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Time Under the Curve: Assessing the Impact of Regional Lead Treatment Center Home Visit on the Length of Exposure in Lead Poisoned Children

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Background

Seventy percent of houses in Connecticut were built before lead paint was banned in 1978, putting a high proportion of residents at risk of exposure to lead. Lead poisoning in infants and young children can lead to cognitive and developmental disorders. Connecticut state law mandates that children receive two blood lead screenings between nine and thirty-six months of age[1]. The Yale Regional Lead Treatment Center (YRLTC) assists families of children with blood lead concentrations at or above the Centers for Disease Control and Prevention (CDC) recommended level of <5 µg/dL.[2] YRLTC incorporates home visits of exposed children in Southern Connecticut communities to mitigate lead poisoning by putting emphasis on public health and social work perspectives in addition to clinical treatment from Yale New Haven Hospital. The present project aims to evaluate the merits of this new interdisciplinary approach and its tangible effects on health outcomes of pediatric lead poisoning. These analyses also examine impacts among key vulnerable patient subgroups of refugee children and chelated cases (medical intervention prescribed for patients with a blood lead level >45 µg/dL).[2]

Objectives

1. Identify risk factors for pediatric lead exposure among clients of the YRLTC
2. Compare the impact on lead exposure recovery times of home visits in addition to primary care vs. primary care only interventions, and traditional care vs. a more interdisciplinary approach
3. Explore stakeholder perspectives on the most useful aspects of home visits
4. Characterize responses to treatment in additional at-risk subgroups such as refugees and clients receiving chelation therapy

Methods

Qualitative Data

- Key-informant, in-person semi-structured interviews with a primary care physician and an attorney working closely with pediatric lead poisoning issues in New Haven.
- Questions focused on: Biomarkers and other physiological measures of lead poisoning/cognitive development, patient interaction for possible reasons of reluctance to cooperate with home visits and challenges to lead abatement procedures

Quantitative Data

- Statistical analysis of 359 cases of elevated pediatric blood lead levels referred to the YRLTC using de-identified data extracted from electronic medical records
  - Cox-proportional hazards ratios predicting survival curves of time to blood lead levels (BLL) <5 µg/dL
  - ANCOVA/MANCOVA tests for time to BLL <5 µg/dL and peak BLL
  - Univariate multiple linear regressions/t-tests predicting mean time to BLL<5 µg/dL
- Independent variables assessed:
  - Main intervention types: primary care treatment vs. primary care treatment and home visits
  - Clinic model type: traditional care (before 1/1/2016) vs. interdisciplinary model (after 1/1/2016)
- Additional stratifications of vulnerable patient subgroups:
  - Refugees (n=73) from countries including Afghanistan, Democratic Republic of the Congo, Syria.
  - Chelation cases (n=32), for whom home visits are mandated by the Connecticut Department of Public Health
- Additional covariates: chelation status, re-exposure status, whether or not the individual received a home inspection from the local health department, whether or not the individual received a targeted phone call, age at first screening and age at peak serum lead level

Results: Key Qualitative Takeaways

- Home visits work better after clinic visits, when staff have prepared the families for home visits during the clinic visit, as it can reduce fear and stress of the caretakers.
- Home visits serve as a "snapshot of family's environment" and may help avoid duplication of social services.
- Potential reasons identified for families not showing up for home visits: privacy issues, fear of Department of Children and Families referral, fear of being judged for living situations (i.e., low-income families may not have furniture), difficulty refusing state mandated home visits, forgetting scheduled appointments, refusal to have a team in the house, and inconvenience to others in the context of multifamily houses

Results: Quantitative Analysis

- Home visit intervention (linear regression)
  - The addition of home visits (HV) have an important impact in reducing the time to BLL <5 µg/dL in children with higher peak blood lead levels, compared to primary care treatment (PMT) only. In patients' receiving HV intervention, time to BLL <5 µg/dL decreases by 0.42 months for each unit of highest BLL greater than 10.27 ug/dL
- Traditional care (OLD) vs. interdisciplinary model (NEW) (two-sample t-test)
  - The NEW model was found to lower the average time with elevated blood lead levels for both PMT and HV cases.
  - Average time with elevated blood lead levels were 8.7 months for NEW PMT cases and 25.7 months for OLD PMT cases (p-value <0.001, with 95% confidence interval =-23.8 to -10.28)
  - Average time with elevated blood lead levels were 11.9 months for NEW HV cases, and 39.9 months for OLD HV cases (p-value<0.001, with 95% Confidence interval= -37.9 to -17.0)
- Refugee patients (n=73) (MANCOVA)
  - NEW vs. OLD model: Patients under the NEW model fared significantly better (lower multivariate mean of peak lead level and time to BLL<5 µg/dL), compared to the OLD model, whether or not they received HV (all test statistics p<0.05)
  - Impact of HV: Under the NEW model, non-re-exposed refugee children who received HV have a 1.3 month reduction in lead mitigation time compared to those who only received primary care (p<.05). Re-exposed patients showed a 3.66 month reduction (p<.05).
  - Phone calls were found to have no significant impact on key BLL measures.
- Chelation patient demographics (n=32)
  - Out of the 32 chelation cases from pre-2014 to March 2019, only three cases are resolved, all of which had peak BLLs near the lower threshold for chelation (44, 45, 48 ug/dL)
  - 40% of chelated cases involved multiple doses of chelation therapy.
  - Common comorbidities: cognitive/social/behavioral (n=16), developmental/weight (n=9), pica (n=9), anemia (n=8), feeding/diet (n=7), asthma/allergies (n=7), constipation (n=7), autism (n=4), sickle cell (n=4), epilepsy (n=4).

Recommendations

- Results are most noteworthy at higher BLLs; more emphasis should be placed on patient's peak lead levels to better understand the impact of HV in this patient population.
- The NEW model was marked by improvements in patients receiving PMT, as well as patients who received HV. Further qualitative analysis into the aspects of the NEW model that are driving improvements in BLL measures could help make further improvements/refinements.
- Given that refugees make up a substantial proportion of patients referred (20% of sample cases) and the positive impact of HV under the NEW model, a continued focus should be placed on interpreter availability during the HV process, as well as building trust with newly-settled families before the HV.
- Considering the compliance and poor resolution rate of chelated cases, follow-ups of unresolved cases should occur more often than every three months. Further qualitative research may inform specific educational material for caretakers to achieve better medical compliance.
- The NEW HV model used by YRLTC should be continued in New Haven, and if possible expanded.
- Limit dependence on phone calls as a method of lead education; opt for face-to-face meetings during the early phase of patient relationship-building, especially for refugee populations.

Limitations

- Inconsistencies in screening practices and enforcement of screening mandates of children in Connecticut will affect generalizability of population estimates of elevated blood lead levels.
- Long periods between screenings contribute to detection bias.
- Qualitative data only included staff prior to model change (2016) and did not include patient feedback relating to the different models or home visit intervention.
- Initial BLL was not obtained for nearly 60% of all chelated patients due to policy and hospital system changes during the long course of the patients' treatment.
- Chelated cases represent a relatively small subset of cases and therefore lack statistical power to conduct robust analysis.

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