Fighting for the Next Generation: US Prematurity in 2030

abstract

Preterm birth (PTB) is a serious problem, with >450,000 neonates born prematurely in the United States every year. Beginning in 1980, the United States experienced a nearly 3-decade rise in the PTB rate, peaking in 2006 at 12.8%. PTB has declined for 7 consecutive years to 11.4% in 2013, but it still accounts for 1 in 9 neonates born every year. In addition to elevated neonatal and infant mortality among those born preterm, many who survive will have lifelong morbidities and disabilities. Because of the burden of morbidity, disability, and mortality for PTB, as well as its impact more broadly on society, including excess annual costs estimated to be at least $26.2 billion by a committee for the Institute of Medicine, the March of Dimes initiated the Prematurity Campaign in 2003. In 2008 the March of Dimes established a goal of reducing the US PTB rate to 9.6% by 2020. However, the United States ranks extremely poorly for PTB rates among Very High Human Development Index (VHHDI) countries, subjecting untold numbers of neonates to unnecessary morbidity and mortality. Therefore, the March of Dimes proposes an aspirational goal of 5.5% for the 2030 US PTB rate, which would put the United States in the top 4 (10%) of 39 VHHDI countries. This 5.5% PTB rate is being achieved in VHHDI countries and by women from diverse settings receiving optimal care. This goal can be reached and will ensure a better start in life for many more neonates in the next generation. Pediatrics 2014;134:1–7
Preterm birth (PTB), or birth at <37 completed weeks’ gestation, is a major public health problem. Beginning in 1980, the United States experienced a nearly 3-decade rise in the PTB rate, peaking in 2006 at 12.8%. Since then, PTB has declined for 7 consecutive years to 11.4% in 2013, but it still accounts for 1 in 9 or >450,000 neonates born premature every year. In addition to elevated neonatal and infant mortality among those born preterm, compared with full term or 39 to 40 weeks’ gestation, many who survive will have lifelong morbidities and disabilities. Because of the burden of morbidity, disability, and mortality for PTB, and its impact more broadly on society, including decreased productivity and annual excess costs, the March of Dimes initiated the Prematurity Campaign in 2003.

The total societal costs were subsequently determined to be ≥$262.2 billion in 2005, or $51,600 per preterm baby, of which $16.9 billion or $33,210 per preterm baby was attributed to “medical care services.”

The medical costs per child vary according to gestational age (Table 1). The medical costs are highest in the birth year but remain higher in subsequent years than those for neonates born at 37 to 40 weeks (defined as term in this reference). The costs are 57.3 times higher at <28 weeks than at 37 to 40 weeks, 28.5 times higher at 28 to 31 weeks, and 4.1 times higher at 32 to 36 weeks (Table 1). Total costs from birth through year 7 are lower relative to birth year costs when compared with 37 to 40 weeks: 36.1 times higher at <28 weeks, 18.2 times higher at 28 to 31 weeks, and 2.9 times higher at 32 to 26 weeks (Table 1). Despite these differences per child, because of the larger numbers of neonates born late preterm, these late preterm neonates represent the largest proportion of neonates in the NICU and the majority of NICU costs.

In recognition of the significance of the problem of prematurity in the United States, in 2008 the March of Dimes established a 2020 target for the US PTB rate of 9.6%. At the time, this target was aggressive. Among the 39 Very High Human Development Index (VHHD) countries in 2010, the United States ranked in the bottom 10% at number 37 (Table 2). Similarly, in a global analysis of PTB rates, the US performed extremely poorly. This level of PTB in the United States subjects our newborns to excess preventable neonatal and infant mortality and lifelong morbidity and disability that the March of Dimes and our Prematurity Campaign partners, including the American Academy of Pediatrics, find unacceptable and unnecessary.

### HEALTH INEQUITY IN THE UNITED STATES AS A SOURCE OF POOR PTB RATES

In the United States, inequities are observed in PTB rates according to racial and ethnic groups. For example, in the 2013 data from the Centers for Disease Control and Prevention’s National Center for Health Statistics (NCHS), when the overall PTB rate for the United States was 11.4%, the rates were 16.3% for non-Hispanic blacks, 13.0% for Native Americans, 11.3% for Hispanics, 10.2% for non-Hispanic whites, and 10.1% for Asians.

Improving quality by providing access to comprehensive maternity care and education, including prenatal and parenting classes, reduces the preterm birth rate, NICU admissions, and neonatal costs. Improvements in access to care in an underserved community can improve equity. Healthy Babies Are Worth the Wait, a comprehensive PTB prevention initiative undertaken in Kentucky and involving partnership of the March of Dimes, hospitals, clinicians, public health professionals, and community advocates, was complemented by extensive community educational outreach (D.M. Ashton, MD, personal communication, August 12, 2014). This initiative addressed multiple

<table>
<thead>
<tr>
<th>Gestational Age</th>
<th>Average Total Annual Medical Care Costs per Child</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth Year</td>
<td>Cumulative Birth-Year 7</td>
</tr>
<tr>
<td>&lt;28 wk</td>
<td>$190,467</td>
</tr>
<tr>
<td>28–31 wk</td>
<td>$84,785</td>
</tr>
<tr>
<td>32–36 wk</td>
<td>$13,621</td>
</tr>
<tr>
<td>37–40 wk (term)</td>
<td>$53,25</td>
</tr>
</tbody>
</table>

Adapted from Behrman and Butler.
modifiable risk factors to prevent PTB through patient, provider, and community interventions. The result was improved PTB rates in Kentucky compared with surrounding states. Healthy Babies Are Worth the Wait incorporated group prenatal care, which has been shown to improve pregnancy outcomes in women from underserved communities.11,12 Therefore, these inequities can be overcome, but this requires an investment in resources and improved access to interconception, prenatal, and perinatal care.

Excessive stress is observed among women in underserved communities, particularly African American women, and stress during pregnancy is recognized as an independent risk factor for PTB.13 This stress is thought to be associated with “weathering” or “wear and tear” or “deteriorating health with cumulative disadvantage.”14 The stress and disadvantaged outcomes have been speculated to be mediated by epigenetic mechanisms14 that may influence a woman throughout her life and perhaps even into future generations.15 However, recent findings in other conditions suggest that there may be more plasticity to epigenetic changes and these might be modifiable.16,17 Therefore, programs may modify the influences of stress and weathering.

REDUCTION OF EARLY ELECTIVE DELIVERIES AND IMPACT ON PTB

An early elective delivery (EED) is a delivery by elective induction or cesarean delivery during the early term period (37–38 weeks),5,4 without a medical indication. The rationale for subdividing term into early term, full term (39–40 weeks), and late term (41 weeks) is the recognition of the stratification of outcomes within what was previously considered to be a single 5-week period (37–41 weeks), with outcomes optimum for the full-term neonates. There is a “dose–response” relationship between gestational age and many outcomes, including intellectual achievement, lung disease, and infant mortality (S.M. Dolan, MD, personal communication, August 12, 2014). Recent studies have shown that neuronal complexity and function are affected negatively by earlier gestational ages at delivery at <39 weeks’ gestation.18,19 When full term and late term were combined (39–41 weeks), infant mortality was 2.08 per 1000, by comparison, infant mortality was 3.14 per 1000 for infants born early term, or a 1.5 relative risk.20

For these reasons, the March of Dimes, in collaboration with professionals and hospitals, initiated a rapid process quality improvement program to reduce EEDs.21 Among the 26 hospitals that participated, elective scheduled early term deliveries decreased from 27.8% in January 2011 to 4.8% in December 2011, representing an 83% reduction in scheduled EEDs during this 12-month period.

One might ask about the relevance of a program directed at a reducing EEDs, because by definition they are early term and not preterm. The dating of gestational age in utero may be inaccurate, and therefore a pregnancy estimated to be 37 to 38 weeks (early term) may result in a baby who, according to physical examination, is <37 weeks (preterm). The infant mortality rate among those born late preterm is 7.4 per 1000, or >3.5 relative risk compared with full and late term, and therefore would elevate the relative risk to a significantly higher value.20 Studies have shown that ~20% of PTBs have no known medical reason for early delivery, and therefore programs to reduce EEDs could reduce PTB rates up to this amount.22,23

PROJECTED IMPACT OF KNOWN FACTORS ON US PTB RATE

We will examine the projected impacts of evidence-based prematurity reduction interventions and potential risk reduction efforts and consider the use of a more accurate measure of gestational age for tracking US statistics. We will argue that current proven interventions are insufficient for full success. Furthermore, if we are to fight effectively for healthy birth outcomes for the next generation of US neonates, then we must align our PTB rate target with the best rates being achieved globally.

Current national statistics on PTB, as reported by the Centers for Disease Control and Prevention’s NCHS, are calculated based on gestational ages estimated from the last menstrual period (LMP). Studies have shown that the obstetric estimate (OE), which uses ultrasound evaluation of fetal size when it is available, provides a more accurate measure of gestational age.24,25 Beginning with the release of 2014 birth year data, NCHS plans to report PTB rates using OE-based gestational age measurements. Extrapolation from the available data indicates that, at the current rates, changing the gestational measure from LMP to OE will result in a downward correction of the US PTB rate in the range of 1.7% to 2.0% (see Supplemental Information). With 11.4% of neonates born preterm according to the 2013 preliminary data released by the NCHS in 2014 (based on LMP gestational dating), the current trajectory and the improved data reporting using OE will probably drive the United States before the LMP-to-OE correction. California is taking a comprehensive approach to PTB reduction, integrating stakeholders, developing process improvement strategies, establishing metrics and goals, and requiring accountability, all within a patient safety and quality improvement framework (E.R.B.M., personal...
communication, August 12, 2014). Even with a US rate of 9.6%, nearly 380,000 neonates will be born premature in the United States annually unless additional progress can be achieved.

In 2010, the PTB rate in the United States was 11.99% when LMP-based gestational age was used, compared with 9.98% based on OE (Fig 1). If the 5 interventions originally modeled by Chang et al were adjusted for OE, they would cumulatively yield a 0.83-point reduction, taking the US rate from 9.98% to 9.15% (Fig 1). These interventions include reduction of non–medically indicated inductions and cesarean deliveries to yield a 0.50-point reduction; increased use of cerclage to provide a 0.18-point reduction; increased safety of assisted reproductive technologies, such as the use of single embryo transfer, to yield a 0.11-point reduction; increased use of progesterone in women with a singleton pregnancy and history of previous PTB with a singleton pregnancy to provide a 0.02-point reduction; and increased smoking cessation interventions to yield a 0.02-point reduction. The effect sizes vary based on the number of pregnancies amenable to the intervention and the efficacy of the intervention. The impacts of these interventions might be expected to have differing influences on groups born preterm. For example, reduction in non–medically indicated inductions and cesarean delivery is a strategy to decrease EEDs (37–38 weeks) and therefore would be more likely to prevent late preterm births (34–36 weeks’ gestation) than earlier births, because of inaccurate estimate of term. The use of progesterone is intended to prolong gestation by 2 or 3 weeks to improve maturation and decrease morbidity and mortality, and therefore it may have an impact beginning with very early PTB.

Since the publication of the Chang et al article, low-dose aspirin as an intervention to reduce preeclampsia, a major contributor to preterm birth, has shown promise as a PTB rate reduction strategy. Full implementation of this intervention among all at-risk women could yield a 0.21-point reduction in the overall PTB rate (Fig 1). Other risk factors, specifically inadequate interpregnancy interval and teen pregnancy, have been shown to contribute to prematurity in the United States, although evidence-based interventions have not been proven and modeled for effect size. If effective strategies were identified and implemented, reducing the total risk associated with these 2 factors could yield a maximum reduction of an additional 0.72 points. Even with the maximum impact of these proven interventions and liberally modeled risk reduction strategies, the US PTB rate would decrease only to 8.22% (Fig 1), still well above those of the best-performing countries (Table 2).

If the United States is to achieve a PTB rate similar to those of the

![FIGURE 1](http://pediatrics.aappublications.org/)

**FIGURE 1**

Potential impact of interventions and reduction of risk factors on the US preterm birth rate. Adapted from Chang et al, with additional factors, including the change in gestational age measurement from LMP to OE, optimized use of low-dose aspirin to reduce preeclampsia, optimizing interpregnancy interval, and eliminating teenage pregnancy. ART, assisted reproductive technologies. (Prepared by the March of Dimes Perinatal Data Center, 2014.)
best-performing VHHDI countries, then we must invest in research and its rapid translation into evidence-based prevention strategies. The March of Dimes has chosen to do this by establishing a group of transdisciplinary Prematurity Research Centers that bring the talents of outstanding investigators to bear on a biomedical problem that may be outside their usual research foci. This transdisciplinary approach is needed because although prematurity may be a single syndrome, it has many causes. Deciphering the complexity of prematurity will involve the commitment of investigators in a broad range of disciplines, and translating this research into practice will be a challenge.

The achievements of the Prematurity Campaign, once considered a nearly impossible undertaking, have already been impressive and indicate that we can overcome significant challenges.

**ESTABLISHING THE 2030 TARGET PTB RATE: ALIGNING THE UNITED STATES WITH THE BEST GLOBAL OUTCOMES**

Why should the United States not aspire to align its PTB rate with the best global outcomes? Poor birth outcomes subject untold numbers of neonates to unnecessary morbidity and mortality. Therefore, the March of Dimes proposes an aspirational goal for the US PTB rate in 2030 to be 5.5%, which would put the United States in the top 4 (10%) of 39 VHHDI countries based on their 2010 rates, rather than in the bottom 10% (Table 2). This 2030 PTB target is also a rate observed in a recent study of fetal growth among 2 cohorts of women, both in diverse settings with ideal levels of health, nutrition, and prenatal care; 1 cohort had a rate of 4.5% and the second had a rate of 5.5%. Therefore, a 5.5% PTB rate is being achieved in VHHDI countries and by women from diverse settings receiving optimal care. These are conditions we should strive to achieve for every woman in the United States.

We propose that the United States can achieve or surpass this aspirational 5.5% PTB rate goal by 2030. The United States has the means and compelling reasons to do this for the health and well-being of the next generation and for increased productivity for family members, employers, and society. Through the use of proven interventions, we have already seen the impact of the 7-year decline in the PTB rate from 2006 through 2013. With that reduction, an estimated 231,000 fewer neonates have been born prematurely, and $11.9 billion has been saved (Fig 2). The estimate of the total costs saved is based on the average cost of $51,600 for each PTB calculated from the Institute of Medicine’s estimated total societal costs of PTB. The consequent burden of death and disability...
associated with PTB has been reduced significantly.

The additional improvements we propose by 2030 will lead to better lives for millions of neonates and their families. To achieve this goal the United States must aspire to be among the best globally in PTB rates. This goal can be reached through the optimal use of known interventions, by learning from countries that are achieving better outcomes than our own\(^7\) (Table 2), and by transdisciplinary research and its rapid translation to bridge the gap.\(^{30,31}\) This continued focus on improving pregnancy outcomes can give millions more US neonates a better start in life.

**ACKNOWLEDGMENTS**

We thank the following people for codeveloping the 2030 target PTB rate, collaborating on the statistical and epidemiological calculations and modeling, or reviewing the manuscript: Caroline C. Alter, MS; Janis Biernacki, MS; Todd Dias, MS; Kate Disare, MPH; Mary C. Giammarino; Christopher P. Howson, PhD; Michael Katz, MD; Motoko Okunuma; Joe Leigh Simpson, MD; Douglas Staples; Ann Umemoto, MPH, MPA; and Salimah Walani, PhD, MPH, RN.

**REFERENCES**


6. Ramachandrapa A, Jain L. Health issues associated with PTB has been reduced significantly.


28. DeFranco E, Ehrlich S, Mughia L. Influence of interpregnancy interval on birth timing...


Fighting for the Next Generation: US Prematurity in 2030
Edward R.B. McCabe, Gerard E. Carrino, Rebecca B. Russell and Jennifer L. Howse

Pediatrics originally published online November 3, 2014;

<table>
<thead>
<tr>
<th>Updated Information &amp; Services</th>
<th>including high resolution figures, can be found at: <a href="http://pediatrics.aappublications.org/content/early/2014/10/29/peds.2014-2541">http://pediatrics.aappublications.org/content/early/2014/10/29/peds.2014-2541</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>Supplementary Material</td>
<td>Supplementary material can be found at: <a href="http://pediatrics.aappublications.org/content/suppl/2014/10/29/peds.2014-2541.DCSupplemental">http://pediatrics.aappublications.org/content/suppl/2014/10/29/peds.2014-2541.DCSupplemental</a></td>
</tr>
<tr>
<td>Permissions &amp; Licensing</td>
<td>Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at: <a href="https://shop.aap.org/licensing-permissions/">https://shop.aap.org/licensing-permissions/</a></td>
</tr>
<tr>
<td>Reprints</td>
<td>Information about ordering reprints can be found online: <a href="http://classic.pediatrics.aappublications.org/content/reprints">http://classic.pediatrics.aappublications.org/content/reprints</a></td>
</tr>
</tbody>
</table>
Fighting for the Next Generation: US Prematurity in 2030
Edward R.B. McCabe, Gerard E. Carrino, Rebecca B. Russell and Jennifer L. Howse

Pediatrics originally published online November 3, 2014;

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://pediatrics.aappublications.org/content/early/2014/10/29/peds.2014-2541