the efficiency of comprehensive environmental remediation interventions.

In the sample of children studied, there was no increased likelihood of asthma diagnosis or symptoms among young children with lead poisoning. Children with lead poisoning received less timely health care and lived in older homes. These data may provide information that will guide interventions aimed at preventing or reducing the severity or impact of lead poisoning and asthma.

may be at highest risk. Health providers should use all patient contacts to update immunizations and conduct blood lead screening.

Although nearly all children in this study resided in homes built before 1950, there was increased risk for lead poisoning among residents of the oldest homes. Houses in the BLL25 group were significantly older than in the BLL5 group. The increased age of homes among BLL25 subjects is consistent with the environmental risk factors (eg, household lead) and demographic/social risk factors (eg, poverty) associated with lead poisoning and is consistent with previous studies.

In summary, among these young children, there was no significant association between lead poisoning and asthma diagnosis or asthma symptoms. This may be owing to disparate peak incidences of these diseases. Further studies of school-aged children should be conducted to confirm and expand our findings. We did find that lead poisoning was associated with delayed immunizations, a late start to pediatric primary care at this clinic, and residence in the oldest houses. These data should be considered when developing a strategy for entry into comprehensive home environmental remediation programs.

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