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Maximizing the return on investment in Early Childhood Home Visiting through enhanced eligibility screening

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Abstract

Background: The MIECHV (Maternal, Infant, and Early Childhood Home Visiting) program invests substantial federal resources to prevent child maltreatment and emergency medical costs. Eligibility is based on screening of demographic or clinical risk factors, but because screening accuracy in predicting poor outcomes is unknown, assignment to home-visiting might miss high-risk families or waste resources on low-risk families.

Objectives: To guide eligibility decisions, this study tested accuracy of demographic and clinical screening in predicting child maltreatment and emergency medical care.

Participants and setting: A population-representative sample of 201 birthing mothers (39.8% Black, 33.8% Latina) in Durham, NC, was enrolled between July 2009, and December 2010, and followed through December 2015.

Methods: Participants were screened demographically (i.e., Medicaid, first-born, teenage, no high school diploma) and clinically (i.e., health/health care, parenting readiness, home safety, and parent mental health) at birth and followed through age 60 months, when Child Protective Services and hospital records were reviewed. Cox hazard models tested accuracy of prediction from screening variables.

Results: Demographic factors did not significantly predict outcomes, except having Medicaid/ uninsured predicted more emergency medical care and being first-born was a (surprising) protective factor against a child maltreatment investigation. In contrast, clinical factors strongly predicted both maltreatment investigations (Hazard Ratio = 4.01 [95% CI = 1.97, 8.15], sensitivity = 0.70, specificity = 0.64, accuracy = 0.65) and emergency medical care (Hazard Ratio = 2.14 [95% CI = 1.03, 2.14], sensitivity = 0.50, specificity = 0.69, accuracy = 0.58).

Conclusions: Even with added costs for clinical screening, selecting families for home visiting based on assessed clinical risk will improve accuracy and may yield a higher return on investment. The authors recommend a universal system of screening and care to support birthing families.

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Keywords

Screening; Home visiting; Risk factors

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1. Introduction

Family home visiting across the prenatal to early childhood period has assumed a prominent role in the promotion of population health and prevention of child maltreatment. The Maternal Infant and Early Childhood Home Visiting (MIECHV) Program of the Health Resources and Services Administration (HRSA) administers over $400 million annually to evidence-based home-visiting programs to serve over 150,000 parents and children at a per-family cost up to $15,000, with additional dollars coming from other sources (Health Resources and Services Administration, 2020).

Not all families are eligible for all programs. Screening for eligibility is intended to help programs recruit families at high risk, presumably to maximize return on investment by excluding low-risk families that would have positive outcomes even without the program, thus avoiding costs (Dodge, 2020). Screening also narrows the heterogeneity of participants so that home-visiting interventions can be tailored to the needs of a subgroup (Craig and Spring, 2007).

As shown in Table 1, eligibility criteria vary widely across the 19 MIECHV-approved programs, with 7 programs selecting families based on screening of demographic factors alone, 2 on screening of clinically-identified factors alone, 9 on either demographic factors or clinical factors, and 1 reaching universally. Demographic screening criteria identify families in domains such as low-income, primiparous, teenage, and without a high school degree. Clinical screening criteria identify families with problems in domains such as health care access (e.g., no insurance or no compliance with protocols); parenting difficulties (e.g., history of being investigated for maltreatment or parenting skill deficits); safe home problems (e.g., domestic violence); or parent mental health problems (e.g., substance abuse, perinatal mood disorders).

Factors are (presumably) selected based on risk for later child maltreatment, although the empirical basis as a risk factor for later child maltreatment is not well established. Further, it is not clear whether clinical risk screening outperforms demographic screening in identifying birthing families at risk of later poor outcomes and is worth the added cost. Demographic measures are often already available to program providers or can be collected at minimal additional cost, whereas clinical measures require trained screeners and population access. The advantages of demographic screening include easy access to eligible families because of families' participation in other government programs that are based on demographic factors, such as Medicaid, and presumed rapid identification by low-cost screening tools. Disadvantages include possible stigma to families ("stained by circumstances of birth") and programs ("a program for the poor is a poor program") and low take-up rates because parents do not see a rationale for intervention. The advantages of clinical screening include the potential to identify substantive targets that could tailor intervention (e.g., screening based on substance abuse guides the parent toward substance

abuse treatment), parents' understanding of a rationale for intervention, and therefore possible higher take-up rate. Disadvantages include higher screening costs.

Unfortunately, few studies have tested the predictive validity of different screening criteria. Investigators in a 2002 California birth-cohort study (Putnam-Hornstein & Needell, 2011) examined the risk of maltreatment investigation by infant-age 60 months from demographic criteria at birth and found increased risk for families with low income (indexed by MediCal status), mother's age at less than 20 years, and mothers with less than high school education. Clinical factors increasing risk were poor infant health at birth and late prenatal care initiation. Other prospective studies have identified clinical risk factors at birth that predict later maltreatment, including maternal depression, substance use, and parenting skill deficits (Berlin et al., 2013) and parental childhood-trauma exposure (Berlin et al., 2011). Correlational studies have identified risk factors that include domestic violence (Herrenkohl et al., 2008) and parental substance abuse (Wilens et al., 2002).

Given the large resources being devoted to home-visiting and the high stakes of child maltreatment, maximizing screening accuracy is crucial. The 19 MIECHV-approved programs and other home-visiting programs are intended to be preventive; that is, their impact is measured not only in immediate outcomes but in preventing poor infant outcomes and costs in future years after the program has ended. Because the goals of early childhood programs are often directed toward getting children and families ready for kindergarten matriculation, we chose infant age 60 months (5 years, age of kindergarten entry) as an optimal age to test outcomes against which screening accuracy at birth could be tested.

The primary goal of this study was to test the predictive validity of demographic and clinical factors in identifying families that are eventually investigated for child maltreatment or access costly emergency medical care in the first five years of life. We hypothesized that clinical factors would be stronger predictors, even when demographic factors are controlled. We approached a representative community sample of birthing families and assessed four demographic factors (i.e., low-income, first-time birth, teen parent, no high school diploma) and four clinical factors (i.e., need in domains of health care, parenting/child care, home safety, and parent mental health) in the context of a home-visiting intervention. We then prospectively followed families through infant-age 60 months and used Cox hazard models to predict timing and ultimate child maltreatment investigations as recorded in the state Child Protective Services registry and emergency medical care utilization due to injuries and illnesses as noted in hospital records. Our goal was to produce findings that could guide future policies for screening of families for early home-visiting intervention.

2. Methods

2.1. Participants

Participants were a county population-representative sample drawn from the Family Connects (FC) universal postnatal nurse home-visiting program in Durham, NC (Dodge et al., 2013). As part of a randomized controlled trial of FC, all 2327 even-birthdate families between July 1, 2009, and December 31, 2010, were assigned to receive intervention. From this group, a computer generated a random, representative group of 269 families

(one per even birthdate across an 18-month period) for longitudinal inquiry in return for $50 compensation. The computer-generated group did not differ significantly from the population of birthing families (Dodge et al., 2014). Of this group, 201 families (74.7%) gave consent for follow-up and were successfully followed through age 60 months. These participants included 39.8% who were Black, and 33.8% who were Latina. The participant group did not differ from the non-participant group in infant gender, marital status, being a first-time mother, being a teenage mother, or being a mother without a high school diploma, but was slightly more likely to have Medicaid or no health insurance (Dodge et al., 2014). IRB approval was granted by the Duke University Institutional Review Board.

2.2.   Procedure

During a 2-hour home visit conducted at about 3 weeks of infant age, trained nurses completed a semi-structured interview with mothers (and fathers if available) about their needs. Items included open-ended questions and screening instruments.

2.3.   Measures

2.3.1.   Demographic risk—Four demographic variables were coded from administrative birth and hospital records. *Health insurance* for infant was coded 1 if Medicaid or uninsured and 0 if private insurance. *Primiparous status* was coded 1 if this was the mother's first time giving birth (0 otherwise). *Teenage mother* was coded 1 if the mother was less than 20 years old when giving birth (0 otherwise). *No high school diploma* was coded 1 if the mother had not graduated from high school (0 otherwise). In addition to these four variables, *any demographic risk* was scored 1 if any of the four demographic variables was scored as 1 (0 otherwise).

2.3.2.   Clinical risk—Four clinical-risk domains (with three factors within each domain) were assessed through combined clinical interviews, screening instruments, and observations by trained nurses during a home visit within the first four weeks after birth (Dodge et al., 2014):

Health care domain:

1.   *Maternal healthcare*: inadequate plan to receive ongoing health care for any maternal physical health problems, or no family planning;

2.   *Infant healthcare*: inadequate plan for infant feeding, lactation support, or pediatric health care delivery;

3.   *Healthcare participation*: uncertainty about family likely adherence to maternal or pediatric healthcare.

Parenting/childcare domain:

1.   *Childcare*: inadequate childcare plans including emergency and respite care;

2.   *Parent-infant relationship*: parent disdain or lack of parent knowledge about child development;

3.   *Infant crying*: inadequate parental knowledge of how to respond to infant crying.

Safe home domain:

1. *Material support*: inadequate food, shelter, transport, or equipment;

2. *Domestic violence*: concerns about partner violence or personal safety within the home or neighborhood;

3. *Family child maltreatment history*: child maltreatment history or vulnerability.

Parent mental health domain:

1. *Parent mental health*: clinically significant anxiety, depression, or other psychiatric symptoms;

2. *Parent substance abuse*: clinically significant alcohol or substance abuse; or.

3. *Parent social support*: significant social isolation or lack of minimal social support.

For each of the 12 factors, the nurse rated clinical need as: 1 if non-existent or minimal; 2 if minor and immediately remediable (e.g., location of nearest childcare facility); 3 if severe enough to merit referral to community agency for intervention (e.g., mental health agency for postpartum depression); or 4 if urgent requiring emergency intervention such as a 911 call (e.g., infant high fever; this code occurred in fewer than 1% of all cases). Factor scores of 1 or 2 were then recoded as "minimal risk," and scores of 3 or 4 were recoded as "clinically significant risk." Any score of clinically significant risk on any of the three factors within a domain led to a domain risk score of 1 (0 otherwise). In addition to these four variables, *any clinical risk* was scored as 1 if any of the four clinical-risk domain variables was scored as 1 (0 otherwise).

Nurses were trained to certification through direct observation, practice in home visiting, adherence to the manualized protocol, testing with feedback, and ongoing supervision. Independent observer-rated adherence to 65 items in the manual as tested on 11% of cases was 84%, and inter-rater independent agreement on scoring of risk was strong ($K = 0.69$).

2.3.3.   Child outcomes—Two outcome measures were derived from administrative record review. *Child Protective Services investigation* (*CPS*; Easterbrooks et al., 2013) was scored as 1 if any reported episode was found in the statewide registry (0 otherwise). Substantiations of maltreatment were also recorded but occurred for fewer than 5% of all families because of a temporary local practice to avoid this designation, and so they were dropped from all analyses. *Emergency medical care* (*EMC*; Dodge et al., 2013) was scored as 1 if the child had any record of receiving emergency department care or unexpected hospital overnight for injury or illness, taken from the records of the two local hospitals (Duke Hospital and Duke Regional Hospital). In the years of data collection (2010–2015), in Durham, NC, non-Duke urgent care facilities accounted for a miniscule proportion of emergency medical care and were not included. Measures were scored for each month from birth through 60 months of age for hazard analysis and were combined across months as a measure of "ever" lifetime outcome.

2.4. Analysis plan

All variables are binary and reported as percentages. Missing data accounted for fewer than 5% of all data points. Multiple imputation was applied to independent variables for all statistical analyses, and raw proportions are reported in tables (McGinniss & Harel, 2016; Schafer & Graham, 2002). We used STATA 14.2 (Stata, 2016).

The primary research question was evaluated by Cox proportional hazards regression models (Mills, 2011), which estimated the independent effects of having any demographic risk and any clinical risk on the interval in months of infant age to each of the two outcome variables (CPS investigation and EMC). All analyses included 201 participants. Data were right censored. The censor variable indicated whether the child experienced the outcome (censor = 1 indicates yes, and censor = 0 otherwise). The hazard rate was the probability that a child experienced the outcome at time t (range = 0 to 60 months) while that child was at risk for having the event. A Cox t coefficient tested significance. Secondary models tested each of the 4 demographic and 4 clinical risk domains individually. Tests revealed no violations of the proportional-hazards assumption ($p > 05$; Grambsch & Therneau, 1994). Supplemental Chi-squares tested whether risk variables predicted ever experiencing an outcome by age 60 months (coded as 1 or 0).

Finally, before conducting primary analyses, we considered whether participation in the FC intervention might alter the correlations between predictor and outcome variables, so we examined a representative group of 280 control-group families that had not been assigned to intervention. Demographic variables were available for this group but not clinical variables because the latter were collected only during intervention. The intervention and control groups did not differ reliably from each other or the full population on means for each of 10 demographic variables available from birth records (Dodge et al., 2014). A Cox proportional hazards regression model was estimated to test whether the correlation between the demographic risk factor at birth and age-60 month outcomes differed for the participant group and the control group. Two variables and their interaction term were included: any demographic risk (0 = no/1 = yes), intervention status (0 = no/1 = yes), and the interaction term (any demographic risk * intervention status). The interaction term was not statistically significant for either outcome, child protective services investigations or emergency medical care. We conclude that assignment to intervention did not alter the correlation between demographic variables at birth and later infant outcomes; therefore, findings for analyses of the participant group will likely represent those for the full population. Similar analyses were not possible for clinical risk variables because they were available only for the families participating in intervention. If intervention did have an effect, it would likely be to lower the estimated relation between risk and outcome; thus, estimates for clinical risk are likely lower-bound. Only the 201 intervention families were included for all reported analyses.

3. Results

3.1. Descriptive analysis

Table 2 lists descriptive statistics. 68.5% of infants were insured by Medicaid or uninsured, 39% of mothers were primiparous, 9.5% were younger than 20 years old, 29.8% did

not have a high school diploma, and 85.6% had at least one of these demographic characteristics. Base rates of clinical risks were: health care, 25.9%; parent/childcare, 8.5%; safe home, 20.8%; and parent mental health, 15.5%. 42.4% of families had at least one clinical risk factor. The "any" demographic risk variable was modestly related to the "any" clinical risk variable, $X(I) = 5.20$, $p < .03$. Of families with any demographic risk, 45.6% also had clinical risk, in contrast with 22.2% of families with no demographic risk.

Base rates for outcomes were 18.9% for any CPS investigation and 60.7% for any EMC.

3.2. Prediction of maltreatment and emergency medical care

Table 2 presents statistics for all tests, sensitivity, specificity, and overall accuracy. Figs. 1, 2, and 3 depict risk-group differences.

3.2.1. Child maltreatment investigations (CPS)—The primary hypothesis was tested through a Cox regression model predicting time to the first CPS investigation from the demographic variable of any demographic risk and the clinical variable of any clinical risk. The test revealed a highly significant coefficient for the clinical risk variable (Hazard Ratio [HR] = 4.01, 95% CI = 1.97, 8.15) and a non-significant coefficient for the demographic risk variable (HR = 2.45, 95% CI = 0.58, 10.26). Fig. 1 depicts the more rapid onset and higher ultimate rate of CPS investigations for the group with any clinical risk than the group with no clinical risk. As shown by the earliest age at which the confidence intervals in Fig. 1 no longer overlapped, the difference between these two groups was significant by age 12 months and grew across the life course. The difference between the any demographic-risk group and the no demographic-risk group was never significant. Fig. 2 shows the rate of ever having a CPS investigation is higher for the any-clinical risk than the no-risk group. Table 2 shows the clinical-risk variable had high sensitivity, high specificity, and overall accuracy of 0.64. Although the demographic risk variable also had high sensitivity, its specificity was poor and its overall accuracy was only 0.31.

Follow-up analyses were conducted for each of the four demographic variables taken individually without controlling other variables, to see whether any single variable alone could identify families at risk of child maltreatment. Both Cox regression analyses of time to hazard (reported in Table 2) and chi-square tests of ever being investigated for maltreatment by age 60 months (depicted in Fig. 2) revealed that only Medicaid/uninsured status predicted the CPS outcome significantly in the hypothesized direction ($p < .01$), but accuracy of prediction from this variable was under 50%. Surprisingly, being a first-time mother significantly predicted *protection* from the child maltreatment outcome. That is, first-time mothers were at *lower risk* (p < .01): 8.9% of primiparous mothers had a CPS investigation, in contrast with 25.4% of multi-parous mothers. The protective value of being a first-time birth held among both Medicaid/uninsured families (11.6% of primiparous births had a CPS investigation, in contrast with 31.5% of later births) and privately insured families (5.7% of primiparous birth had a CPS investigation, in contrast with 7.4% for later births). Being a teenage mother was unrelated to CPS outcomes, and not having a high school diploma was unrelated to CPS outcomes.

Cox model analyses (reported in Table 2) and chi-square tests (depicted in Fig. 2) of each of the four clinical-risk variables taken individually without controlling other variables revealed that each of the four variables robustly predicted later CPS outcomes. In particular, 41.9% of families identified as having a mental health risk later had a CPS investigation, in contrast with 14.8% of those not having this clinical need ($p < .001$). Follow-up analyses indicated each of the three factors within the mental health domain strongly predicted a later CPS investigation. For depression/anxiety, 38.1% of high-risk families had a later CPS investigation, in contrast with 16.8% for low-risk families ($p = .02$). For substance abuse, 75.0% of high-risk families had a CPS investigation in contrast with vs. 18.1% of low-risk families ($p = .01$). For lack of minimal social support, 41.7% of high-risk families had a CPS investigation, in contrast with vs. 17.6% of low-risk families ($p = .04$).

We next examined whether combined demographic and clinical risk was superior to either type of risk alone in predicting outcomes. Because the only demographic factor significantly predicting a CPS investigation in the hypothesized direction was Medicaid/uninsured status, a follow-up analysis was conducted using a risk indicator that was scored 1 if Medicaid/ uninsured status plus at least one clinical-risk factor (otherwise 0). A highly significant Cox coefficient (HR = 4.22, 95% CI = 2.15, 8.30) indicates this indicator was superior to Medicaid/uninsured status alone by increasing accuracy from 0.47 to 0.69, but it was only modestly superior to clinical-risk status alone by improving accuracy from 0.65 to 0.69. Thus, assessment of demographic variables does not appreciably enhance the prediction of child maltreatment beyond clinical-risk status by itself, whereas assessment of clinical risk significantly improves the prediction of child maltreatment beyond demographic variables.

Subgroup analyses were conducted to examine whether the clinical-risk variable predicted the CPS outcome within Medicaid/uninsured subgroups. Within the Medicaid/uninsured subgroup, having any clinical risk significantly increased the probability of having any CPS investigation, $X(1) = 6.11$, $p < .02$. Within the privately-insured subgroup, having any clinical risk marginally significantly increased the risk of having any CPS investigation, $X(1) = 2.78$, $p < .10$.

Subgroup analyses were also conducted to examine whether Medicaid/uninsured status predicted the CPS outcome within clinical risk groups. Within the no-clinical-risk group, Medicaid/uninsured status was not significantly predictive of a CPS outcome, $X(1) = 1.02$, n.s. Within the high clinical risk group, Medicaid/uninsured status was marginally significantly predictive of a CPS outcome, $X(1) = 3.32$, $p = .07$.

These findings indicate that even when Medicaid status is controlled or taken into consideration, clinical risk provided an increment in the prediction of a maltreatment outcome. In contrast, when clinical risk was controlled, Medicaid/uninsured status did not have a robust increment in predicting a CPS outcome.

3.2.2. Emergency medical care (EMC)—Cox regression models predicted time to the first EMC event from having any demographic risk and from having any clinical risk. Fig. 3 depicts more rapid onset and higher ultimate rate of CPS investigations for the group with any clinical risk than the group with no clinical risk. The difference between these two

groups was significant by age 18 months and grew across the life course. The difference between the any demographic-risk group and the no demographic-risk group was never significant. Analyses reported in Table 2 and depicted in Fig. 4 reveal that the clinical-risk variable significantly predicted higher and earlier-onset of EMC (HR = 2.14, 95% CI = 1.03, 2.14), whereas the demographic risk variable did not significantly predict later EMC (HR = 1.54, 95% CI = 0.88, 2.87). Table 2 shows the clinical-risk factor had good sensitivity and good specificity. Although the demographic factor had high sensitivity, its specificity was poor.

Individual Cox models of demographic factors that did not control other demographic factors as reported in Table 2 revealed that EMC was significantly predicted from being Medicaid/uninsured ($p < .001$), a teenage mother (p < .001), and not graduating from high school (p < .001). In contrast, being a first-time mother significantly *protected against* this outcome ($p < .05$), and protection was observed among both Medicaid/uninsured infants (69.8% of primiparous births had EMC, in contrast with 77.2% of later births) and privately-insured infants (22.9% of primiparous births had EMC, in contrast with 48.1% for later births).

Individual Cox models of clinical factors that did not control other clinical factors as reported in Table 2 indicated that EMC was robustly predicted from each of the four clinical-risk variables: health care ($p < .03$), parenting ($p < .06$), safe home (p < .03), and parent mental health ($p < .04$). Each indicator had poor sensitivity but high specificity, indicating that a positive screen was highly predictive of later EMC, but a negative screen was not diagnostic. This pattern suggests that one clinical-risk variable does not substitute for other clinical-risk variables in prediction accuracy, and the most accurate prediction would come from using a combination of all clinical variables or an "any risk" variable.

Follow-up analyses using a combined risk indicator of Medicaid/uninsured status plus at least one clinical risk factor revealed a significant Cox coefficient (HR = 1.76, 95% CI = 1.23, 2.53) which had lower sensitivity but higher specificity than Medicaid/uninsured status alone, and equivalent sensitivity, specificity, and accuracy to having any clinical risk factor alone.

Subgroup analyses were conducted to examine whether the clinical-risk variable predicted the EMC outcome within Medicaid/uninsured subgroups. Within the Medicaid/uninsured subgroup, those with any clinical risk had a probability of 0.75 of having any EMC, which was similar to 0.74 for those with no clinical risks, $X(I) = 0.03$, n.s. Among the privately-insured subgroup, those with a clinical risk had a probability of 0.45 of having any EMC, in contrast with 0.29 for those with no clinical risks, $X(I) = 1.09$, n.s.

Subgroup analyses were also conducted to examine whether Medicaid/uninsured status predicted the EMC outcome within clinical risk groups. Within the no-clinical-risk group, those with Medicaid/uninsured had a probability of 0.74 of having any EMC, in contrast with 0.29 for those with private health insurance, $X(I) = 21.52$, $p < .001$. Within the high clinical-risk group, those with Medicaid/uninsured had a probability of 0.75 of having any EMC, in contrast with 0.46 for those with private health insurance, $X(I) = 4.05$, $p < .05$.

These findings show that clinical risk significantly predicts the emergency medical care outcome, and an omnibus demographic risk variable that includes primiparous status does not predict emergency medical care. However, having Medicaid/being uninsured robustly predicts higher later emergency medical care, even when clinical risk is taken into account. Families with Medicaid or who are uninsured have a much higher likelihood of coming to the emergency department for care than do privately insured families, and this finding holds for families with high clinical risk as well as those with low clinical risk.

4. Discussion

The findings show that screening of clinical needs and risk just after birth robustly predicts later child protective services (CPS) investigations for child maltreatment and emergency medical care (EMC) outcomes. Clinical screening significantly improves the prediction of later CPS outcomes beyond reliance on demographic factors alone. Within the high demographic risk group of Medicaid and uninsured families, clinical risk factors strongly enhance the prediction of later child maltreatment; and within the private health insurance group, clinical risk factors strongly enhance the prediction of later child maltreatment. Screening of clinical risk accurately identifies high-risk families for eligibility for home-visiting intervention.

In contrast, demographic factors that are currently used in selecting families for MIECHV-approved home-visiting are comparatively poor predictors of child maltreatment outcomes. The supposed risk from being a primiparous mother is actually protective against maltreatment and emergency medical care. Having Medicaid or no health insurance strongly predicts later emergency medical care (EMC) but not CPS investigations, after accounting for clinical risk factors.

The findings show that predictors of CPS investigations and EMC differ from each other. Emergency medical care is a function of both clinical risk and demographic risk status, and is a particularly strong function of Medicaid/uninsured status. It appears that having Medicaid or being uninsured renders a family especially likely to appear in an emergency department, whether or not clinical risk is present. Being privately insured protects a family from using emergency medical care, most likely because other forms of health care through a private pediatrician are more effective. Current health care delivery in the United States for Medicaid and uninsured families includes comparatively high reliance on emergency department medical care, perhaps as a substitute for privately paid pediatric care. This fact poses challenges for health policy generally. For MIECHV policy, it suggests that risk for emergency medical care might not be the most appropriate criterion when selecting families for home-visiting intervention or the most sensitive measure to evaluate impact of home-visiting programs.

4.1. Identifying families for home visiting

Identifying families for home-visiting based solely on Medicaid or uninsured status at an infant's birth yields a group that includes most of the problematic CPS and EMC outcomes but with so many false positives that costs for program delivery may be inflated beyond cost-effectiveness. Narrowing this group by adding other demographic indicators such as

mother's status as first-time, teenage, or high school dropout, does not improve prediction appreciably.

In contrast, using clinical-risk factors to identify families for home-visiting programs would enable program administrators to target the highest-risk families and to plan tailored clinical interventions based on individual family needs. Prediction of child maltreatment is improved by screening of clinical risk in domains of health care, parenting readiness, safe home, and parental mental health. Screening positive in any of these clinical domains predicts CPS and EMC outcomes more strongly than does any demographic factor.

4.2.   Return on investment

The findings indicate that families at highest risk for child abuse could be more accurately selected by clinical screening than by demographic screening. Furthermore, clinical screening enables the home visitor to target the content of intervention toward the family's vulnerability, consistent with the assertion that precision approaches to prevention could improve public health outcomes (Bayer & Galea, 2017). Supplee and Duggan (2019) suggest that precision approaches for screening and intervention planning for home-visiting programs could improve efficiency and effectiveness.

Simulations based on the findings of Table 2 illustrate these points. Assume each investigated CPS case bears a lifetime cost to society of approximately $71,404 (Fang et al., 2012). Assume a population of 1000, the current-sample age-5 CPS lifetime base rate of 0.189, an average HV intervention cost of $10,000 per family, and a strong treatment impact of reducing maltreatment by one-half. If Medicaid alone makes a family eligible for HV, 685 families would qualify at a total treatment cost of $6,850,000. With sensitivity of 0.895, 169 CPS cases would be present in the treated group, if untreated; with effective HV intervention, 85 CPS cases would be prevented at a savings of $6,033,638. Nonetheless, return on investment (ROI) would be a loss of 11.9%.

If eligibility requires having Medicaid and being a primiparous mother, 218 families would be treated at a cost of $2,180,000. With sensitivity of 0.132, 25 CPS cases would occur in this group if left untreated. Effective treatment would save 12 CPS cases and $890,693. Still, ROI would be a loss of 59.2%.

In contrast, if eligibility requires screening positive for any clinical risk, 424 families would be treated at a cost of $4,240,000, with sensitivity of 0.703. If untreated, 133 CPS cases would occur in this group. Effective treatment would save 66 cases and $4,741,226. ROI would be a positive 11.8%. However, screening costs must be considered. Dodge et al. (2013) found that universal screening can be completed at a cost of about $300 per family. Factoring in a hypothetical screening cost of $300 for every member of the population ($300 × 1000 = $300,000) would still yield a positive ROI of 4.4%.

Of course, different populations might yield different base rates of maltreatment, different screening costs would yield different ROIs, treatment costs and effectiveness might vary across programs, and other outcomes could increase or decrease ROI. We encourage future studies to collect and report this information in diverse contexts to enrich this database

toward more systematic calculation of screening utility and more precise estimates of return on investment.

A surprising finding is how strongly being a first-born infant protects that infant from later CPS or EMC outcomes. We call this finding "surprising" because this factor is used to select families for some home-visiting programs. This finding is not due solely to the fact that proportionately more first births are privately insured; even within insurance-status groups, being first born lowers rather than increases risk. Home-visiting programs that select first-time mothers, even when combined with having Medicaid, target families that have *lower* risk for CPS and EMC than a randomly selected infant in the population.

Why is a first-born infant at lower risk for maltreatment than later-born infants? We can only speculate that parenting later-born infants, particularly if closely spaced, is a more challenging task that brings increased financial and parenting stress burden. It is also plausible that families with multiple infants have contact with more agencies with mandated reporters, increasing the probability of detection rather than actual maltreatment; however, we find that later-born infants are at increased risk for emergency medical costs as well as maltreatment investigations, reducing the likelihood that the phenomenon is a detection problem alone.

It should be noted that a home-visiting program with primiparous Medicaid mothers could still be effective in reducing the rate of CPS and EMC outcomes within this group, but it is not likely that intervention with this group will lower population-level outcomes substantially because this group is already at low risk. It could also be that intervening at a family's first birth is a way to reach every child in the population (because parents of later-born children will have been reached indirectly through the first-born) and that maltreatment might be prevented for later births, although we know of no studies showing impact of home visiting at a first birth on the prevention of maltreatment in subsequent births.

4.3. Limits

The findings support screening of clinical-risk factors to select families for home visiting, but several cautions are in order. First, the cost and feasibility of clinical screening must be considered in overall economic analyses of home-visiting program administration. Using demographic factors alone has the appeal of low cost and ready access. A compromise sequential strategy could be explored, in which Medicaid/uninsured status is used as the first gate, followed by clinical screening only among this subgroup. However, this strategy would miss the privately-insured families that have a positive clinical-risk factor, for whom a not-insignificant 18% have a child abuse investigation by age 60 months. We find that clinical screening significantly enhances accuracy of prediction of abuse outcomes within both insured and Medicaid/uninsured groups. We conclude that universal clinical screening may well be worth the cost.

Second, we note that this study was conducted with only one community population. We advocate for more studies with diverse populations to determine the contexts in which clinical screening alone or clinical screening combined with demographic screening

maximizes efficiency. Third, our analyses were limited to only two outcomes: child protective services investigations and emergency medical care through age 60 months. It is plausible that demographic factors predict other costly outcomes that could be prevented by home-visiting with demographically-targeted groups. Fourth, the current study is limited by its relatively small sample size that precludes analysis of more subgroups. It is possible that risk profiles differ across subgroups.

Identification of a highest-risk group based on either clinical or demographic factors does not imply that home-visiting will be effective with this subgroup of families. Nor does it imply that home-visiting for lower-risk families will be ineffective. For example, the Nurse Family Partnership was found to be effective for families without domestic violence but not for families with domestic violence (Eckenrode et al., 2000), and Healthy Families Massachusetts was found to be effective for families without maternal depression but not for families with maternal depression (Easterbrooks et al., 2013). Future randomized trials should include measures of demographic and clinical risk factors with large enough samples to evaluate effectiveness of intervention within various risk subgroups.

Finally, although MIECHV funding is contingent on past demonstrated effectiveness in preventing infant maltreatment and health outcomes, many home-visiting programs have additional goals, such as improving parenting skills, parent economic self-sufficiency, and infant behavioral development. It will be important to evaluate whether demographic or clinical risk variables better predict these outcomes.

5. Public health implications

Given the large federal investment in home visiting, these findings should guide public health planning and further epidemiological studies. The findings suggest the merits of transforming the current haphazard early childhood system of care, which relies on families to initiate interventions they need, into a universal public psychological health system that screens all birthing families with brief clinical interviews to identify families for longer-term intervention to promote infant healthy development and prevent costly outcomes in maltreatment and emergency medical care. Such a system will likely require a public-private partnership to ensure that all families are reached at birth, get screened by professional providers who interact with families, and are then supported in receiving home-visiting or other (perhaps even more clinically tailored, based on assessed need) services that are delivered in the context of parent or infant health care by public, private, or nonprofit providers.

Acknowledgements

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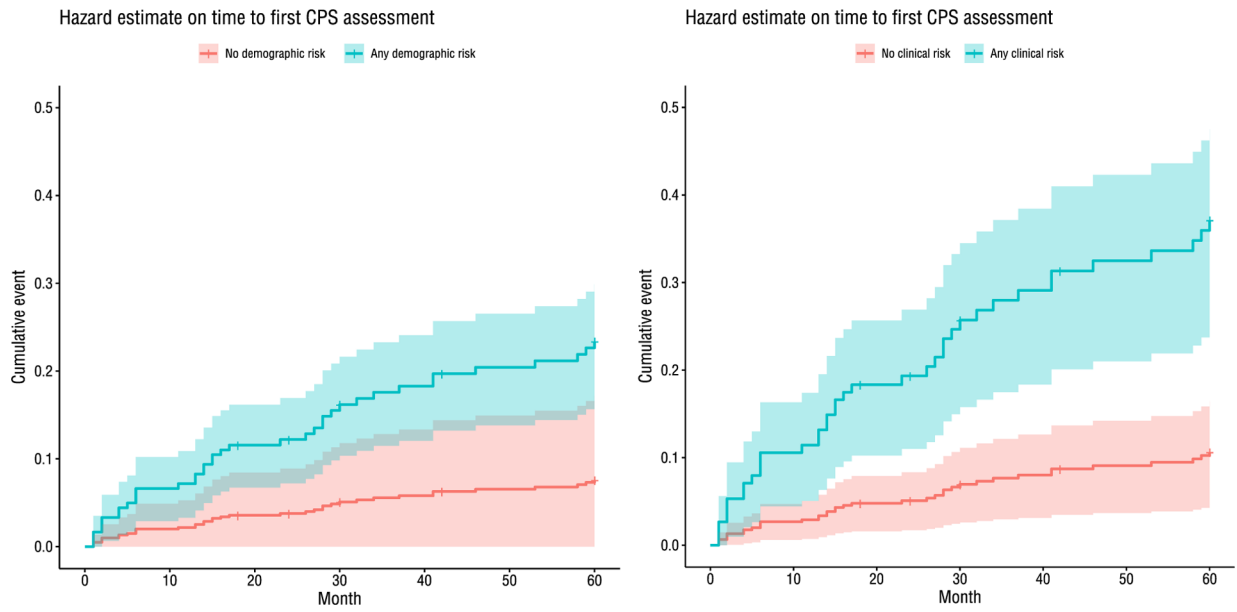
Fig. 1.
Cox hazard estimates for time to first CPS assessment for clinical-risk, no-clinical risk, demographic risk, and no-demographic risk groups. Note: Bars for each line indicate the 95% confidence interval. Nonoverlapping bars indicate a significant difference at that point in time.
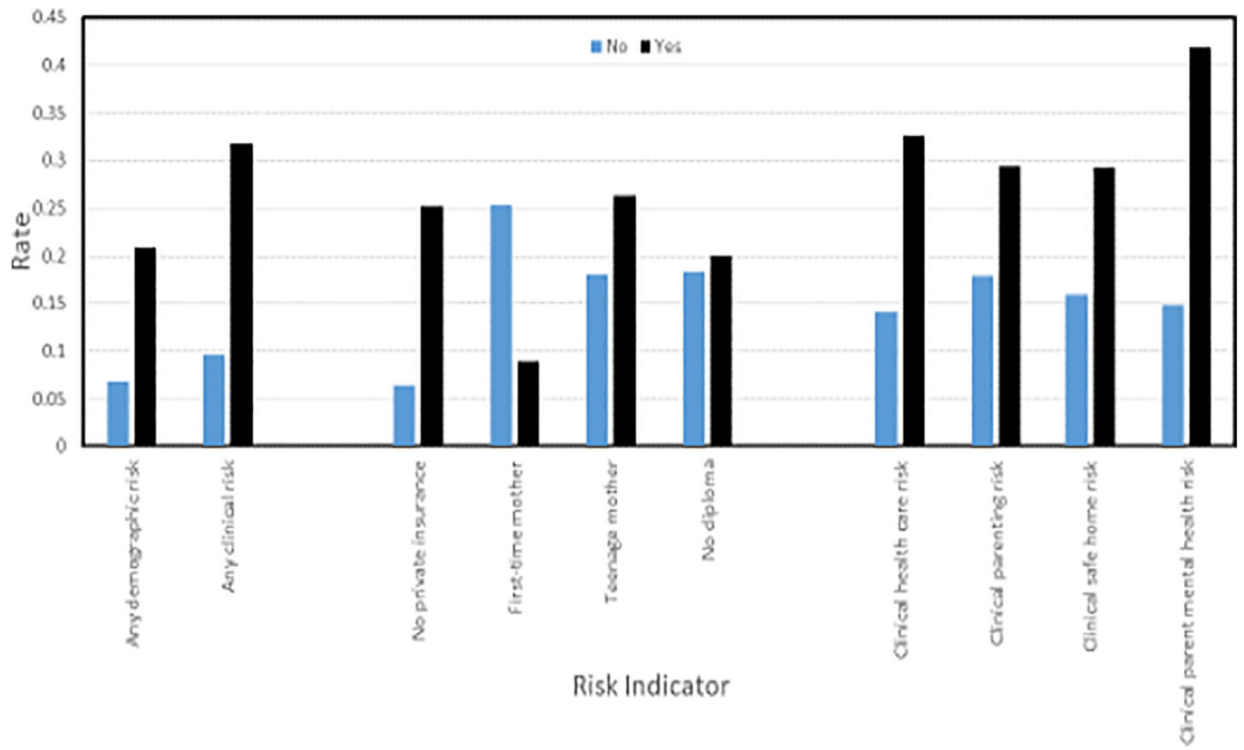
Fig. 2.
Rate of ever having a Child Protective Services investigation (CPS) by age 60 months as a function of demographic and clinical risk indicators.
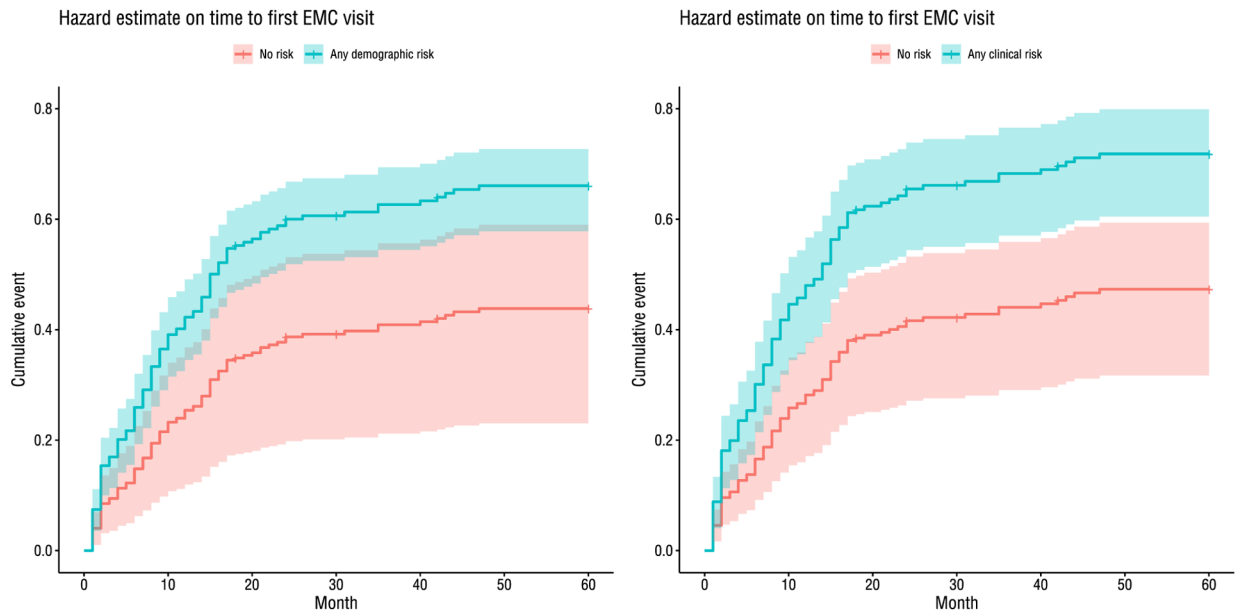
Fig. 3.
Cox hazard estimates for time to first emergency medical care visit for clinical-risk, no-clinical risk, demographic risk, and no-demographic risk groups. Note: Bars for each line indicate the 95% confidence interval. Nonoverlapping bars indicate a significant difference at that point in time.

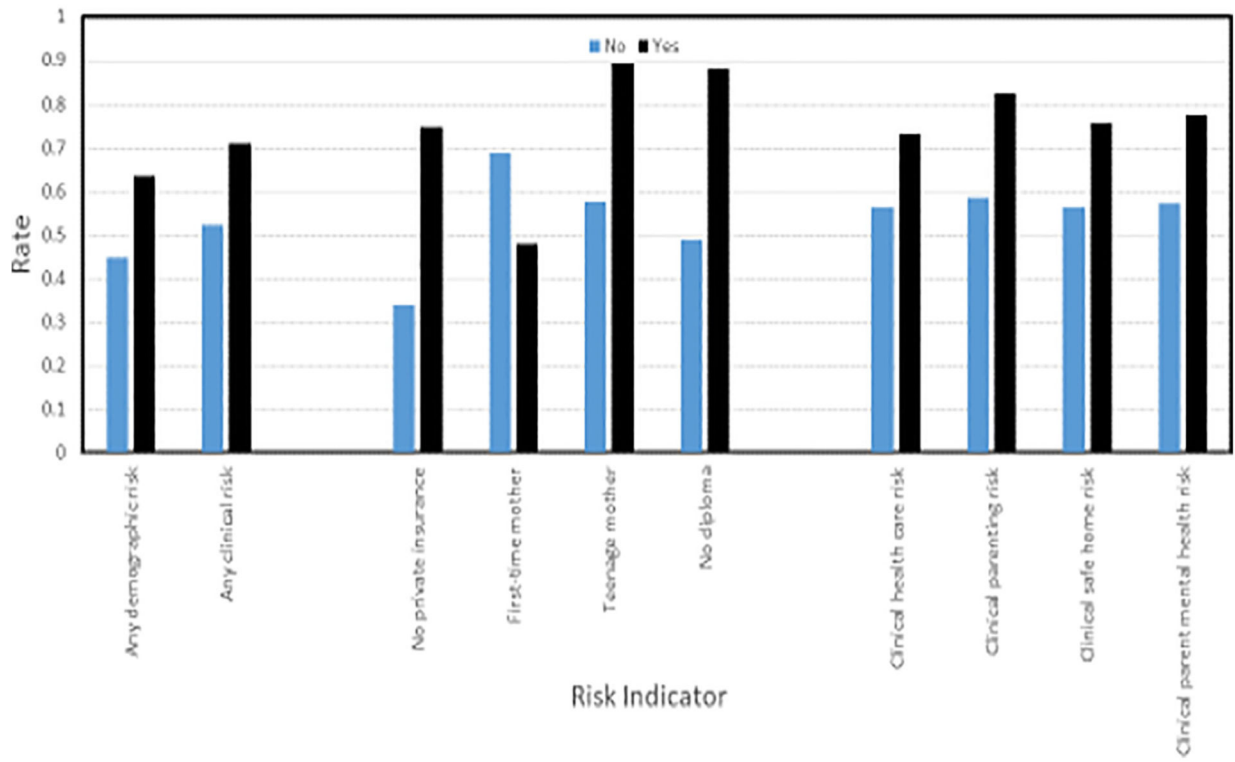**Fig. 4.**
Rate of ever receiving Emergency Medical Care (EMC) by age 60 months as a function of demographic and clinical risk indicators.

Table 1

Eligibility criteria for all MIECHV approved programs.

Program	Demographic criteria				Clinical criteria				Universal
	Low income	Primiparous	Teen parent	Other (e.g., no diploma; ethnicity)	Parent history of maltreatment	Recent infant maltreatment	Parent risk	Child risk	
Attachment Biobehavioral Catch-Up						X			
Child First						x	x	x	
Healthy Families America	x	x		x	x		x		
Family Connects									X
Home Instruction for Parents of Preschool Youngsters	x			x			x		
Early Head Start	X								
Maternal Early Childhood Sustained Home-Visiting Program	X				x		X		
Early Intervention Program for Adolescent Mothers		X	X	X			–		
Minding the Baby®	X	X	X				–		
Early Start			x			x	x		
Nurse Family Partnership	X	X							
Family Check-Up	X						x	x	
Parents as Teachers	x	x	x	x	x	x	x	x	
Family Spirit				X					
Play and Learning Strategies				x			x		
Health Access Nurturing Development Services	x	X					x		
Safe Care Augmented			x		x	x	x	x	
Healthy Beginnings	X	X							
Maternal Infant Health Program	x								

Note: "X" indicates necessary criterion; "x" indicates sufficient criterion; "–" indicates exclusionary criterion. Health Resources and Services Administration (2020). Home visiting. https://mchb.hrsa.gov/maternal-child-health-initiatives/home-visiting-overview

Table 2

Cox Model prediction of child abuse and emergency medical care from demographic and clinical criteria.

Models	Base rate	CPS investigations (base rate = 0.189)					Emergency medical care (EMC) (base rate = 0.607)				
		Cox t (p)	X²(1); (p)	Sensitivity	Specificity	Accuracy	Cox t (p)	X²(1); (p)	Sensitivity	Specificity	Accuracy
Primary: demographic and clinical-risk											
Any Demographic	0.856	2.45	3.19(0.08)	0.947	0.166	0.313	1.54	3.58(0.06)	0.893	0.203	0.622
Any Clinical	0.424	4.01(0.001)	14.6(0.001)	0.703	0.642	0.653	2.14 (0.04)	7.11(0.008)	0.500	0.692	0.577
Secondary: individual factors Demographic											
Medicaid or uninsured	0.685	4.47(0.01)	9.58(0.002)	0.895	0.365	0.467	3.48(0.001)	30.2(0.001)	0.828	0.547	0.721
Primiparous mother	0.393	*0.31(0.01)*	*8.57(0.003)*	0.184	0.558	0.488	*0.62(0.05)*	*8.66(0.003)*	0.311	0.481	.378
Teenage mother	0.095	1.46	0.75	0.132	0.914	0.766	2.55(0.001)	7.28(0.007)	0.139	0.975	0.468
No diploma	0.298	1.19	0.07	0.316	0.706	0.632	2.97(0.001)	27.4(0.001)	0.434	0.911	0.622
Clinical											
Health care	0.259	2.94(0.001)	8.69(0.003)	0.447	0.785	0.721	1.44	4.51(0.04)	0.311	0.823	0.512
Parenting	0.085	1.83	1.34	0.132	0.926	0.776	1.79(0.05)	3.65(0.06)	0.115	0.962	0.448
Safe home	0.208	2.10(0.05)	3.73(0.06)	0.324	0.819	0.726	1.62(0.05)	5.00(0.03)	0.261	0.872	0.503
Mental health	0.155	3.48(0.001)	12.5(0.001)	0.342	0.889	0.785	1.41	4.39(0.04)	0.198	0.911	0.480

Note: Cox models predict interval to first CPS or EMC in months with all predictors variables included. Chi-square tests predict ever having the outcome by age 60 months from individual risk variables without any other predictors in the model. Sensitivity = rate of bad outcomes correctly identified = (true positive/true positive + false negative); Specificity = rate of good outcomes correctly identified = (true negative/true negative + false positive); Accuracy = (true positive + true negative)/total. Two-tailed p values are listed but only for values of 0.25 or less. Italicized figures indicate prediction in opposite direction than hypothesized.