

# Preventing Abusive Head Trauma Among Infants and Young Children: A Hospital-Based, Parent Education Program

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**ABSTRACT.** *Objective.* Abusive head injuries among infants (shaken infant or shaken impact syndrome) represent a devastating form of child abuse; an effective prevention program that reduces the incidence of abusive head injuries could save both lives and the costs of caring for victims. We wished to determine whether a comprehensive, regional, hospital-based, parent education program, administered at the time of the child's birth, could be successfully implemented and to examine its impact on the incidence of abusive head injuries among infants <36 months of age.

*Methods.* All hospitals that provide maternity care in an 8-county region of western New York State participated in a comprehensive regional program of parent education about violent infant shaking. The program was administered to parents of all newborn infants before the infant's discharge from the hospital. The hospitals were asked to provide both parents (mothers and, whenever possible, fathers or father figures) with information describing the dangers of violent infant shaking and providing alternative responses to persistent infant crying and to have both parents sign voluntarily a commitment statement (CS) affirming their receipt and understanding of the materials. Program compliance was assessed by documenting the number of CSs signed by parents and returned by participating hospitals. Follow-up telephone interviews were conducted with a randomized 10% subset of parents, 7 months after the child's birth, to assess parents' recall of the information. Finally, the regional incidence of abusive head injuries among infants and children <36 months of age during the program (study group) was contrasted with the incidence during the 6 preceding years (historical control group) and with statewide incidence rates for the Commonwealth of Pennsylvania during the control and study periods, using Poisson regression analyses with a type I error rate of 0.05.

*Results.* During the first 5.5 years of the program, 65 205 CSs were documented, representing 69% of the 94 409 live births in the region during that time; 96% of CSs were signed by mothers and 76% by fathers/father figures. Follow-up telephone surveys 7 months later suggested that >95% of parents remembered having re-

ceived the information. The incidence of abusive head injuries decreased by 47%, from 41.5 cases per 100 000 live births during the 6-year control period to 22.2 cases per 100 000 live births during the 5.5-year study period. No comparable decrease was seen in the Commonwealth of Pennsylvania during the years 1996–2002, which bracketed the control and study periods in western New York State.

*Conclusions.* A coordinated, hospital-based, parent education program, targeting parents of all newborn infants, can reduce significantly the incidence of abusive head injuries among infants and children <36 months of age. *Pediatrics* 2005;115:e470–e477. URL: [www.pediatrics.org/cgi/doi/10.1542/peds.2004-1896](http://www.pediatrics.org/cgi/doi/10.1542/peds.2004-1896); *shaken baby syndrome, shaken impact syndrome, nonaccidental head injury, abusive head trauma, child abuse, head trauma, injury prevention.*

ABBREVIATIONS. WCHOB, Women and Children's Hospital of Buffalo; WNY, western New York State; CS, commitment statement.

Caffey<sup>1,2</sup> first used the term whiplash-shaken infant syndrome to describe the association of intracranial injuries, retinal hemorrhage, and certain long bone fractures attributable to child abuse among infants (the majority <1 year of age). Other terms for this condition include shaken baby syndrome or shaken infant syndrome, shaken impact syndrome,<sup>3</sup> infant shaken impact syndrome,<sup>4</sup> infant whiplash-shake injury syndrome,<sup>5</sup> abusive head trauma,<sup>6</sup> and inflicted, nonaccidental, or intentional head injury. Shaken infant syndrome is the most widely used and recognized term, although shaking alone may not account for all injuries.<sup>3</sup> Whatever the terminology and pathogenesis, abusive head injuries among infants represent one of the most severe forms of child abuse, with 13 to 30% mortality rates<sup>4,5,7,8</sup> and significant neurologic impairments in at least one half of the survivors.<sup>9</sup>

The economic costs of abusive head injuries are significant; initial inpatient hospitalization costs average \$18 000 to \$70 000 per child, and average ongoing medical costs can exceed \$300 000 per child.<sup>10–12</sup> Many children require long-term medical services, physical, occupational, speech, and educational therapies, and lifelong custodial care. Long-term management costs exceeded \$1 million in 1 case.<sup>11</sup> Additional costs associated with loss of societal productivity and occupational revenue and with prosecution and incarceration of a perpetrator are

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unknown. An effective prevention campaign could potentially save the lives of many children and improve the lives of many others; the costs of such a campaign could be recovered from the economic savings to society.

Despite the severity of the injuries and enormous societal costs, previous studies suggested that 25 to 50% of people have not received information about this problem.<sup>13–16</sup> In some cases of abuse, the perpetrators admitted to shaking the infant violently but confessed that they were unaware of the dangers of doing so.<sup>17</sup> However, the American Academy of Pediatrics suggested that “the act of shaking leading to shaken baby syndrome is so violent that individuals observing it would recognize it as dangerous and likely to kill the child.”<sup>18</sup> Moreover, recent news coverage of individual cases and scattered public awareness campaigns in the past 2 decades might have increased significantly public awareness about this problem. Therefore, the role of prevention might be not to educate the general public but to remind the right people at the right time.

Parents and their partners are responsible for nearly three fourths of cases, with fathers or stepfathers (37% of cases) and boyfriends (21% of cases) accounting for the majority of cases and mothers accounting for an additional 13%.<sup>6</sup> The average age of the victims is 5 to 9 months, and almost all are <36 months of age.<sup>3,9</sup> The temporal proximity to the child’s birth, the relatively short period during which infants and children are at risk, and the preponderance of parent perpetrators afford unique opportunities to intervene through a program of hospital-based parent education administered at the time of the infant’s birth and to study the impact of such a program on the frequency of these injuries.

In December 1998, a comprehensive, hospital-based, parent education campaign began in an 8-county region of western New York State (WNY) served by the Women and Children’s Hospital of Buffalo (WCHOB). The goals of the program were (1) to provide a universal consistent education program to parents of all newborn infants in the region, (2) to assess parents’ knowledge about the dangers of violent infant shaking, (3) to track the dissemination of information through the return of commitment statements (CSs) signed by 1 or both parents, and (4) to assess the impact of the program on the regional incidence of abusive head injuries among infants and children <36 months of age. The 8-county region of WNY is well suited to studies of the effectiveness of a prevention campaign because (1) the region is surrounded on 3 sides by state or international borders and therefore is geographically isolated, (2) a review of regional insurance databases and the Statewide Planning and Resource Cooperative Systems database of hospital discharge diagnoses confirmed that essentially all infants with head trauma in this region are referred to a single center, the WCHOB, and (3) the minimal historical incidence of abusive infant head injuries during the preceding 6-year period (December 1992 through November 1998, inclusive) could be calculated from WCHOB admission data and Erie County Medical Examiner’s Office records

and compared with data collected prospectively during the subsequent study period.

## METHODS

In December 1998, a hospital-based, parent education program, provided at the time of the infant’s birth, was administered through nurses at all 16 hospitals that provide maternity services in the 8 counties of WNY. In October 1998, the principal investigator (M.S.D.) provided a 1-hour training session for nurse managers from these hospitals during an annual, regional, perinatal outreach conference, emphasizing the dangers of violent infant shaking, discussing the program methods, and providing a short set of written instructions to train the nurses on their units. A few nurse managers who were not in attendance were contacted individually after the conference. All nurse managers were asked to train nurses on their units (both maternity wards and intensive care nurseries) to administer the program to parents. The unit nurses were asked, at a minimum, to disseminate information about violent infant shaking to both parents of newborn infants before the infant’s discharge from the hospital and to have both parents sign a CS affirming their receipt and understanding of the materials. Nurses were encouraged to seek actively fathers or father figures for education whenever possible, to provide program information separate from other materials, so as not to detract from the central message, and to answer parents’ questions about violent infant shaking and shaken infant syndrome.

The program and its message were intentionally kept very simple, to maximize hospital compliance. Nurses were asked to have parents read a 1-page leaflet (*Prevent Shaken Baby Syndrome*; American Academy of Pediatrics) and view an 11-minute videotape (*Portrait of Promise: Preventing Shaken Baby Syndrome*; Midwest Children’s Resource Center, St Paul, MN) that discussed the dangers of violent infant shaking (but not striking, slamming, or other mechanisms of abuse) and suggested ways to handle persistent infant crying. Educational posters (*Never, Never, Never Shake a Infant*; SBS Prevention Plus, Groveport, OH) were displayed on the wards, to provide information for families and visitors. All educational materials were available in both English and Spanish.

Both parents were also asked to sign voluntarily a CS affirming their receipt and understanding of the materials (Fig 1). In the few cases in which the parents chose not to sign, the nurse was instructed to expunge all individually identifying information and return the CS (indicating that the parents had been exposed to the program). The CSs were collected by the nurses and returned monthly to the study coordinators. The CS asked simple demographic questions about the parents’ ages, highest educational level, marital status, and type of insurance and the town of the infant’s residence, to ensure that the program reached a broad cross-section of parents. The CS also asked parents whether the information was helpful, whether this was the first time they had heard that shaking an infant was dangerous, and whether they would recommend this information for all new parents. Parents were asked to consent to a brief, follow-up, telephone survey 7 months after the child’s birth and to provide their home telephone number. Ten percent of the parents who had consented to the follow-up survey were selected randomly and were contacted 7 months later, to test their recall of the program information. A 7-month follow-up period was chosen because it is in the middle of the range of average ages of victims reported in the literature.

The regional incidence of abusive head injuries among infants and children <36 months of age was tracked prospectively during the 66-month period of the study (December 1998 through May 2004, inclusive) and was contrasted both with the minimal regional incidence during the 60 months immediately preceding the program (December 1992 through November 1998, inclusive) and with incidence rates of substantiated abusive head trauma in the Commonwealth of Pennsylvania (determined through judicial ruling or by the Office of Children and Family Services and obtained from the Child Line Database, Pennsylvania Department of Public Welfare) during the years 1996–2002, inclusive, with Poisson regression analyses with a type I error rate of 0.05. Because the exact mechanisms of abuse (shaking versus impact) might not be known with certainty in individual cases, all infants and children <36 months of age evaluated at WCHOB with either the *International Classification of Diseases, Ninth Revision*, code for shaken infant syndrome (code 995.55) or an *International Classification of Diseases, Ninth Revision*, code for intracranial injury, skull fracture, or retinal

**Prevent Shaken Baby Syndrome!**  
Please help us to track the effectiveness of our program!

I have received information about Shaken Baby Syndrome, and have been asked to voluntarily sign a commitment statement acknowledging that I have received, read, and understand this information. I have also been asked to voluntarily provide a phone number where the study coordinators may call me in approximately 9 months to ask me a few questions regarding my recollections about the information I received today. I can refuse to participate in this project, and neither the medical care for myself nor my baby will be affected in any way. All information I provide is confidential. The collective results from all of the participants in this study will be presented at scientific meetings, but no identifying information about any individual will be disclosed. I am free to withdraw from the project at any time. I have read this information, my questions have been answered, and I consent to participate in this project. If I have further questions I can call either of the study coordinators, Dr. Mark Dias (716) 878-7386, or Dr. Linda Barthauer (716) 275-7815.

I have received the educational material about Shaken Baby Syndrome, and I understand that violent shaking is harmful and potentially deadly to a baby. I agree to participate in this study.  
(Do not sign for your spouse; they should sign themselves!)

Mother's Name \_\_\_\_\_ Signature \_\_\_\_\_

Father's Name \_\_\_\_\_ Signature \_\_\_\_\_

Witness Name \_\_\_\_\_ Signature \_\_\_\_\_

Baby's Date of Birth \_\_\_\_/\_\_\_\_/\_\_\_\_ Hospital where baby was born \_\_\_\_\_

In what city or town will the baby live? \_\_\_\_\_ Zip Code \_\_\_\_\_

What is your age? Baby's Mother \_\_\_\_\_ Baby's Father \_\_\_\_\_

| What is your highest education?    | Baby's Mother            | Baby's Father            |
|------------------------------------|--------------------------|--------------------------|
| Some high school                   | <input type="checkbox"/> | <input type="checkbox"/> |
| High school graduate, no college   | <input type="checkbox"/> | <input type="checkbox"/> |
| Some college                       | <input type="checkbox"/> | <input type="checkbox"/> |
| College graduate                   | <input type="checkbox"/> | <input type="checkbox"/> |
| Post-college degree (Masters, PhD) | <input type="checkbox"/> | <input type="checkbox"/> |

What best describes the baby's home situation?

Mother and father are married and living together, with the baby

Single mother, living with the baby and the father of the baby

Single mother, living with a man who is not the father of the baby

Single mother living with the baby's grandparents

Single mother, living alone

Other \_\_\_\_\_

What type of medical insurance do you have (check all that apply)?

None

Medicaid, Medicaid sponsored HMO, or other government sponsored program (Medisource, Family Health Plus, etc.)

Private Insurance or HMO

Unsure / Don't know

Was the information you received helpful to you?  Yes  No

Is this the first time you've heard that shaking a baby is dangerous?  Yes  No

Would you recommend this information be given to all new parents?  Yes  No

May we call you in 9 months to ask about your recollections of this information?  Yes  No

If you answered yes, please provide a phone number where we may reach you (\_\_\_\_) \_\_\_\_\_ - \_\_\_\_\_

Any comments about our program?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

STUDY COORDINATOR COPY

Fig 1. CS that parents were asked to sign voluntarily, affirming their receipt and understanding of the program materials.

hemorrhage with an external cause of injury code for known or suspected homicide or child abuse (codes E960–E968 and E980–E989) were included. One of the authors (P.M.) served on the regional child fatality team and maintained contact with child protective services workers, law enforcement officials, and medical examiners to identify additional cases. Local television and newspaper coverage was reviewed. Finally, abusive head injury admissions to Strong Memorial Hospital, the tertiary referral center in Rochester, New York, for the adjacent 9-county region of upstate New York, were reviewed, to ensure that cases from the involved counties had not been referred out of the region. Each identified case of abusive head injury in WNY was cross-referenced to the study database, to identify a signed CS.

All suspected cases of abusive head injury during the historical and study periods were reviewed in detail by the same multidisciplinary medical team, which included a dedicated child abuse physician (P.M.) and 2 pediatric neurosurgeons (M.S.D. and V.L.) working with pediatric ophthalmologists, pediatric radiologists, pediatric orthopedists, and pediatric surgeons (when necessary) and New York State Children, Youth, and Family caseworkers, to confirm the nature of the inflicted injuries in all identified cases. A common definition of abusive injury was used throughout both

the historical and study periods and included intracranial injuries and/or skull fractures without a history of trauma, a trauma history that was wholly inconsistent with the identified injuries or developmental age of the child, a pattern of intracranial injuries (such as subdural and retinal hemorrhage with diffuse brain hypodensities) that fit a pattern of abusive injury without an adequate explanation, or intracranial injuries associated with other identified abusive injuries (rib or long-bone fractures or abdominal injuries) that fit a pattern of abuse without an adequate explanation. Cases involving only extracranial soft-tissue injuries (scalp swelling or facial bruising), without an accompanying intracranial injury or skull fracture, were not included during either period.

The number of cases per year and the number of cases per 100 000 live births for both the historical control and study periods were compared with a Poisson regression model.<sup>19</sup> In addition, in an attempt to avoid the inevitable lag time for infants born during the control period but abused during the study period, the 2 groups were also analyzed by assigning each infant to the year of birth (rather than the year of abuse) and assessing the incidence of abusive head injuries during the subsequent 36 months. To do this, a correction factor was calculated for infants born during the second half of the third year and during the fourth and fifth years

of the study period (who would not have been monitored for the full 36 months). The correction factor was determined on the basis of the number of live births in WNY during the corrected years and the empirical, cumulative, distribution function<sup>20</sup> of age at injury for case subjects born during the control and treatment periods with a full 36-month follow-up period. This correction estimated the number of additional cases expected if these children had been monitored for the full 36 months. The study was approved by the WCHOB institutional review board before implementation.

## RESULTS

Of the 16 regional hospitals providing maternity care, 13 participated fully during the entire 66-month study period. One hospital, accounting for 3% of the region's deliveries, and 1 of 2 wards at a second hospital began participating during the third year. The ward at the second hospital cared for mothers of infants in the hospital's intensive care nursery, an unknown number of whom had been transferred from other hospitals where they might have received program materials. Two hospitals, accounting for 19% and 2% of the region's deliveries, provided educational materials throughout the program but began collecting CSs 15 and 24 months into the program, respectively. All hospitals in the region have participated fully since the beginning of the third year.

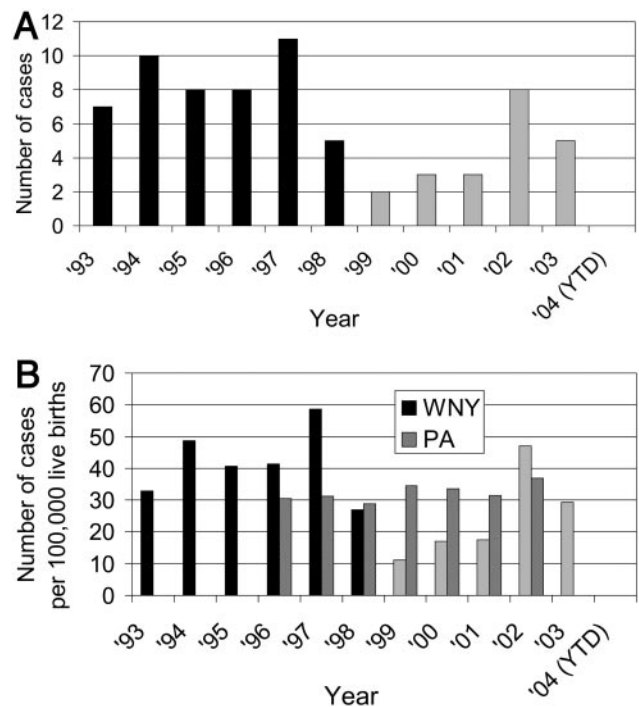
A total of 65 205 CSs were recorded, representing 69% of the 94 409 live births during the study period. Ninety-seven percent of returned CSs were signed by at least 1 parent. Ninety-six percent of the returned CSs were signed by mothers and 76% by fathers. Although there are no specific regional normative values for new parents against which the demographic features of the study group could be compared statistically, the returned CSs demonstrated a broad demographic representation, in terms of parent age, highest educational level, marital status, type of insurance, and town of the child's residence.

Ninety-three percent of the parents who returned the CS acknowledged having heard previously about the dangers of infant shaking, confirming one of the study hypotheses. Ninety-two percent of the parents thought that the information was helpful; many of the rest commented that the reason they did not was that they already knew about the dangers of violent infant shaking. Ninety-five percent of the parents thought that the information should be provided to all new parents. Approximately 10% of respondents provided positive comments about the program. The few negative comments were of 2 types, ie, parents thought that the subject was either emotionally unsettling or redundant and unnecessary.

A survey of nurse managers undertaken at the end of each year suggested that nurses at all hospitals regularly (75–100% of live births) provided brochures, displayed posters, spoke with parents, and had parents sign the CS. Unfortunately, less than two thirds of the hospitals regularly had parents view the videotape. Follow-up telephone surveys with parents confirmed that they remembered the program but many were not shown the videotape. When asked simply what health and safety topics they

remembered receiving information about at the time of their child's birth, 27% of the respondents mentioned shaken infant syndrome or infant shaking by name. Among the remaining 73% of respondents, 94% responded affirmatively when asked specifically whether they remembered receiving information about infant shaking. Among parents who could recall the program information, 98% remembered the written materials, 92% the CS, 89% conversations with the nurse, and 60% viewing the posters; in contrast, only 23% remembered seeing the videotape. Because parents remembered other aspects of the program, the assumption is that they were never shown the videotape.

During the 6 years before the program began, 49 cases of substantiated abusive head injury were identified. This represented an average of 8.2 cases per year (range: 5–11 cases per year) and 41.5 cases per 100 000 live births (Fig 2). During the 66 months of the study period, 21 cases of substantiated abusive head injury were identified. This represented an average of 3.8 cases per year (a 53% reduction) and 22.2 cases per 100 000 live births (a 47% reduction). This 47% reduction in incidence was statistically significant ( $P = .0168$ ). In addition, statewide incidence rates for the Commonwealth of Pennsylvania between 1996 and 2002 (which bracketed the historical and control periods in WNY) did not change significantly during this time (Fig 2B). The incidence in WNY relative to the incidence in Pennsylvania was 1.40 during the years 1996–1998 (before the program began) and 0.67 during the years 1999–2002 (after the

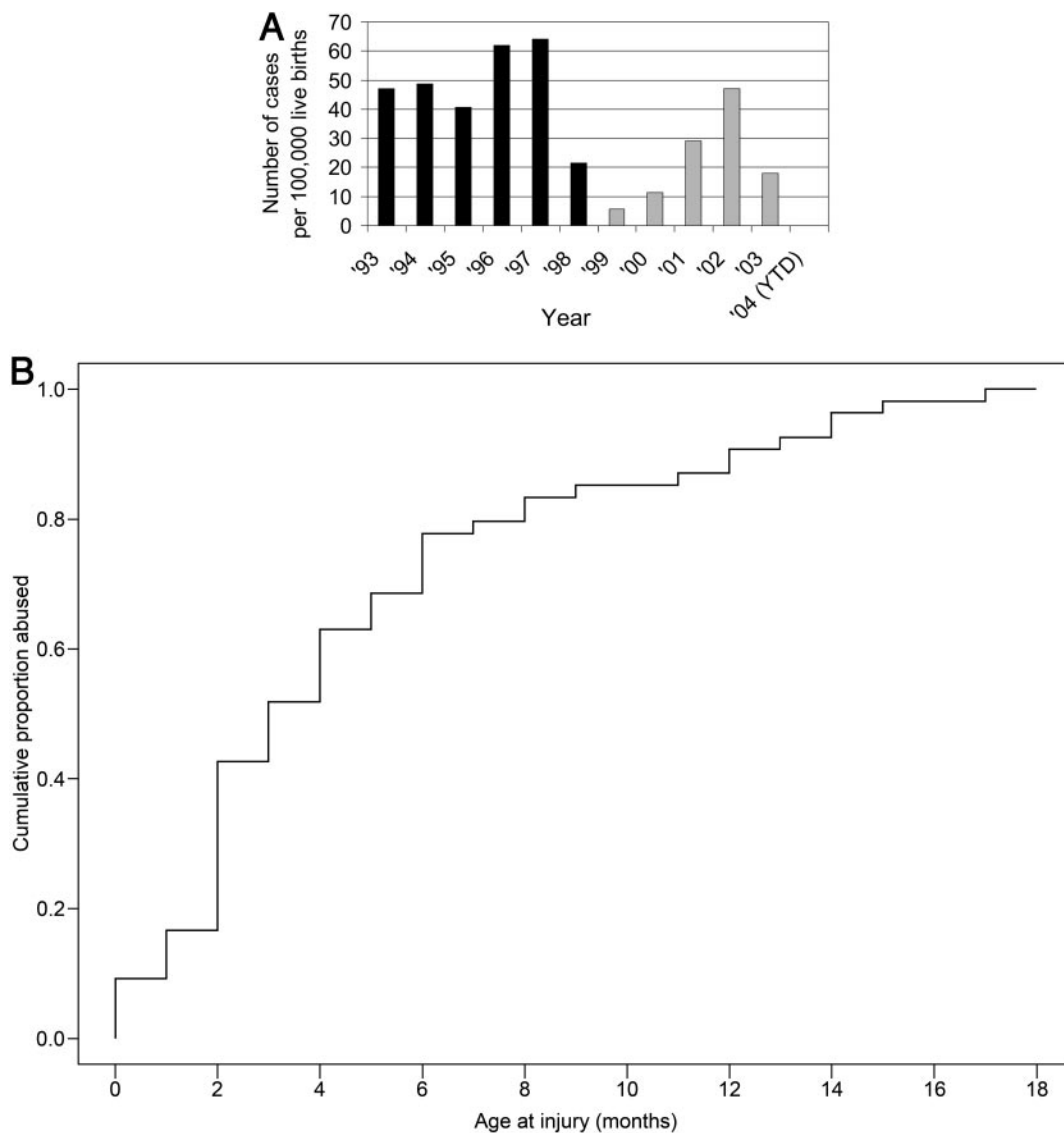


**Fig 2.** Annual incidence of abusive head injuries in the 8-county WNY region before (December 1, 1992, through November 30, 1998, inclusive) and during (December 1, 1999, through May 31, 2004, inclusive) the prevention program. A, Number of cases per year; B, incidence per 100 000 live births. Pennsylvania (PA) incidence rates for the years 1996–2002 (inclusive) are shown in B for comparison purposes.

program began); this change was also statistically significant ( $P = .0305$ ).

Recalculation of the incidence figures according to year of birth rather than year of injury also yielded statistically significant reductions in incidence during the study period (Fig 3). The incidence during the historical control period was 42.3 cases per 100 000 live births (2 children born before but injured during the historical control period were excluded from this analysis because incidence figures for the year preceding the historical control period were not available) and that during the study period was 23.1 cases per 100 000 live births (Fig 3A) with the calculated empirical, cumulative, distribution function correction (Fig 3B). The reduction in incidence remained significant ( $P = .0221$ ). Even after addition of 1 additional case per year for the latter 3 years of the study period (an overly conservative analysis), significant reductions persisted ( $P = .0461$ ).

A subgroup analysis demonstrated that 7 of the 21 case subjects identified during the program were born to parents who had not been exposed to the program; 2 were born before the program had begun and 5 were born at hospitals that were not yet participating at the time of the infant's birth. Of the 14 remaining infants, the birth hospital was unknown for 1 and 3 were born at participating hospitals but without a returned CS. The remaining 10 infants were born at participating hospitals from which there was a CS signed by the parents; the perpetrator in each of these 10 cases (the father in 9 and the mother in 1) had signed the CS. Excluding the 2 individuals born before the program began and the 1 individual for whom the birth hospital was unknown, the incidence was 35.3 cases per 100 000 live births for cases with no signed CS (and therefore no record of participation in the program) and 15.5 cases per 100 000 live births for cases with a signed CS. The



**Fig 3.** Annual incidence of abusive head injuries in the 8-county WNY region for infants classified according to the year of birth. A, Comparison of incidence per 100 000 live births in WNY for infants born before (December 1, 1992, through November 30, 1998, inclusive) and after (December 1, 1998, through May 31, 2004, inclusive) implementation of the prevention program. B, Cumulative distribution of abused infants as a function of age at injury (used in calculating the empirical cumulative distribution function). All infants were injured before 18 months of age.

relative risk of sustaining an abusive head injury for infants without a signed CS was therefore 2.3 (95% confidence interval: 0.90–5.77;  $P = .0830$ ).

## DISCUSSION

Child abuse prevention efforts are of 3 general types, ie, primary, secondary, and tertiary.<sup>21</sup> Primary prevention efforts, of which this program is an example, address a broad segment of the population (such as all new parents). Secondary prevention efforts, such as the home visitation (or nurse-family partnership) program developed by Olds et al,<sup>22,23</sup> target a specific subset of the population considered to be at higher risk for child maltreatment. Tertiary prevention efforts target perpetrators of child maltreatment and seek primarily to prevent recidivism.

Secondary prevention programs such as home visitation programs have had the greatest demonstrated success in reducing child maltreatment<sup>22,23</sup> but require considerable resources and are impractical for an entire population. Moreover, their effectiveness in specifically preventing abusive infant head injuries has not been assessed. Primary prevention programs designed to educate the public about the dangers of violent infant shaking have included television and radio public service announcements, billboard advertisements,<sup>24</sup> provision of educational materials to health care providers' offices, schools, and/or community agencies,<sup>25</sup> and hospital-based education programs.<sup>17,26</sup> No published study has yet assessed the impact of any of these programs on the incidence of abusive infant head injuries.

Because they must reach large numbers, primary prevention programs must be neither expensive nor time-consuming to administer. A simple program containing a powerful message, administered at the appropriate moment and requiring very little effort or time on the part of those who deliver the message and those who receive it, has the greatest chance of success. This prevention program meets these criteria and can be successfully implemented on a wide scale.

We chose a hospital-based, primary prevention program targeting parents of newborn infants for several reasons. First, parents are the most common perpetrators of abusive infant head injuries. Second, the period of greatest risk is during the months after the infant's birth. Third, childbirth is a time of almost universal contact between parents and the medical community. Fourth, educated parents might be advocates in disseminating this information to others. Finally, research on adult learning suggests that adults learn best when practical and contextually significant information is provided to help them cope with specific life-changing events, such as marriage, a new job, or the birth of a child. Moreover, the greater the life-changing event, the more likely adults are to seek out information and to learn. Adults are willing to engage in learning before, after, or during such a life-changing event.<sup>27</sup>

This program is unique in several respects. First, it is the only attempt to provide universal, consistent, hospital-based, parent education to an entire region; although not yet universal, the program reached the

parents of at least 69% of newborn infants in the region during the study period. Second, it is the only program with demonstrated success in reaching large numbers of parents, particularly fathers and father figures. Third, it is the only program to require active parent participation in the process through the signing of the CS, cementing the central theme of the program and perhaps creating a "social contract" between parents and their community. The signing of the CS may be a very important (perhaps even the most important) component of the program's success. Although there might be many possible reasons for the lower incidence of abusive head injuries among those who signed the CS, the degree of protection was significant, which emphasizes the potential importance of this part of the program. Fourth, this is the only program to track program compliance through the return of CSs. Most importantly, this is the only program with demonstrated effectiveness in reducing the incidence of abusive infant head injuries. The observed reductions are likely a minimum, because cases were more likely to have been missed during the control period (when they were identified retrospectively) than during the study period (when they were identified prospectively).

The data also confirmed that 93% of the parents were already aware of the dangers of violent infant shaking, which suggests that parents need only to be reminded at the appropriate time, ie, the child's birth, and the message needs to be retained only for a short period to be effective. Viewed in this manner, the program may be likened to a vaccination program in which parents, once "inoculated" with information, are "immunized" against violent infant shaking during this critical period. The costs of such a program can therefore be compared with the costs of immunizations. The direct cost of administering this program (including the collection and tracking of CSs) was \$177 268 per year, including salaries for nurse coordinators to administer the program and to perform data entry, costs of supplies, travel expenses, postage costs, telephone costs, miscellaneous expenses, and in-kind costs for nurses at participating hospitals (we estimated an average of 15 minutes of the nurse's time per family, which was a generous estimate considering that the nurse need not be present during the 11-minute videotape). The costs were therefore approximately \$10 per infant, comparable to the costs of many immunizations. Assuming a 47% reduction in incidence, the costs of the program could be reclaimed if the average costs of caring for victims of injury (including initial costs for new cases and ongoing costs for survivors) exceeded \$21 925 per case each year, well within the range currently quoted for medical costs of abusive head injuries.<sup>10–12</sup> These costs would be substantially lower if only "face time" between nurses and parents (more realistically estimated at 5 minutes per family) were included and research costs were excluded.

There are at least 5 potential criticisms of such a study. First, it is difficult for some to believe that such a simple intervention could be this effective in changing human behavior. Many have suggested that a more comprehensive program, providing

more materials or incorporating postprogram self-testing to assess parents' understanding of the materials, might be more effective and/or provide additional information. However, our experience suggests that the more time-consuming the program, the less likely it is to be implemented by nurses and accepted by parents. For practical reasons, the program was designed to require <5 minutes of actual contact time between nurses and parents.

Second, a short intervention implemented at a time of increased parental stress might be unlikely to be recalled months later during a period of frustration and rage. However, adult education principles suggest that adults are capable of learning well during periods of life change. Moreover, the follow-up telephone surveys suggested that the majority of parents remembered having received this information for at least 7 months after the child's birth.

Third, although the program was incapable of reaching every male caregiver (such as a mother's subsequent boyfriend), the program was very successful in reaching a significant proportion of fathers and father figures and also emphasized to participating mothers that they should share this information with all care providers. Follow-up telephone surveys with mothers suggested that a significant number of them shared this information with the child's father if he was not initially present. However, the program might be less effective in a setting in which few fathers are available during the perinatal period.

Fourth, there was not an inverse "dose-response" relationship between the increasing number of CSs signed each year and the incidence of abusive head injuries. Although it may be difficult or impossible to identify accurately a dose-response relationship, given the small numbers of annual cases and inherent random variability, the sharp increase in the incidence during 2002 is interesting to note. It is even more interesting that 5 of the 8 cases identified during 2002 occurred during the autumn, at a time when the national economy was in decline. A slight increase was also noted in Pennsylvania during that year (Fig 2), and an inordinate number of abusive head injury cases were reported in Ohio newspapers during that time. We wonder whether the number of cases in WNY might have been even higher during 2002 without the prevention program.

Fifth, this was not a randomized, controlled trial, which raises the possibility that confounding variables had an effect on the outcome. Although it was initially considered, a prospective, randomized trial was impractical. A randomized study would require enrollment of many more families to ensure adequate statistical power, given the relatively low incidence of abusive head injuries in the population. Prospectively randomizing certain hospitals to participate and others not to participate is difficult because of the widely disparate sizes, birth rates, geographic distributions, and demographic features of the hospitals' constituent patient populations. Prospectively randomizing families within each hospital would generate the problem of cross contamination; families randomized not to receive information would likely receive information through conversa-

tions with medical staff members or other families, room sharing, or posters on the wards. In addition, families going through the program more than once during the study period could potentially be assigned randomly to different arms of the study with each birth. We thought that a study comparing the incidence during the study period both with historical control rates in the same region during the immediately preceding period and with the state incidence rates for Pennsylvania during both the control and study periods would minimize the effects of confounding variables on the results.

It is possible that the dramatic decline in incidence is attributable to other, unidentified, confounding variables. For example, the celebrated conviction of Louise Woodward (the "Boston nanny"), which generated international attention during 1997, could have affected public perceptions about infant shaking. In addition, regional nurse-family partnership programs (2 of which began in 1 county of WNY in 1996, with a third program beginning in a second county in 2001) could have accounted in part for the decline, although the results of this study were much more widespread. Several features suggested that the reductions were specifically related to the parent education program. First, neither the team of physicians identifying cases of abuse at WCHOB nor the criteria on which they based the diagnosis of abusive head injury changed between the control and study periods, and all cases during both the control and study periods fit a common definition of abusive head injury. Second, there was no corresponding decrease in the number of other types of child abuse in the region during the study period. Third, a query of child abuse specialists on the Special Interest Group on Child Abuse listserv (SIGCA-MD, Cornell University) failed to identify a decline of this magnitude in other areas of the country. Fourth, preliminary results from the 9-county region surrounding Rochester, New York, where the program began in January 2000, showed a similar 41% reduction in the incidence of abusive head injuries during the first 3 years of the program (M.S.D., K.S., K.D., and M. Silberstein, MD, unpublished data, 2004). Finally and perhaps most importantly, the statewide incidence of substantiated abusive head injuries in the Commonwealth of Pennsylvania did not change significantly during the period 1996–2002 (which bracketed the period of study in WNY).

This study provides the first firm evidence that a comprehensive program of hospital-based, parent education at the time of a child's birth can reduce effectively the incidence of abusive infant head injuries. The success of this pilot program in WNY is currently being tested on a larger scale in the Commonwealth of Pennsylvania, where there is now a statewide mandate to provide this program to parents of all newborn infants. The program began in May 2002 in central Pennsylvania and expanded to the eastern and western regions in 2004. The WNY program has entered a second phase (as of January 2004) in which the hospital-based information is being supplemented with additional information (and another CS) provided to parents at the time of the

infant's first visit with the pediatric care provider. It is hoped that a systematic approach to prevention (with appropriate authentication of results), although it will likely not completely eliminate abusive head injury, will at least reduce it to a fraction of its present level.

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