

Characteristics Associated with Failure to Complete the Pneumococcal Vaccine Series among Children with Sickle Cell Disease or Sickle Cell Trait

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BACKGROUND

- The Centers for Disease Control and Prevention (CDC) releases immunization schedules for various age groups that are approved by the Advisory Committee on Immunization Practices, the American Academy of Pediatrics, and the American Academy of Family Physicians (Table 1).¹
- Children with sickle cell disease (SCD) are at increased risk of acquiring invasive infections.
- Timely completion of the pneumococcal vaccine series, defined as receiving 4 pneumococcal vaccines by 15 months of age, could reduce the number and burden of invasive infections among children with SCD.

| Vaccine | Age | | | | | | | | | | |
|-------------------------------|-------|------------|-------------|--------------------|----------------|--------------|--------------|--------------|-----------------|--------------|--------------|
| | Birth | 1 month | 2 months | 4 months | 6 months | 12 months | 15 months | 18 months | 19-23 months | 2-3 years | 4-6 years |
| Hepatitis B | НерВ | He | pВ | | HepB | | | | | | |
| Rotavirus | | | RV | RV | RV | | | | | | |
| Diptheria, Tetanus, Pertussis | | | DTaP | DTaP | DTaP | DTaP | | | | DTaP | |
| Haemophilus influenzae type b | | | Hib | Hib | Hib | н | ib | | | | |
| Pneumococcal | | | PCV | PCV | PCV PCV | | PPSV | | •sv | | |
| inactivated Poliovirus | | | IPV | IPV | IPV | | | | IPV | | |
| Influenza | | | | Influenza (Yeariy) | | | | | | | |
| Measles, Mumps, Rubella | | | | | | MMR | | | | | MMR |
| Varicella | | | | | | Vari | cella | | | | Varicella |
| Hepatitis A | | | | | HepA (2 doses) | | | | HepA | Series | |
| Meningeococcal | | | | | | | | MCV | | | |

STUDY QUESTIONS

- What proportion of children with SCD or sickle cell trait (SCT) in Michigan completes the pneumococcal vaccine series following the recommended schedule?
- What maternal and infant characteristics are associated with failure to complete the pneumococcal vaccine series?

METHODS

- Newborn screening (NBS) records for all children born from 2004-2008 with SCD or SCT were linked with live birth certificates.²
- Through live birth certificates, NBS data were linked with the Michigan Care Improvement Registry (MCIR), a web-based system where all immunizations of Michigan residents are reported.
- Immunization data were retrieved for children with SCD or SCT.
- Data Sources for Maternal and Infant Characteristics
 - Birth certificate records: Birth date, race, maternal age at time of birth, gestational age, maternal education, maternal county of residence at time of birth, sex, and neonatal intensive care unit (NICU) admission after birth
 - · Immunization records: Vaccine type and date

METHODS

• Age at time of vaccination was calculated using the birth date and vaccine date.

Characteristics of those with SCD were compared to those of children with SCT using chi-square tests.
Bivariate and multivariable logistic regression analyses were conducted to assess characteristics associated with failure to complete the pneumococcal vaccine series.

RESULTS

From 2004-2008, 291 newborns were diagnosed with SCD and 14,536 were reported as SCT.
Through linkages, approximately 97% of these newborns were matched with birth certificate records, and immunization data were available for 90% of the linked NBS/birth certificate records (n=12,743).
Overall, 45% of children with SCD (n=117) and 36% of children with SCT (n=4,392) completed the pneumococcal vaccine series by 15 months of age (Table 2).

• Children with SCD were similar to those with SCT, though they did differ on a few characteristics. Children with SCD were significantly more likely to be admitted to the NICU at birth, to be black, and to reside in the region of Detroit at birth compared to children with SCT.

Among those with SCD, no characteristics were significantly associated with pneumococcal vaccination series completion in either crude or adjusted analyses.

Among those with SCT, NICU admission at birth, black race, residing in the Detroit region, maternal education of high school or less, and maternal age <25 years were all significantly associated with increased odds of failing to complete the pneumococcal series in both crude and adjusted analyses.

| $ \begin{array}{ c c c c c c c c c c c c c c c c c c c$ | Table 2: Characteristics and Essectations between those characteristics and Pathie to Complete the Friedmotocccat vaccination series anong mose with Sickle Cell Disease or Sickle Cell Trait born 2004-2008, Michigan | | | | | | | | | | |
|---|---|---------|----------|----------------------|----------------|---------------------------------|------|----------------|----------------|--|--|
| | | | Children | with Sickle Cell Dis | ease | Children with Sickle Cell Trait | | | | | |
| | | Overall | | Crude | Adjusted* | Overall | | Crude | Adjusted* | | |
| | Characteristic | N | % | OR (95% CI) | OR (95% CI) | Ν | % | OR (95% CI) | OR (95% CI) | | |
| c34 weeks 15 5.8 1.8 (0.6, 5.3) 1.3 (0.3, 5.3) 443 3.6 10 (0.8, 1.2) 0.8 (0.6, 1.0) 34-36 weeks 25 9.7 1.3 (0.6, 3.1) 1.3 (0.5, 3.3) 1083 8.7 1.2 (1.0, 1.4) 1.1 (1.0, 1.3) 237 weeks 218 8.45 1.0 1.0 1.0 1.0 1.0 1.0 NCU Admission at Birth | Gestational Age | | | | | | | | | | |
| 34.3 weaks 25 9.7 1.3 (0.5 , 3.3) 1083 8.7 1.2 (1.0 , 1.0) 1.1 (1.0 , 1.3) 237 weaks 218 8.5 1.0 1.0 1.0898 8.7 1.2 1.1 (1.0 , 1.3) 237 weaks 218 8.5 1.0 1.0 1.0898 8.7 1.0 1.0 NCU Admission at Birth 229 11.2 1.6 (0.7 , 3.7) 1.5 (0.5 , 4.1) 940 7.6 1.2 (1.0 , 1.0 1.0 No 229 8.8 1.0 1.0 1.1455 92.4 1.0 1.0 Sec $$ | <34 weeks | 15 | 5.8 | 1.8 (0.6, 5.3) | 1.3 (0.3, 5.3) | 443 | 3.6 | 1.0 (0.8, 1.2) | 0.8 (0.6, 1.0) | | |
| 237 weeks 218 84.5 1.0 1.0 10898 $8.7.7$ 1.0 1.0 NICU Admission at Birth | 34-36 weeks | 25 | 9.7 | 1.3 (0.6, 3.1) | 1.3 (0.5, 3.3) | 1083 | 8.7 | 1.2 (1.0, 1.4) | 1.1 (1.0, 1.3) | | |
| NICU Admission at Birth Image: Second | ≥37 weeks | 218 | 84.5 | 1.0 | 1.0 | 10898 | 87.7 | 1.0 | 1.0 | | |
| Yes 29 11.2 $1.6.0.7, 3.7)$ $1.5(0.5, 4.1)$ 940 7.6 $1.2(1.0, 1.3)$ $1.2(1.0, 1.3)$ No 229 8.8 1.0 1.0 1145 92.4 1.0 1.0 Sex <td< td=""> 1.0 1.0 1.145 92.4 1.0 1.0 Male 118 45.4 $1.2(0.7, 2.0)$ $1.3(0.8, 2.1)$ 6351 5.0 $1.0(0.9, 1.0)$ $1.0(0.9, 1.0)$ Female 142 54.6 1.0 1.0 6123 49.1 1.0 1.0 Rec 967.5 7.7 $1.4(1.3, 1.5)$ $1.3(1.1, 1.4)$ White 249 95.8 1.0 $9.67.5$ 7.9 $1.4(1.3, 1.5)$ $1.3(1.1, 1.5)$ Other 0 0.0 $9.67.5$ $9.97.5$ 5.59 4.5 $0.8(0.6, 0.9)$ $0.68(0.6, 0.9)$ Other 1.0 1.44 $0.7(0.3, 1.5)$ $0.97.5$ 3.25 $1.6(1.5, 1.7)$ $1.5(1.4, 1.7)$</td<> | NICU Admission at Birth | | | | | | | | | | |
| No 229 88.8 1.0 1.0 1.455 9.24 1.0 1.0 Sex | Yes | 29 | 11.2 | 1.6 (0.7, 3.7) | 1.5 (0.5, 4.1) | 940 | 7.6 | 1.2 (1.0, 1.3) | 1.2 (1.0, 1.4) | | |
| Sex Image Image <thi< td=""><td>No</td><td>229</td><td>88.8</td><td>1.0</td><td>1.0</td><td>11455</td><td>92.4</td><td>1.0</td><td>1.0</td></thi<> | No | 229 | 88.8 | 1.0 | 1.0 | 11455 | 92.4 | 1.0 | 1.0 | | |
| | Sex | | | | | | | | | | |
| Fenale 142 54.6 1.0 1.0 6123 49.1 1.0 1.0 Race Black 249 95.8 I.C 9675 7.9 1.4(1.3, 1.5) 1.3(1, 1.4) Wine 11 4.2 I.C 2168 1.6 1.0 1.0 Other 0 0.0 I.C 2168 1.6 1.0 1.3(1, 1.4) Other 0 0.0 I.C 2188 1.6 1.0 1.0 1.3(1, 1.4) Other 0 0.0 I.C 2188 1.5 8.6 1.0 1.0 Region of Residence at Birh I.C I.C I.S | Male | 118 | 45.4 | 1.2 (0.7, 2.0) | 1.3 (0.8, 2.1) | 6351 | 50.9 | 1.0 (0.9, 1.0) | 1.0 (0.9, 1.1) | | |
| Race Image: Second Secon | Female | 142 | 54.6 | 1.0 | 1.0 | 6123 | 49.1 | 1.0 | 1.0 | | |
| | Race | | | | | | | | | | |
| | Black | 249 | 95.8 | | | 9675 | 77.9 | 1.4 (1.3, 1.5) | 1.3 (1.1, 1.4) | | |
| | White | 11 | 4.2 | | | 2186 | 17.6 | 1.0 | 1.0 | | |
| Region of Residence at Birth Image: style s | Other | 0 | 0.0 | | | 559 | 4.5 | 0.8 (0.6, 0.9) | 0.8 (0.6, 0.9) | | |
| Denoit 154 59.2 0.9(0.5, 1.5) 0.9(0.6, 1.6) 6635 53.2 1.6(1.5, 1.7) 1.5(1.4, 1.7) Elsewhere 106 40.8 1.0 1.0 5835 4.6 1.0 1.0 Matemal Education <td>Region of Residence at Birth</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> | Region of Residence at Birth | | | | | | | | | | |
| Elsewhere 106 40.8 1.0 1.0 58.35 4.6.8 1.0 1.0 Maternal Education - | Detroit | 154 | 59.2 | 0.9 (0.5, 1.5) | 0.9 (0.6, 1.6) | 6635 | 53.2 | 1.6 (1.5, 1.7) | 1.5 (1.4, 1.7) | | |
| Maternal Education V V Less than high school 62 24.1 0.8 (0.4,1.4) 0.7 (0.3, 1.5) 3245 26.7 1.4 (1.5, 1.5) 1.4 (1.2, 1.6) High school 95 37.0 0.7 (0.4, 1.3) 0.6 (0.3, 1.2) 4565 37.5 1.2 (1.1, 1.3) 1.2 (1.1, 1.3) More than high school 100 38.9 1.0 1.0 4353 35.8 1.0 1.0 Maternal Age | Elsewhere | 106 | 40.8 | 1.0 | 1.0 | 5835 | 46.8 | 1.0 | 1.0 | | |
| Lest han high school 62 24.1 0.8 (0.4, 1.4) 0.7 (0.3, 1.5) 3245 2.6.7 1.4 (1.3, 1.5) 1.4 (1.2, 1.5) High school 95 37.0 0.7 (0.4, 1.3) 0.6 (0.3, 1.2) 4565 37.5 1.2 (1.1, 1.3) 1.4 (1.2, 1.5) More than high school 100 38.9 1.0 1.0 4353 35.8 1.0 1.0 Maternal Age | Maternal Education | | | | | | | | | | |
| High shool 95 37.0 0.7 (0.4, 1.3) 0.6 (0.3, 1.2) 456 37.5 1.2 (1.1, 1.3) 1.2 (1.1, 1.3) More than high shool 0.0 3.8 1.0 435 37.5 1.2 (1.1, 1.3) 1.2 (1.1, 1.3) Maret han high shool 0.6 0.7 (0.3, 1.6) 0.6 (0.3, 1.2) 435 37.5 1.2 (1.1, 1.3) 1.0 (1.1, 1.3) Maret han high shool 0.7 3.1 (0.7 0.7 (0.3, 1.6) 0.9 (0.4, 2.2) 21.71 1.7.7 1.2 (1.6, 1.3) 1.0 (0.9, 1.1) 20.4 years 69 26.7 1.1 (0.5, 2.4) 1.2 (0.5, 2.9) 37.8 30.9 1.2 (1.6, 1.4) 1.1 (0.9, 1.2) 30.3 years 75 29.1 1.0 (0.4, 2.0) 1.0 (0.4, 2.1) 3069 25.3 1.1 (1.0, 1.2) 1.0 (0.9, 1.2) 30.3 years 42 16.3 1.0 1.0 2072 16.9 1.0 1.0 25 years 21 8.1 0.6 (0.2, 1.6) 0.5 (0.2, 1.5) 110 9.1 1.1 (1.0, 1.3) 1.1 (1.0, 1.3) 25 years | Less than high school | 62 | 24.1 | 0.8 (0.4, 1.4) | 0.7 (0.3, 1.5) | 3245 | 26.7 | 1.4 (1.3, 1.5) | 1.4 (1.2, 1.5) | | |
| More than high school 100 38.9 1.0 1.0 4353 35.8 1.0 1.0 Maternal Age | High school | 95 | 37.0 | 0.7 (0.4, 1.3) | 0.6 (0.3, 1.2) | 4565 | 37.5 | 1.2 (1.1, 1.3) | 1.2 (1.1, 1.3) | | |
| Maternal Age 9 <20 yaars | More than high school | 100 | 38.9 | 1.0 | 1.0 | 4353 | 35.8 | 1.0 | 1.0 | | |
| <20 years 51 19.8 0.7 (0.3, 1.6) 0.9 (0.4, 2.2) 21.71 1.7 1.2 (1.0, 1.3) 1.0 (0.9, 1.1) 20-24 years 69 26.7 1.1 (0.5, 2.4) 1.2 (0.5, 2.9) 37.8 30.9 1.2 (1.0, 1.4) 1.1 (0.9, 1.2) 25-29 years 75 29.1 1.0 (0.4, 2.0) 1.0 (0.4, 2.1) 3069 25.3 1.1 (1.0, 1.2) 1.1 (1.0, 1.2) 30.34 years 42 16.3 1.0 1.0 2072 16.9 1.0 1.0 253 years 21 8.1 0.6 (0.2, 1.6) 0.5 (0.2, 1.5) 1119 9.1 1.1 (1.0, 1.3) 1.1 (1.0, 1.3) Timely Vaccine Completion | Maternal Age | | | | | | | | | | |
| 20-24 years 69 26.7 1.1 (0.5, 2.4) 1.2 (0.5, 2.9) 3783 30.9 1.2 (1.0, 1.4) 1.1 (1.6, 1.3) 25-29 years 75 29.1 1.0 (0.4, 2.0) 1.0 (0.4, 2.1) 3009 25.3 1.1 (1.0, 1.2) 1.1 (0.9, 1.2) 30-34 years 42 16.3 1.0 1.0 2072 16.9 1.0 1.0 325 years 21 8.1 0.6 (0.2, 1.6) 0.5 (0.2, 1.5) 1119 9.1 1.1 (1.0, 1.3) 1.1 (1.0, 1.3) Timely Vaccine Completion | <20 years | 51 | 19.8 | 0.7 (0.3, 1.6) | 0.9 (0.4, 2.2) | 2171 | 17.7 | 1.2 (1.0, 1.3) | 1.0 (0.9, 1.1) | | |
| 25-29 years 75 29.1 1.0(0A, 2.0) 1.0(0A, 2.1) 3090 25.3 1.1(1.0, 1.2) 1.1(0.9, 1.2) 30.34 years 42 16.3 1.0 1.0 2072 16.9 1.0 1.0 355 years 21 8.1 0.6(0.2, 1.6) 0.5(0.2, 1.5) 1119 9.1 1.1(1.0, 1.3) 1.1(1.0, 1.3) Timely Vaccine Completion | 20-24 years | 69 | 26.7 | 1.1 (0.5, 2.4) | 1.2 (0.5, 2.9) | 3783 | 30.9 | 1.2 (1.0, 1.4) | 1.1 (1.0, 1.3) | | |
| 30-34 years 42 16.3 1.0 1.0 2072 16.9 1.0 1.0 ≥35 years 21 8.1 0.6 (0.2, 1.6) 0.5 (0.2, 1.5) 1119 9.1 1.1 (1.0, 1.3) 1.1 (1.0, 1.3) Timely Vaccine Completion | 25-29 years | 75 | 29.1 | 1.0 (0.4, 2.0) | 1.0 (0.4, 2.1) | 3090 | 25.3 | 1.1 (1.0, 1.2) | 1.1 (0.9, 1.2) | | |
| ≥35 years 21 8.1 0.6 (0.2, 1.6) 0.5 (0.2, 1.5) 1119 9.1 1.1 (1.0, 1.3) 1.1 (1.0, 1.3) Timely Vaccine Completion | 30-34 years | 42 | 16.3 | 1.0 | 1.0 | 2072 | 16.9 | 1.0 | 1.0 | | |
| Timely Vaccine Completion | ≥35 years | 21 | 8.1 | 0.6 (0.2, 1.6) | 0.5 (0.2, 1.5) | 1119 | 9.1 | 1.1 (1.0, 1.3) | 1.1 (1.0, 1.3) | | |
| | Timely Vaccine Completion | | | | | | | | | | |
| Yes 117 45.0 4392 36.1 | Yes | 117 | 45.0 | | | 4392 | 36.1 | | | | |
| No 143 55.0 7782 63.9 | No | 143 | 55.0 | | | 7782 | 63.9 | | | | |

CONCLUSIONS

- Children with SCD had slightly higher pneumococcal vaccination series completion rates compared to children with SCT, though both groups had completion rates below 50%.
- The immunization completion rates for the pneumococcal vaccination series should be improved for children with SCD given their increased risk for infections.
- Select characteristics are associated with decreased likelihood of vaccine receipt among children with SCT, while no associations were found among children with SCD. This study finding could be due to a lack of heterogeneity among the SCD population.

PUBLIC HEALTH IMPLICATIONS

- Linkages between NBS, live births, and immunization data provide up-to-date, continued information on
- immunization status. This information was used to develop educational materials to meet the needs of specific high-risk populations.



 Using the lifespan surveillance process as a long-term follow-up strategy for SCD and SCT proved to be an efficient way of identifying unmet needs and developing targeted prevention strategies.³

FUTURE DIRECTIONS

- Knowing the predictors of receiving immunizations in a timely manner is helpful in further targeting educational materials.
- Plans are in place to assess what specific factors are associated with decreased immunization receipt for other vaccinations of particular importance for the SCD population.
- Michigan recently launched a Sickle Cell Follow-up Module on MCIR. The information collected through this module will be used for continued assessment of health outcomes of those with SCD.

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