

## COMMENTARY

# Improving perinatal health: a novel approach to improve community and adult health

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Recent trends of increasing infant morbidity and mortality are inconsistent with this nation's vision of advances in adult quality of life and longevity. Infant mortality and weight at birth are important predictors of the health of a society, making these findings all the more disturbing. Infant morbidity could be a reflection or alternatively, a harbinger of increasing national rates of obesity, diabetes mellitus, community violence and widening economic disparities. This paper presents the linkage between perinatal health and adult health using infant morbidities (infant mortality, low birthweight, prematurity) as examples. Infant morbidities/mortalities are social problems with health-care consequences. All social classes suffer the results of poor infant health. Improving perinatal health can improve the health of a community in a cyclic fashion. We propose that improving the health of reproductive age women and infants; will result in a reduction in the incidence of severe/chronic and costly adult health outcomes.

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### Introduction

Despite continued improvements in perinatal/neonatal care, our nation is experiencing an increasing trend of adverse infant outcomes, including increasing prematurity (12.4%), a rising low birthweight (LBW) rate (8.1%) and a flattening of the infant mortality rate (IMR) (6.9/1000 live births).<sup>1</sup> Though rates in IMR in the US declined over the past decade (9.2/1000 live births, 1990, to 6.84/1000 live births, 2005<sup>2</sup>), the US is still ranked 27th in the world in IMR, worse than virtually all the European Union, Canada, many of the Pacific rim countries and Cuba. IMRs vary widely across the US from 4.8/1000 in Massachusetts to 11.4/1000 in our nation's capital.<sup>3</sup> These rates mirror the percentages of prematurity and LBW infants. Though the greatest increase in preterm/LBW infants was in non-Hispanic white women, non-Hispanic black infants continue to die at a rate of 2.4 times that of non-Hispanic white infants.<sup>1</sup>

Infant mortality is often used internationally as the defining measure of poor infant health but may be only the 'tip of the

iceberg' when considering long-term complications of preterm birth and low birthweight. Of the leading causes of infant deaths (Table 1)<sup>4</sup> most are directly attributable to perinatal health disorders and most often the direct result of premature or LBW infants. LBW infants are 40 times more likely to die than full-term infants and very low birthweight infants (VLBW), 200 times more likely to die. Infant morbidity rates are higher in those communities with greater social and economic disparities, as reflected by higher rates of minorities, teenagers, unmarried mothers; women not completing high school; women beginning prenatal care after the first trimester; or mothers smoking during pregnancy.<sup>5</sup>

Infant mortality/morbidity has been termed a social problem with health consequences. It is linked to poverty, lack of access to health care, economic disparities, social behavior, substance abuse, community violence and loss of hope.<sup>5</sup> Though minorities in the United States have a greater likelihood of perinatal morbidity/mortality, recent studies reveal increased perinatal morbidity across all race and social classes in countries with greater economic disparities.<sup>5–7</sup> Extensive international epidemiological data link poor perinatal outcomes (low birthweight, prematurity) with several adult health conditions (diabetes mellitus, stroke, coronary heart disease). Adverse perinatal events may lead to fetal adaptations that permanently change structure, physiology and metabolism and predispose to adult diseases by predetermining pathophysiologic changes that may only be prevented with lifelong improved health practices.<sup>8</sup> These fetal changes begin a 'generational' effect with poor pregnancy outcomes, leading to poor adult health and resulting in infant morbidities in the following generation. Going along with this hypothesis, the pathway to adverse adult health may be averted by first improving perinatal health. Improvement in the perinatal health of a community will require improvements in the social, political, economic and health-care milieu of mothers and infants.

### Health

Community health includes economic security, protection from harm, adequate housing, health care, supportive personal and

**Table 1** Top 20 leading causes of infant death in the United States

| Leading-cause category and associated ICD-10 codes  | No. of infant deaths | % Born preterm |
|---|----------------------|----------------|
| Congenital malformations, deformations and chromosomal abnormalities (Q00–Q99)            | 5630                 | 49.5           |
| Disorders related to short gestation and low-birth weight, not elsewhere classified (P07) | 4636                 | 93.6           |
| Sudden infant death syndrome (R95)  | 2295                 | 23.2           |
| Newborn affected by maternal complications of pregnancy (P01)                             | 1704                 | 91.3           |
| Newborn affected by complications of placenta, cord and membranes (P02)                   | 1013                 | 87.5           |
| Respiratory distress of newborn (P22)   | 949                  | 94.8           |
| Accidents (unintentional injuries) (V01–X69)  | 940                  | 20.2           |
| Bacterial sepsis of newborn (P36)   | 753                  | 87.1           |
| Diseases of the circulatory system (I00–I99)  | 662                  | 42.3           |
| Intrauterine hypoxia and birth asphyxia (P20–P21)   | 582                  | 54.0           |
| Atelectasis (P28.0–P28.1)   | 396                  | 90.4           |
| Neonatal hemorrhage (P50–P52, P54)  | 390                  | 84.9           |
| Necrotizing enterocolitis of newborn (P77)  | 352                  | 94.3           |
| Birth trauma (P10–P15)  | 348                  | 93.8           |
| Chronic respiratory disease originating in the perinatal period (P27)                     | 316                  | 93.6           |
| Sepsicemia (A40–A41)  | 295                  | 67.7           |
| Homicide (X85–Y09, Y87.1)   | 289                  | 25.7           |
| Gastritis, duodenitis and noninfective enteritis and colitis (K29, K50–K55)               | 268                  | 80.5           |
| Influenza and pneumonia (J10–J18)   | 260                  | 35.9           |
| Hydrops fetalis not attributable to hemolytic disease (P83.2)                             | 195                  | 87.0           |
| Total   | 22273                | 66.6           |

community relationships, and faith beliefs. Many factors have been used to measure the health of a nation, that is, average life span, rates of poverty/per capita, incidence of homicide/suicide, level of education, rates of hunger, rates of infant mortality and low birthweight/prematurity. Perinatal measures were chosen in the early 1900s as part of the measurement of national health because they were easily collected and were felt to reflect the public's investment in a community. These measures were linked to poverty, malnutrition, isolation, violence, health-care access and general health. Infants dying prior to their first birthday were thought to be a critical indicator of poor social health in a community.<sup>9</sup>

### The perinatal paradox

The etiology of adverse health outcomes lies in a complex relationship between health, human behavior and disease. Investigators have established close relationships among LBW,

prematurity and infant mortality/morbidity. Previous epidemiological studies were unable to establish causation of perinatal morbidity/mortality using exclusive medical models. Several paradoxes exist. As an example, 1.6% of all infants born to black mothers are VLBW as compared to 0.5% of all infants born to white mothers, yet very low birthweight accounts for 59% of black infant mortality but only 37% of white infant mortality.<sup>10</sup> Why are black infants with similar medical problems more likely to die than their white counterparts? Why are infant morbidity rates greater in children of college educated/unmarried mothers than children of married high school dropouts?<sup>11</sup> When baseline demographic differences are minimized, the black–white dichotomy remains. Rawlings studied perinatal outcomes in one United States Army medical center in Washington State. This base population had higher education and income levels than the national average and equal access to health care. Nevertheless, blacks had higher rates of premature, LBW and VLBW infants regardless of rank, a measure of social class.<sup>12</sup> Genomic and proteomic applications are starting to demonstrate that poor infant outcomes are related to complex genetic and pathogenic pathways that are not protected by wealth, race or access to and utilization of medical services. Social standing and supportive relationships in a community appear to be protective of poor infant outcomes.<sup>5</sup>

The United States is one of the wealthiest nations in the world. However, the amount of disparity that exists between upper and lower social classes in our country may hold a clue to explain the dramatic differences in perinatal morbidity/mortality. A comparison of social class and infant mortality between the United Kingdom and Sweden, two countries with similar gross national products, demonstrated inferior IMRs for every social class in the United Kingdom. Each nation had better perinatal outcomes with improving social class, but poor infant health was linked to the greater disparity of income distribution between the richest and poorest classes in the United Kingdom (Figure 1).<sup>6</sup> Other nations with greater inequalities between the wealthiest and poorest have compromised health outcomes for all social classes that begin with infant health. These findings illustrate the need to investigate more comprehensively the complex interrelationships of social standing, economic privilege and infant morbidity/mortality.

### Infant health and adult health: the linkages

Barker *et al.* and others reported, ‘... that alterations in fetal nutrition and endocrine status result in developmental adaptations that permanently change structure, physiology and metabolism, thereby predisposing individuals to cardiovascular, metabolic and endocrine diseases in adult life.’<sup>8</sup> Their studies support an association between LBW infants and coronary artery disease, chronic hypertension, type II diabetes mellitus, obesity, developmental delays, failure to thrive, increased incidence in future generations of LBW and premature infants, increased

cholesterol and abnormalities in Fibrinogen and Factor VII synthesis in subsequent adult life.<sup>8,13-15</sup> These adult morbidities are hypothesized to result from ‘fetal programming’, a process whereby a stimulus or an insult during fetal development leads to long-term departures from homeostasis in the adult organism. Unfavorable changes in the fetal milieu leads to slowing of cell divisions, alterations in fetal growth factors and depending on the time of gestation, adverse development of different fetal organ and cellular functions. These alterations reflect the remarkable ‘plasticity’ of early fetal development and improved in-utero survival, but may also prove to be detrimental in later life.<sup>8</sup>

Others have proposed that additional complex social processes including maternal stress and depression, poor nutrition, domestic violence, poverty, adverse living conditions and social isolation, depending on the gestational age of the fetus, can also adversely affect infant health and lead to life-long health consequences

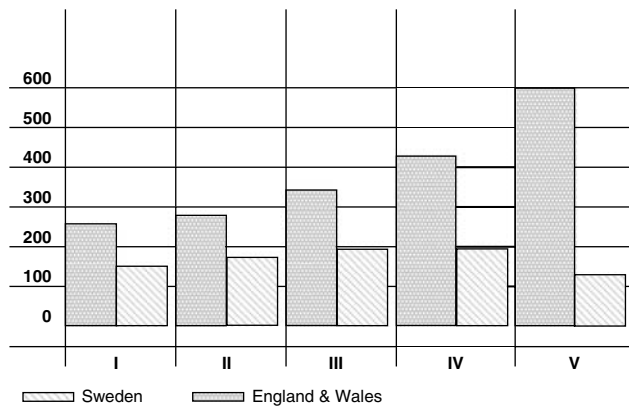
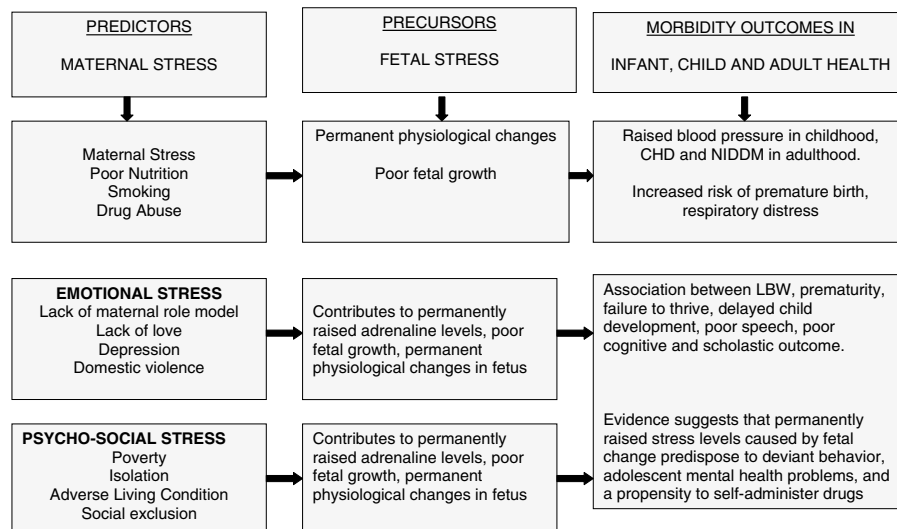


Figure 1 Post-neonatal infant mortality (per 100,000 live births, 1986).

(Figure 2).<sup>16</sup> Perinatal health may be the prime example of social problems interacting with early biological systems resulting in eventual adverse adult health consequences.

Gorski proposes a theory combining social and biological etiologies that leads to adverse health events. ‘Individuals and communities with perceived limited opportunities to share in the gains of a dominant culture lose hope, trust and energy for their future health and happiness.’<sup>5</sup> These individuals stop caring about their health and community and express passion through anger and violence. As this process continues, the materially advantaged members of the society become disinterested, distant and distrustful of the less fortunate. Disparities between the rich and poor increase, and malaise pervade life in the community. No segment of the population is immune to this distress of social alienation and amorality, including the pregnant mother. This universal malaise pervades in the community and affects not only perinatal health, but also long-term adult health outcomes.<sup>5</sup>

Over the past two centuries two treatment models have primarily been used to address infant morbidities. The societal model stresses improvement in social variables affecting infant outcomes (poverty, malnutrition, health-care access) while the medical model champions’ treatment of the ‘frank pathophysiologies’ leading to adverse outcomes (preterm labor, chorioamnionitis). The societal model predominated in the 1800s and led to improvements in public health, nutrition, housing and labor laws protecting pregnant women and children. The medical model became predominant as research and technological development led to improvements for some of the pregnancies that did not respond to the social model. As science and medicine became more sophisticated, they almost totally supplanted the societal model. There was an undesired consequence of this transformation, as



Perinatal Stressors and Adult Disease

Figure 2 Perinatal stressors and adult disease.

noted by Wise. “The more science becomes an idiom of societal discourse, the more likely it will be involved to consecrate hierarchal world views or justify policy determinations . . . science can be transformed from social tool to social weapon, from a collective instrument for societal advancement to a technical guarantor of the status quo.”<sup>17</sup> Though both models have been used to help decrease infant morbidities, they have often worked independently of the other and neither has been totally effective.

Studies and history have shown that adverse social environments contribute to poor perinatal health outcomes. These manifold and interactive problems result in adverse medical conditions that affect pregnancy and infant outcomes, and may give at least partial explanation to the increase in LBW infants, the plateau in IMRs and the dramatic rise in premature births.<sup>18</sup> We propose that only by improving maternal, fetal and infant health can we break this vicious cycle. Since history has shown neither the societal nor medical model successful alone, improvement in infant outcomes will require a union of the societal and medical models and novel preventive approaches.

### A novel solution

The malaise of adverse perinatal health has far-reaching negative affects on adult health and is intimately interwoven with the societal status and opportunities of communities over multiple generations. Since improvements in health care can only affect one aspect of the ‘health’ of a community, changes will need to arise from many aspects of society. Thomas L Friedman in his recent book, *The World is Flat*, has shown that since the late 1980s, our world has become much smaller and ‘flatter’ via globalization and the explosion of information technology.<sup>19</sup> Friedman believes these changes affect the way we integrate among systems, countries and diverse cultures; alters societal, political and business boundaries; and allows novel ways of manufacturing solutions to diverse problems. The key is integration of available thinking with other resources. In order to be successful, the business and health-care industries must transition approaches from an isolated, nonintegrated ‘vertical’ to a comprehensive ‘horizontal’ response to improve perinatal and ultimately adult health. For industries and business to be successful in the future, they must learn to plan the future of national health in such a way that the United States can be competitive in the ‘flat’ global economy.

Horizontal thinking allows changes in infrastructures with improvement in communication and problem solving across diverse economic, political and social structures. Thinking, planning, and working ‘horizontally’ allows for the integration of multiple systems and the sharing of multiple strategies and resources to achieve a common goal with reduced and streamlined components. This approach should be adaptable to health care and social systems that have previously existed in ‘vertical silos’ of caring. An example of how far we have to go is that it is easier to

order a Dell computer from China than to obtain patient records from within a single hospital system. In the United States health care, social systems and governmental resources have remained primarily vertical models. Using infant morbidity as a health example, various professions (medical, social, epidemiological, governmental) have approached the problem from within their own ‘academic’ institutions and cultures formulating well-meaning theories of change. Their ‘silos’ of care prevent sharing of literature, research and successful models to solve these social problems with dire health consequences. Silos of care have also arisen in the social and governmental programs specifically designed to help decrease infant morbidities. Medicaid, WIC, food stamps, public housing, childcare and child protective services all have Byzantine vertical systems with different individual administrations, registrations and qualifications for eligible services. Most require the same patient who would qualify for all the above services to apply at different locations, complete different registration forms and meet varying qualification standards to receive the necessary social sustenance that could nourish a healthy pregnancy. The United States health-care system builds other silos by requiring patients to move to various facilities and departments and repeat the same information multiple times. These silos of complicity are barriers to solving our worsening perinatal health outcomes.

### Horizontal solutions

There is a change toward horizontal thinking in perinatal care. The report *Recommendations to Improve Preconception Health and Health Care—United States* by the CDC/ATSDR Preconception Care Work Group and the Select Panel on Preconception Care presents 10 recommendations that spans various disciplines, service lines and agencies (Table 2).<sup>20</sup> “The recommendations present a conceptual frame work for innovative service delivery models so that women are afforded the benefit of risk appropriate preconception services during every encounter with the health-care system.”<sup>20</sup> The report recognizes that to improve the fetal milieu, we must enlarge the concept that improving perinatal health is a life-long process with emphasis on improving health of reproductive age men and women before conception.

The support surrounding women’s health should change from a preconception/pregnancy model to one encompassing her entire reproductive life cycle from birth to adulthood. Support for pregnancy should begin at puberty and end at menopause. The world of women’s health needs to become ‘flat’ and managed horizontally at all ages. ‘A medical model directed at a 6 to 8 months interval in a women’s life cannot erase the influence of years of social, economic and emotional distress and hardship. Ultimately the ability to achieve and sustain improved birth outcomes will coincide with improved health status and increased

**Table 2** Ten preconception recommendations

|  |   |
|--|---|
| (1). Health coverage for low income women          | Increase public and private coverage to improve access to preventive care including preconception and interconception care                    |
| (2). Public health programs and strategies         | Integrate components of preconception health into existing local public health programs, including emphasis on women with prior poor outcomes |
| (3). Research                                      | Augment research knowledge related to preconception health  |
| (4). Monitor improvements                          | Maximize public health  |
| (5). Interventions for identified risks            | Increase the proportion of women who receive interventions as follow-up to preconception risk screening                                       |
| (6). Interconception care                          | Use the interconception period to provide additional intensive interventions to women who have had prior adverse outcome                      |
| (7). Pre-pregnancy check-up                        | Offer one pre-pregnancy visit as a part of maternity care   |
| (8). Individual responsibility across the lifespan | Encourage each woman and every couple to have a reproductive life plan  |
| (9). Consumer awareness                            | Increase public awareness of the importance of preconception health   |
| (10). Preventive visits                            | Preconception care should be a part of primary care visits, and should include education and counseling for all women of reproductive age     |

care for women before they become pregnant or between pregnancies.<sup>21</sup>

This audacious task will require similar horizontal changes in infrastructure as developed by successful international companies.<sup>19</sup> Medical, social, political, nutritional and protective services will require shared linkages to improve registrations, automatically enroll and capture those women in need. Every service that touches women's health should be involved, whether that be obstetrical providers, WIC, AFDC, housing or childcare services. Such changes in women's health-care provision will also require changes in the way women's health care is financed. Increasing financial qualifications to 300% of the federal poverty level for women and children by combining Medicaid and SCHIP, as recently proposed by Congress and the Children's Defense Fund, could improve access and thereby outcomes. By reallocating funds from the Maternal and Child Title V Block grants (only 6 to 18% of those dollars actually are spent on pregnant women in the Southeast<sup>21</sup>) new emphases could be placed on preventive women's services with added advantage of eventually improving infant and adult health.

The emphasis on pregnancy as a learning process throughout a women's reproductive life cycle will allow providers previously not involved in preconception and pregnancy care, that is internists, family medicine specialists, cardiologists, endocrinologists, nephrologists and pediatricians, to champion a healthy mother

and pregnancy at every contact and include 'healthy' lifestyle and pregnancy education at every encounter. Each visit of a reproductive age women with a health-care provider should be viewed as a method of improving the outcome of future pregnancies and adult health indicators. New partners traditionally not advocating for women and children, such as the American Heart Association and American Diabetes Association, should be challenged to emphasize improving women's general and preconception health to help break the cycle of increasing obesity, diabetes and heart disease. Only by improving women's preconception and general health will these seemingly nonpregnancy related associations be able to achieve their goals of reductions in future obesity, diabetes and heart disease.

As the American Academy of Pediatrics has done with *Bright Futures*<sup>22</sup> and children's preventive health, we propose primary health-care visits for women of all ages, a 'Women's Reproductive Well Care' or 'Bright Futures for Women'. At every encounter with a woman who may become pregnant, anticipatory guidance and preventative care can be initiated. Innovative prenatal care models (content, visit number, centering care, prevention education) should be considered. Evidence-based programs to decrease infant mortality/morbidity, such as Old's home visiting nurse program,<sup>23</sup> could be resurrected and savings from adverse outcomes used to further improve women's preventative health services. Culturally sensitive, evidenced based and patient 'friendly' health services, as proposed by the Lawton and Rhea Chile's Center for Healthy Mothers and Babies' Friendly Access Program<sup>24</sup> should increase compliance with women and infant's preventative care. A plan to 'regionalize' low-risk prenatal care, especially for rural and disadvantaged populations, could revolutionize prenatal care models, much like the regionalization of tertiary perinatal care in the 1970s as described by the March of Dimes' *Toward Improving the Outcome of Pregnancy*.<sup>25</sup> For those populations at greatest risk the reintroduction of the 1970s model utilizing 'one-stop-shopping' community health centers, as the basis for holistic prenatal care with wrap-around services, that is, Medicaid enrollment, WIC, mental health, child care should be reconsidered.<sup>25-27</sup>

Only by realizing that investments in women's health at all points of contact determine our communities' health can we begin to break the downward spiral of infant and adult health outcomes. This investment in women's health will require a horizontal change in thought; one that will require shared finances, administrations, care provision and staffing. New horizontal systems would lead to savings by dismantling vertical silos of bureaucratic administrations that could then be channeled into future women's services. These renovations in systems will need all 'caring' services to abandon their vertical silos of care, think horizontally and act locally. By celebrating the prospective mother at every possible point throughout her reproductive life cycle we can begin to flatten her world of health and improve future health. The next generation's health must begin with the next healthy pregnancy.

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