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Factors Associated with Failure to Screen Newborns for Retinopathy of Prematurity

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Abstract

Objectives—To evaluate ROP screening rates in a population-based cohort; To identify characteristics of patients that were missed.

Study design—We used the California Perinatal Quality Care Collaborative data from 2005-2007 for a cross sectional study. Using eligibility criteria, screening rates were calculated for each hospital. Multivariable regression was used to assess associations between patient clinical and socio-demographic factors and the odds of missing screening.

Results—Overall rates of missed ROP screening decreased from 18.6% in 2005 to 12.8% in 2007. Higher gestational age (odds ratio [OR] 1.25 for increase of one week, 95% confidence interval [CI] 1.21-1.29), higher birth weight (OR 1.13, 95% CI 1.10-1.15), and singleton birth (OR 1.2, 95% CI 1.07-1.34) were associated with higher probability of missing screening. Level II NICUs and NICUs with lower volume were more likely to miss screenings.

Conclusion—Although ROP screening rates improved over time, larger and older infants are at risk for not receiving screening. Furthermore, large variations in screening rates exist among hospitals in California. Identification of gaps in quality of care creates an opportunity to improve ROP screening rates and prevent impaired vision in this vulnerable population.

Keywords

Retinopathy of Prematurity; Premature; Quality of Care; Neonatal

Retinopathy of Prematurity (ROP) is a leading cause of childhood vision impairment and blindness.(1-5) It is one of the major morbidities faced by infants born prematurely, and

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infants with poor visual outcomes due to ROP have a lower health-related quality of life than those infants who do not develop severe visual impairment.(6) Importantly, progression of disease to more severe disability is treatable with screening and early treatment.(2-4, 7-9)

Both the CRYO-ROP and ETROP studies showed considerable risk for ROP in premature infants with a significant reduction in unfavorable outcomes as a result of peripheral retinal ablation.(7, 10) For these reasons, screening for ROP has been identified as an important first step in preserving vision in premature infants. Furthermore, national organizations such as the National Quality Forum have identified ROP screening as an area of particular importance in delivering high quality of care to neonates,(11) and the American Academy of Pediatrics (AAP), American Academy of Ophthalmology (AAO), and American Association for Pediatric Ophthalmology and Strabismus (AAPOS) have developed guidelines specifying which neonates should be screened.(8)

What is not known is how well neonatal intensive care units (NICUs) adhere to the guidelines. In one US study that examined ROP screening behavior, there was large variation in how children are identified for ROP screening and how screening and treatment are provided.(12) Although that study involved a survey of 300 neonatologists, no study has evaluated actual ROP screening rates in a population-based sample.

We examined overall ROP screening rates in California and investigated factors associated with missed screening. Using the California Perinatal Quality Care Collaborative (CPQCC) database,(13) we identified infants who qualified for ROP screening by the AAP, AAO and AAPOS criteria and determined what percent of these infants did not receive screening. We then investigated patient and hospital characteristics associated with missed screening.

Methods

This cross-sectional study used CPQCC data from 2005-2007. The CPQCC collects data in a prospective manner for neonates born at member hospitals in California. Membership is offered to any hospital in California that provides neonatal intensive care. During the study period, eligible patients were cared for in 126 member hospitals, representing more than 90% of NICUs. Data are abstracted by NICU personnel including physicians, nurses and other trained data abstractors. Annual training sessions help to promote accuracy and uniformity in data abstraction. Each record has range and logic checks both at the time of data collection and data closeout, with auditing of records with excessive missing data. Data on race and ethnicity were obtained through the use of a linkage with the California Vital Records, which was made possible with support from the March of Dimes and has been described previously.(14)

The AAP AAO and AAPOS recommend ROP screening for all infants with gestational age less than or equal to 30 weeks or birth weight less than or equal to 1500g.(8) Screening is also recommended for infants greater than 30 weeks or 1500 grams at birth who have an unstable clinical course. For our study, we considered as eligible subjects those infants born at 30 weeks or less or 1500 grams or less, as this was a homogeneous population that should have all received screening according to the guidelines, regardless of clinical course. Specific timing of the initial ROP screen is also recommended based on the infant's age. Infants born between 27 and 30 weeks gestation should be screened at age 4 weeks. Infants born between 22 and 26 weeks gestation should be screened one week later for each additional week of prematurity. For example, infants born at 22 weeks are screened at 9 weeks of age. We excluded those who died or were discharged or transferred to another hospital before the first eye exam was due. We also excluded those infants who had missing data about the eye exam. Due to standard data collection definitions, we were only able to

determine if an ROP screen should have been performed some time during the hospitalization, not if it was performed at the earliest suggested time as outlined by the screening guidelines.

We calculated annual rates of missed screening by hospital and various socio-demographic and hospital characteristics. As described above, our rates were based on only those infants who met the criteria for screening at the time of hospitalization based on the screening guidelines. Multivariable logistic regression (PROC LOGISTIC, SAS 9.2, SAS Institute, Cary, NC) was used to assess the associations between various socio-demographic characteristics (race, ethnicity, and prenatal care), clinical factors (sex, gestational age, and birth weight), and hospital variables (NICU level of care and annual NICU volume) and the odds of receiving screening. NICU level of care was based on California Children's Services (CCS) classification. The CCS classifies NICUs into three levels – Regional, Community, and Intermediate NICUs—based on the services provided at each center with regional NICUs being equivalent to the AAP's Levels IIIC and IIID designation, community NICUs equivalent to AAP's Level IIIA and IIIB, and Intermediate NICUs being equivalent to AAP's Level II designation.(15)

During the study period, there were 20,595 infants born at CPQCC hospitals who qualified for ROP screening by the AAP, AAO and AAPOS criteria of birth weight or gestational age. We excluded: 3,386 infants who died before discharge (mean gestational age 25.0 weeks, birth weight 746 grams), 3,887 infants who were discharged home or transferred to another hospital before the first eye exam was due (mean gestational age 30.0 weeks, birth weight 1221 grams), and 40 infants who had a missing variable for the eye exam (mean gestational age 27.0 weeks, birth weight 1064 grams).

This study was approved by the Institutional Review Boards of the University of California, San Francisco and Stanford University.

Results

The final cohort eligible for the screening consisted of 13,282 infants with mean gestational age 28.1 weeks (standard deviation 2.3 weeks) and 5th and 95th percentiles at 24 and 31 weeks respectively. The eligible cohort had mean birth weight of 1101 grams (standard deviation 303 grams) and 5th and 95th percentiles at 620 and 1545 grams respectively.

The rates of missed ROP screening decreased over time from 18.6% in 2005 to 12.8% in 2007 ($p<0.0001$). Individual hospital screening rates varied widely for all years. When examining hospitals with at least 12 eligible patients per year, individual hospital rates for missed ROP screening rates ranged widely (Figure 1). In 2007, the median rate of missed screening was 13.0%, with interquartile range of 7.8% to 20.0%, and total range of 1.9% to 73.3%. The percentage of infants appropriately screened also varied with the maternal race/ethnicity, with infants born to African American mothers having the highest rates of missed screening (Table I). Regional (Level IIIC/D NICU) hospitals and those with the highest patient volume were less likely to have missed screenings (Table I). Higher gestational age was associated with increased rates of missed screening, particularly above 28 weeks (Figure 2). Larger birth weight was also associated with increased rates of missed screening (Figure 2).

In multivariable regression, infants born at older gestational ages had 1.25 times the odds of being missed for screening for every week older they were at birth (Table II). For every increase of 100 grams at birth, infants were 1.13 times as likely to be missed (Table II). We saw a protective effect of being born more recently, with infants born in 2005, the earliest year included in the study, having 1.39 times the odds of being missed for screening. Race

was also a risk factor for missing screening, as African American babies had 1.4 times the odds of being missed as compared with non-Hispanic Whites. And infants born to mothers without prenatal care were 1.32 times as likely to be missed for ROP exams. At the hospital level, NICU level of care was found to be a risk factor for missing screening, with infants admitted to Intermediate CCS (Level II) NICUs at 1.61 times the odds of being missed as compared with Regional (Level IIIC/D) NICUs.

Discussion

Our study of California NICUs revealed that a significant number of eligible patients did not receive ROP screening as suggested by the guidelines developed by the AAP, AAO and AAPOS. These findings are concerning, as screening identifies infants who should be treated, and the importance of treating ROP has been repeatedly demonstrated in improving structural and visual outcomes.(7, 10, 16) We also identified several individual level risk factors that put patients at higher risk of missing screening, including higher gestational age, heavier birth weight, singleton birth, African American maternal race, and lack of prenatal care.

Because of the limited information in our dataset, our study cannot address why older and larger infants were less likely to be screened. Although most screens happen at 3 to 4 weeks of life and infants of older gestational age may be discharged to home before their screen is due, we accounted for this possibility by excluding infants who had already been discharged before the first exam was due. Furthermore, this study only included infants who qualified for screening based on birth weight or gestational age. Older and larger infants who may have qualified for screening based on an unstable clinical course were not included in our study, and our results may in fact be underestimating the severity of the discrepancy in screening rates between infants at each end of the spectrum of gestational age and birth weight.

It is possible that older and larger infants are perceived to be healthier than their smaller, younger counter parts and are therefore not considered a priority for screening, although they still qualify as being at risk by the screening criteria. In a study of antenatal steroid administration practices for premature birth, there was a similar finding of decreased application of a well-accepted practice for larger birth weight and higher gestational age, perhaps reflecting a similar complacency in this “moderately” preterm population.(14) There may be some complacency in treating this population that actually has relatively high respiratory morbidity and would benefit from increased antenatal steroid use.(17-19) Another potential reason for decreased screening rates for this group may be limited resources at the NICU in which they received their care, reserving the screen for higher risk infants. The AAO recently found that fewer pediatric ophthalmologists and retinal specialists are willing to perform ROP exams due to liability concerns, poor reimbursement, and the complexity of scheduling care.(12) This may force NICUs to select the highest risk patients for screening. We do not know if this is appropriate, as the existing guidelines do not have a risk stratified approach for screening in the population of infants born before 30 weeks gestation or with birth weight less than 1500 grams.

We also found a differential in screening rates by maternal race. In particular, infants born to African American women were less likely to be screened than those born to Caucasian, Asian or Native American women. This may reflect a perception that African American infants are at lower risk because some studies have shown that they are slightly less likely to have severe disease.(20) The CRYO-ROP study showed that black infants had a 65% lower risk of reaching threshold disease as compared with white infants.(20, 21) However, another study identified Asians and blacks as being at higher risk for developing threshold ROP

compared with white infants.(22) With the current evidence, race should not be considered an eligibility factor for screening.

One striking finding in our study was the large variation in screening rates among hospitals. Even though overall screening rates reached 87% for the whole group in 2007, there was wide variation in rates with some hospitals missing screening for the majority of eligible patients (Figure 1). These patients may have received screening after discharge home, but would have received this screening after the recommended date. There were also several hospitals with 100% screening rates. This wide range in screening rates suggests that there is a very significant opportunity for quality improvement initiatives in this area. Lessons learned from the higher performing hospitals may be applied to the lower performing hospitals in an effort to improve their screening rates. We plan to investigate this in future studies.

Hospitals with higher patient volume had higher screening rates than hospitals with lower patient volume, although the impact of volume was attenuated in multivariable analysis. Higher patient volume has been shown to be associated with improved performance on quality indicators such as operative mortality for various surgeries and neonatal mortality for preterm infants.(23-27) We postulate that hospitals that care for larger numbers of infants are more likely to have a system in place to identify neonates who qualify for screening and potentially more readily available access to an appropriately trained pediatric ophthalmologist.

This study has several limitations. As we only had data about inpatient care, we were unable to evaluate infants who were discharged before their first ROP exam was due. Our study may have underestimated missed screening rates, as infants discharged home could very well miss an outpatient appointment with an ophthalmologist. We were also unable to evaluate certain patient and hospital level variables that were not recorded in the dataset, such as availability of an ophthalmologist to perform ROP exams. Furthermore, as the eye exam data did not include the date of exam, we were only able to evaluate whether an ROP exam was performed, not whether the exam was performed at the exact correct time according to guidelines.

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Abbreviations

ROP	Retinopathy of Prematurity
CPQCC	California Perinatal Quality Care Collaborative
CCS	California Children’s Services
AAP	American Academy of Pediatrics
AAO	American Academy of Ophthalmology
AAPOS	American Association for Pediatric Ophthalmology and Strabismus

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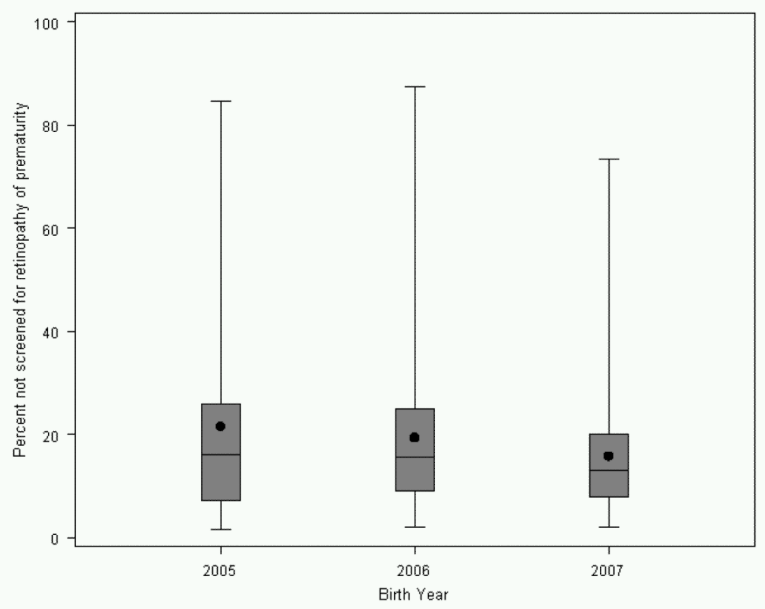

Figure 1.
Rates of missed retinopathy of prematurity screening by year for hospitals with at least twelve eligible patients

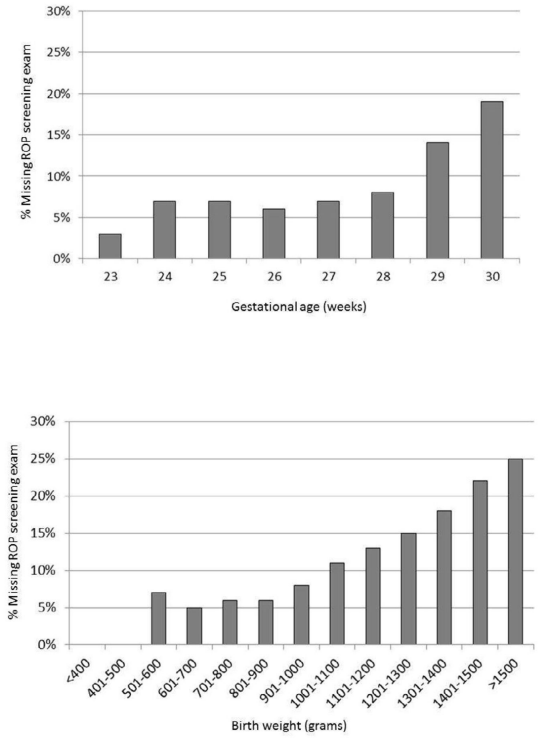

Figure 2.
Rates of missed retinopathy of prematurity screening by gestational age and birth weight

Table 1

Rates of missed retinopathy of prematurity screening

	N*	% ROP exam missed	P value
Year			
2005	4145	18.6%	
2006	4544	16.3%	
2007	4593	12.8%	< 0.0001
Maternal race / ethnicity			
Non-Hispanic White	3554	16.1%	
Hispanic White	6350	15.1%	
African American	1592	18.1%	
Native American	69	13.0%	
Asian	1452	15.6%	
Other / multi-racial	250	15.6%	0.093
Sex			
Female	6534	15.9%	
Male	6745	15.6%	0.65
Prenatal care			
Yes	12550	15.6%	
No	643	18.9%	0.03
Multiple gestation			
No	9615	16.2%	
Yes	3665	14.7%	0.031
CCS Level (AAP Level)			
Regional (III C/D)	4831	12.6%	
Community (III A/B)	6873	15.8%	
Intermediate (II)	757	29.7%	
Non-CCS	821	21.4%	< 0.0001
Hospital volume (patients/year)			
< 25	1842	21.4%	
25 – 49	4330	18.6%	
50-99	4079	15.4%	
>= 100	3031	8.8%	< 0.0001

ROP – retinopathy of prematurity; CCS – California Children's Services; AAP – American Academy of Pediatrics

* Total numbers reflect data that was available in our dataset. Incomplete records are responsible for different totals in each category.

Table 2

Multivariable model assessing risk for not receiving appropriate retinopathy of prematurity screening

		95% confidence interval	
	Odds ratio	**Lower**	**Upper**
Birth weight (increase of 100 grams)	1.13	1.10	1.15
Gestational age (increase of 1 week)	1.25	1.21	1.29
Year			
2005	1.00	(ref.)	
2006	0.82	0.72	0.92
2007	0.61	0.54	0.69
Maternal race / ethnicity			
Non-Hispanic White	1.00	(ref.)	
Hispanic White	0.97	0.86	1.10
African American	1.40	1.19	1.66
Native American	0.63	0.30	1.32
Asian	0.96	0.81	1.15
Other / multi-racial	1.07	0.74	1.55
Sex			
Female	1.05	0.95	1.16
Male	1.00	(ref.)	
Prenatal care			
Yes	1.00	(ref.)	
No	1.32	1.06	1.64
Multiple gestation			
No	1.20	1.07	1.34
Yes	1.00	(ref.)	
CCS Level (AAP Level)			
Regional (III C/D)	1.00	(ref.)	
Community (III A/B)	0.93	0.82	1.05
Intermediate (II)	1.61	1.31	1.98
Non-CCS	1.12	0.91	1.38
Hospital volume (increase of 10 patients/year)	0.94	0.93	0.95

CCS – California Children's Services; AAP – American Academy of Pediatrics