

# TRENDS IN SEVERE BRONCHOPULMONARY DYSPLASIA RATES BETWEEN 1994 AND 2002

VINCENT C. SMITH, MD, MPH, JOHN A. F. ZUPANCIC, MD, ScD, MARIE C. McCORMICK, MD, ScD, LISA A. CROEN, PHD, JOHN GREENE, MA,  
GABRIEL J. ESCOBAR, MD, AND DOUGLAS K. RICHARDSON, MD, MBA (DECEASED)

**Objective** To examine temporal trends in the rates of severe bronchopulmonary dysplasia (BPD) between 1994 and 2002.

**Study design** In a retrospective cohort study, all infants with a gestational age (GA) <33 weeks in a large managed care organization were identified. Annual rates of BPD (defined as an oxygen requirement at 36 weeks corrected GA), severe BPD (defined as respiratory support at 36 weeks corrected GA), and death before 36 weeks corrected GA were examined.

**Results** Of the 5115 infants in the study cohort, 603 (12%) had BPD, including 246 (4.9%) who had severe BPD. There were 481 (9.5%) deaths before 36 weeks corrected GA. Although the decline in BPD in this period was not significant, the rates of severe BPD declined from 9.7% in 1994 to 3.7% in 2002. Controlling for gestational age, the odds ratio (95% CI) for annual rate of decline in severe BPD was 0.890 (0.841-0.941). Controlling for gestational age, deaths before 36 weeks corrected GA also declined, with the odds ratio (CI) for the annual decline being 0.944 (0.896-0.996).

**Conclusions** In this study population, the odds of having of BPD remained constant after controlling for GA. However, the odds of having severe BPD declined on average 11% per year between 1994 and 2002. (*J Pediatr* 2005;146:469-73)

**B**ronchopulmonary dysplasia (BPD) affects as much as 35% of very low birth weight infants (VLBW <1500 grams).<sup>1</sup> This disease is marked by radiographic abnormalities, respiratory compromise, and a prolonged oxygen requirement. BPD is the result of a complex interaction of lung inflammation, lung injury, and lung repair that is in part associated with mechanical ventilation for surfactant deficiency.<sup>2</sup>

Since the 1980s, the treatment of infants born prematurely has changed dramatically with the routine use of surfactant,<sup>2-7</sup> increased use of antenatal steroids,<sup>5,6</sup> decreased use of postnatal steroids,<sup>8</sup> and improvements in mechanical ventilation.<sup>9,10</sup> From the early 1980s to the early 1990s, the rate of infant mortality and BPD development among premature infants decreased.<sup>3</sup> During the 1990s, the rate of infant mortality among premature infants continued to decline.<sup>11</sup> Concurrently, the rate of BPD increased until the end of the 1990s, at which point it appeared to stabilize.<sup>7,12</sup>

Despite its persistence, the BPD of today has been noted anecdotally to be less severe than the BPD of the past.<sup>13</sup> Such documentation of trends in the rate of BPD by severity, however, has not been substantiated with empirical studies. To clarify these trends, we examined the rates of severe BPD in a 9-year period in a cohort of premature infants. We hypothesized that the rate of severe BPD is declining.

## METHODS

### Study Population

The infants were cared for in the 6 level III neonatal intensive care units (NICUs) in the Northern California Kaiser Permanente Medical Care Program (KPMCP) between

From the Department of Neonatology, Beth Israel Deaconess Medical Center Boston, Massachusetts; the Harvard Newborn Medical Program, Boston, Massachusetts; the Department of Society, Human Development, and Health, Harvard School of Public Health, Boston, Massachusetts; and the Kaiser Permanente Medical Care Program, Division of Research, Perinatal Research Unit, Oakland, California.

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Reprint requests: Vincent C. Smith, MD, MPH, 330 Brookline Ave, BIDMC Neonatology Rose 318, Boston, MA 02215. E-mail: vsmith1@bidmc.harvard.edu.

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BPD	Bronchopulmonary dysplasia	NICU	Neonatal intensive care unit
GA	Gestational age	CMH	Cochran-Mantel-Haenszel
NEC	Necrotizing enterocolitis	VLBW	Very low birth weight
KPMCP	Kaiser Permanente Medical Care Program	CPAP	Continuous positive airway pressure

**Table I. Demographic characteristics of the cohort**

	Entire cohort	Infants with BPD	Infants with severe BPD	Infants who died before 36 weeks corrected GA
Mean maternal age (SD)	29.3 (6.7)	29.1 (7.0)	28.7 (6.8)	29.2 (6.6)
Maternal race				
White	2199 (43%)	259 (43%)	103 (42%)	265 (40%)
Black	870 (17%)	103 (17%)	42 (17%)	101 (21%)
Hispanic	1023 (20%)	121 (20%)	49 (20%)	101 (21%)
Asian	921 (18%)	108 (18%)	44 (18%)	77 (16%)
Other	102 (2%)	12 (2%)	8 (3%)	10 (2%)
Mean gestational age (SD)	29.9 (3.1)	27.7 (2.7)	27.6 (2.8)	24.5 (3.3)
Mean birth weight (SD)	1453.4 (555.0)	998.2 (394.2)	968.7 (433.1)	729.8 (416.5)
Mean discharge weight (SD)	2201.4 (564.5)	2745.2 (768.6)	3045.5 (988.1)	988.5 (541.7)
Mean length of NICU hospitalization in weeks (SD)	8.4 (7.2)	13.1 (5.8)	15.7 (7.1)	1.5 (1.8)
Number male	2762 (54%)	362 (60%)	165 (67%)	265 (55%)
Complications				
Necrotizing enterocolitis	153 (3%)	48 (8%)	34 (14%)	43 (9%)
Retinopathy of prematurity	870 (17%)	362 (60%)	153 (62%)	10 (2%)
Intraventricular hemorrhage	409 (8%)	127 (21%)	69 (28%)	130 (27%)

1994 and 2002. All infants were admitted alive to the NICU with a gestational age (GA) <33 weeks. Infants with major congenital malformations were excluded from the study.

Data were obtained from the KPMCP Neonatal Minimum Data Set (NMDS) by using previously described methods.<sup>14-16</sup> The NMDS database captures >95% of level III NICU admissions from a population of approximately 3.2 million members and 30,000 births each year.<sup>16</sup> The institutional review boards of KPMCP and the Beth Israel Deaconess Medical Center approved this study.

### Variables

We had 3 outcome variables: BPD, severe BPD, and death before 36 weeks corrected GA. We defined BPD, according to the National Institute of Child Health and Human Development (NICHD), as the use of supplemental oxygen at 36 weeks corrected GA age,<sup>17</sup> and severe BPD as the use of respiratory support (in the form of mechanical ventilation, continuous positive airway pressure (CPAP), and/or supplemental oxygen) at 36 weeks corrected GA. Because an infant had to reach 36 weeks corrected GA to qualify for the aforementioned definitions, we also examined deaths in infants younger than 36 weeks corrected GA. Some of these infants may have met the definition for BPD or severe BPD had they lived to 36 weeks corrected GA. Retinopathy of prematurity was defined as Stage 1 or greater as documented by the ophthalmologist on an ophthalmologic examination.

Infants were considered to have necrotizing enterocolitis (NEC) when any of the following conditions were present: several progress notes stating the presence of NEC and simultaneously the infant was nothing by mouth (NPO) for

a minimum of 5 days; the infant had surgery for necrotic bowel; necrotic or gangrenous appearance of baby's intestines found at surgery; a pathologist confirmed that NEC was present in a surgically obtained bowel specimen; a pathologist confirmed that NEC was present at autopsy; or an isolated ileal perforation was present. Infants with these conditions were not defined as having NEC: bowel surgery because of conditions other than NEC; the presence of abdominal distention and an NPO order ("NEC scare"); or the presence of bilious vomiting or residuals and an NPO order ("NEC scare").

An infant was defined as having intraventricular hemorrhage when a radiologist documented any of the following: intraventricular blood present without ventricular dilation; intraventricular blood present with ventricular dilation; or parenchymal hemorrhage present.

### Statistical Analysis

We examined the unadjusted observed rates of BPD, severe BPD, and death before 36 weeks corrected GA overall and by GA. We then examined individually the association of severe BPD with race, sex, and small for gestational age (SGA) status, which was defined as being less than the 10th percentile for GA. Finally, we controlled for GA as an ordinal variable in all of the bivariate and logistic regression analyses.

Bivariate analyses of trends were performed with the Cochran-Mantel-Haenszel (CMH) trend test controlled across GAs. We used logistic regression analysis, controlling for GA, to assess the direction and magnitude of the trend in all outcomes. These logistic regression models provided odds ratios (ORs) for the annual rate of decline. The analyses were

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