# Neonatal Transport of Very Low Birth Weight Infants in Jerusalem, Revisited

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**Key words:** referral of premature infants, neonatal outcome, perinatal factors

## Abstract

**Background:** Maternal transport, rather than neonatal transport, to tertiary care centers is generally advocated. Since a substantial number of premature deliveries still occur in hospitals with level I and level II nurseries, it is imperative to find means to improve their outcome.

**Objectives:** To compare the neonatal outcome (survival, intraventricular hemorrhage and bronchopulmonary dysplasia) of inborn and outborn very low birth weight infants, accounting for sociodemographic, obstetric and perinatal variables, with reference to earlier published data.

**Methods:** We compared 129 premature infants with birth weights of 750–1250 g delivered between 1996 and 2000 in a hospital providing neonatal intensive care to 99 premature babies delivered in a referring hospital. In the statistical analysis, variables with a statistical significant association with the outcome variables and dissimilar distribution in the two hospitals were identified and entered together with the hospital of birth as explanatory variables in a logistic regression.

**Results:** Accounting for the covariates, the odds ratios (outborns relative to inborns) were 0.31 (95% confidence interval = 0.11–0.86, $P = 0.03$) for mortality, 1.37 (95%CI = 0.64–2.96, $P = 0.42$) for severe intraventricular hemorrhage, and 0.86 (95%CI = 0.38–1.97, $P = 0.78$) for bronchopulmonary dysplasia. The odds ratio for survival without severe intraventricular hemorrhage was 1.10 (95%CI = 0.55–2.20, $P = 0.78$). Comparing the current results with earlier (1990–94) published data from the same institution showed that mortality decreased in both the outborn and inborn infants (OR = 0.23, 95%CI = 0.09–0.58, $P = 0.002$ and 0.46; 95%CI = 0.20–1.04, $P = 0.06$, respectively), but no significant change in the incidence of severe intraventricular hemorrhage or brochopulmonary dysplasia was observed. Increased survival was observed also in these infants receiving surfactant, more so among the outborn. The latter finding could be attributed to the early, pre-transport surfactant administration, implemented only in the current study.

**Conclusions:** Our data suggest that very low birth weight outborn infants may share an outcome comparable with that of inborn babies, if adequate perinatal care including surfactant administration is provided prior to transportation to a tertiary center.

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The proliferation of neonatologists and neonatal intensive care units and the advent of new technologies during recent decades were accompanied with reduced mortality rates among very low birth weight infants. Many studies have documented higher survival rates among premature newborns delivered in facilities capable of providing intensive care when compared to infants delivered in primary care hospitals and then transferred to a neonatal intensive care unit. Consequently, maternal transport to tertiary care centers, rather than neonatal transport, was advocated [1-4]. However, maternal transport may be hazardous in events such as advanced labor, placental bleeding or fetal distress, and a substantial number of premature deliveries still occur in level I and level II nurseries [5].

Recent studies from Alaska and California reported that about 34% and 16%, respectively, of very low birth weight infants were delivered in primary care and intermediate care facilities [2,6], and the need to transfer premature newborns to more advanced facilities has also been described in England and France [7-9]. While much focus was put on optimizing the quality and availability of neonatal transfer, it is emphasized that a key factor in the long-term outcome of a sick infant is the initial care provided at the hospital of birth [10,11]. Cifuentes et al. [4] found that subsequent neonatal transfer to a regional neonatal intensive care unit only marginally decreased the disadvantage of birth in less advanced facilities.

In our system one neonatal intensive care unit serves two hospitals. The vast majority of VLBW infants delivered in the referring hospital are transferred to the NICU but only very few maternal transports are conducted. We previously evaluated the neonatal outcome of our inborn and outborn VLBW infants delivered during 1990–1994 [12]. Mortality and morbidity were higher among outborn infants than among infants delivered in the tertiary hospital, however the differences were not statistically significant. It was suggested then that improvement of perinatal care including early surfactant administration prior to transportation might minimize the disadvantage of outborn infants. Since the mid-1990s surfactant was increasingly administered within the first hour of life, prior to transportation to our Mount Scopus hospital. Since all inborn babies with a birth weight ≤ 1250 g are cared for in the NICU whether or not mechanical ventilation is needed, an adequate comparison between the two hospital populations required the inclusion of all outborn infants in the study sample, whether transferred or treated locally. We report here our experience with inborn and outborn premature infants

CI = confidence interval
OR = odds ratio

VLBW = very low birth weight
NICU = neonatal intensive care unit

delivered during 1996–2000 with reference to the previously studied group.

## Patients and Methods

The Hadassah Medical Organization operates two university hospitals in Jerusalem, Israel – Mt. Scopus and Ein Kerem – located at the opposite ends of the city. Both hospitals provide high risk obstetric services, each with 4000–4500 annual deliveries. The NICU is located at Mt. Scopus while Ein Kerem has a Level II nursery with the capability of neonatal resuscitation and provision of mechanical ventilation until transportation to the NICU. The distance between the two hospitals is 15 km and the transportation time is 30–40 minutes, depending on traffic conditions. Babies delivered in Ein Kerem and requiring intensive care are transported by a neonatologist to the NICU at Mt. Scopus.

All premature infants with birth weights of 750–1250 g admitted to our nurseries between 1996 and 2000 were included in the study. Those weight limits were taken in order to conform with the weight limits of the previous study [12] where the upper margin was chosen to minimize the portion of the larger and asymptomatic infants remaining in the referring hospital, while the lower margin was chosen to minimize the portion of selective aggressive treatment of smaller babies. Similarly, the same definitions were used as in the previous study. Thus, mortality and morbidity during hospitalization were compared between 129 inborn infants delivered at Mt. Scopus and 99 babies delivered at Ein Kerem including 23 non-referred infants. Babies with major congenital anomalies that may affect outcome were not included in this study. Transportation to the NICU was conducted usually within 4 hours of birth. Neonatal care in the referring hospital included temperature, respiratory and cardiovascular stabilization, initial workup, commencement of antibiotic therapy as needed, central lines insertion, and surfactant administration prior to transportation.

Socioeconomic, obstetric, perinatal and neonatal data were extracted from the hospital files. The effect of delivery in the referring hospital (Ein Kerem) on mortality during hospitalization and selected morbidity (intraventricular hemorrhage and bronchopulmonary dysplasia), as compared with the inborn population (Mt. Scopus), was evaluated. We also compared the neonatal outcome of each hospital population during 1990–1994 and 1996–2000.

The factors considered were:

- *sociodemographic variables*: maternal age, origin and education (complete years of schooling)
- *obstetric variables*: number of pregnancies, live births and abortions, number of previous infant deaths, type of present conception (natural, hormonal or in vitro fertilization), type of delivery (vaginal or cesarean section), single or multiple gestation, pregnancy complications (abruptio placenta, toxemia and other diseases), treatment received during pregnancy (tocolytic, steroids), and hospitalization > 24 hours prior to delivery
- *neonatal variables*: gestational age by weeks calculated from the last menstrual period, birth weight in grams, Apgar scores, weight appropriate or small for gestational age, presence of respiratory distress syndrome, patent ductus arteriosus, pneumothorax, bronchpulmonary dysplasia (defined by the requirement of oxygen or ventilatory support beyond 28 days of age), necrotizing enterocolitis (mild or severe), sepsis, intraventricular hemorrhage (mild: grades I and II, severe: grades III and IV), retinopathy of prematurity (grades I-IV), and treatment received by the infant (oxygen, mechanical ventilation, surfactant).

#### Statistical analysis

Three outcome variables – mortality, severe IVH (grades 3 or 4) and BPD (only for infants that survived at least 28 days) – were compared between hospitals and time periods (1996–2000 vs. 1990–94). The statistical analysis comprised three stages. First, variables with a statistically significant association with the outcome variable at the 0.05 level were identified. In this stage the associations were tested by means of the chi-square test. For tables with any cell having an expected frequency less than 5, exact and not asymptotic *P* values are reported. For two-sided tables Fisher's exact test was used instead. In the second stage each variable selected in the first step was entered together with the hospital as explanatory variables in a bivariate logistic regression. The resulting odds ratio (odds for the outcome, Ein Kerem compared to Mt. Scopus) was then compared to the crude OR. Whenever the absolute difference was ≥ 0.1 (10% of OR = 1) the variable was selected for the multivariate analysis. The third and final stage comprised a multivariate backward stepwise logistic regression of the outcome on the variables that met the criteria established in the previous steps. The stepwise procedure was applied with likelihood ratio tests. The final model included the variables statistically significant at the 0.05 level in the last step. Of the postnatal variables only Apgar scores and RDS were considered in the third stage of the analysis in order to avoid a dual effect of related postnatal factors on the evaluated outcome (i.e., RDS, mechanical ventilation and pneumothorax). We introduced these variables in the analysis to serve as an index of initial illness severity. Also, in cases of co-linearity (i.e., SGA and toxemia, birth weight and pregnancy duration), only one variable was introduced into the final analysis. All analyses were done using SPSS for Windows V12 and StatXact V6.

## Results

The distribution of the variables of the two study populations is listed in Table 1. For comparison we added values of the previous study (1990–1994) [12]. For most variables the distribution in the two hospitals was similar, except for maternal non-Jewish origin and less than high school maternal education, which were more prevalent among mothers delivering in Mt. Scopus, where

IVH = intraventricular hemorrhage
BPD = bronchopulmonary dysplasia
RDS = respiratory distress syndrome
SGA = small for gestational age

**Table 1.** Distribution (%) of sociodemographic, obstetric, perinatal and neonatal variables in each hospital, in the present study versus the 1990–1994 study

| | Ein Kerem | | Mt. Scopus | |
|---|---|---|---|---|
| | 1996–2000 (n=99) | 1990–94 (n=76) | 1996–2000 (n=129) | 1990–94 (n=91) |
| *Sociodemographic variables* | | | | |
| **Origin** | | | | |
| Jewish | 92.9 | 86.8 | 64.3 | 79.1 |
| Non-Jewish | 7.1 | 13.2 | 35.7 | 20.7 |
| **Maternal age (yrs)** | | | | |
| 16–24 | 23.2 | 21.1 | 24.8 | 20.9 |
| 25–29 | 22.2 | 34.2 | 35.7 | 35.7 |
| 30–34 | 26.3 | 27.6 | 22.5 | 20.9 |
| 35–45 | 28.3 | 17.1 | 17.1 | 27.5 |
| **Education (yrs)** | | | | |
| 3–11 | 9.4 | 25.0 | 28.7 | 22.5 |
| 12 | 41.7 | 41.7 | 33.3 | 36.0 |
| 13–20 | 49.0 | 33.3 | 38.0 | 41.6 |
| *Obstetric variables* | | | | |
| **No. of pregnancies** | | | | |
| 1 | 28.3 | 27.6 | 31.8 | 22.0 |
| 2–3 | 36.4 | 39.5 | 32.6 | 38.5 |
| 4–18 | 35.7 | 32.9 | 35.7 | 39.6 |
| **Live births** | | | | |
| 1 | 39.4 | 38.2 | 48.1 | 34.1 |
| 2–3 | 37.4 | 36.8 | 32.6 | 37.4 |
| 4–13 | 23.2 | 25.0 | 19.4 | 28.6 |
| **Abortions** | | | | |
| 0 | 62.6 | 59.2 | 54.3 | 53.8 |
| 1 | 18.2 | 18.4 | 25.6 | 20.9 |
| 2–8 | 19.2 | 22.4 | 20.2 | 25.3 |
| Sibling death < 1 year | 5.1 | 10.5 | 3.1 | 9.9 |
| **Type of conception** | | | | |
| Natural | 70.7 | 68.4 | 65.9 | 80.2 |
| Hormonal treatment | 13.1 | 17.1 | 17.8 | 19.8 |
| IVF | 16.2 | 14.5 | 16.3 | – |
| **Type of delivery** | | | | |
| Vaginal | 33.3 | 34.2 | 24.8 | 18.0 |
| Cesarean section | 66.7 | 65.8 | 75.2 | 82.0 |
| **Pregnancy duration (wks)** | | | | |
| 23–27 | 35.4 | 35.5 | 34.1 | 20.9 |
| 28–29 | 31.3 | 26.3 | 34.9 | 42.9 |
| 30–38 | 33.3 | 38.2 | 31.0 | 36.3 |
| **Pregnancy course** | | | | |
| Abruptio placenta | 28.3 | 10.5 | 24.0 | 22.0 |
| Toxemia | 15.2 | 26.3 | 24.8 | 22.0 |
| Other diseases | 28.3 | 26.3 | 21.7 | 29.7 |
| Antenatal steroids | 49.5 | 31.6 | 68.2 | 41.8 |
| Tocolytics | 20.2 | 32.9 | 37.2 | 37.4 |
| Hospitalization > 24 hr before delivery | 68.7 | 68.4 | 72.7 | 58.2 |
| **Neonatal variables** | | | | |
| Multiple birth | 36.4 | 39.5 | 41.1 | 28.6 |
| Female | 44.4 | 43.4 | 43.4 | 44.4 |
| **Birth weight (g)** | | | | |
| 750–999 | 42.4 | 47.4 | 38.8 | 47.3 |
| 1000–1250 | 57.6 | 52.6 | 61.2 | 52.7 |
| **Birth weight/gestation** | | | | |
| AGA | 84.8 | 75.0 | 75.0 | 70.3 |
| SGA | 15.2 | 25.0 | 25.0 | 29.7 |
| **Apgar at 1 min** | | | | |
| 0–4 | 15.2 | 35.5 | 13.2 | 19.8 |
| 5–6 | 19.2 | 28.9 | 22.5 | 31.9 |
| 7–10 | 65.7 | 35.5 | 64.3 | 48.4 |
| **Apgar at 5 min** | | | | |
| 1–6 | 3.1 | 6.8 | 3.9 | 5.5 |
| 7–10 | 96.9 | 93.2 | 96.1 | 94.5 |
| ***Diseases of the newborn*** | | | | |
| RDS | 52.5 | 48.7 | 39.5 | 37.4 |
| Pneumothorax | 7.1 | 9.2 | 8.5 | 3.3 |
| Patent ductus arteriosus | 18.2 | 22.4 | 20.9 | 14.3 |
| Sepsis | 41.5 | 30.3 | 40.5 | 38.5 |
| Necrotizing enterocolitis | 3.0 | 9.2 | 7.8 | 4.4 |
| **IVH** | | | | |
| No | 52.1 | 56.6 | 55.2 | 67.0 |
| Mild | 27.7 | 18.4 | 31.2 | 15.4 |
| Severe | 20.2 | 25.0 | 13.6 | 17.6 |
| **BPD** | 25.3 | 22.4 | 22.5 | 16.5 |
| ***Treatment of the newborn*** | | | | |
| Oxygen | 91.9 | 86.8 | 93.0 | 81.3 |
| Mechanical ventilation | 69.1 | 73.7 | 71.9 | 63.7 |
| Surfactant | 44.4 | 36.8 | 31.8 | 28.6 |

**Table 2.** Logistic regression of mortality on hospital, maternal age, pregnancy duration and RDS

| | N | OR | 95%CI | *P* |
|---|---|---|---|---|
| **Hospital** | | | | |
| Mt. Scopus | 129 | 1 | | |
| Ein Kerem | 99 | 0.31 | 0.11–086 | 0.03 |
| **Maternal age (yrs)** | | | | |
| 16–24 | 55 | 1 | | |
| 25–29 | 68 | 0.15 | 0.03–0.66 | 0.01 |
| 30–34 | 55 | 0.52 | 0.15–1.78 | 0.30 |
| 35–45 | 50 | 1.49 | 0.45–4.89 | 0.51 |
| **Pregnancy duration (wks)** | | | | |
| 24–27 | 79 | 1 | | |
| 28–29 | 76 | 0.17 | 0.06–0.52 | 0.002 |
| 30–38 | 73 | 0.10 | 0.02–0.51 | 0.01 |
| **RDS** | | | | |
| No | 125 | 1 | | |
| Yes | 103 | 4.50 | 1.56–12.94 | 0.01 |

the administration of antenatal steroids and tocolytic treatment was also more frequently practiced.

#### Comparison between Ein Kerem and Mt. Scopus (1996–2000)

The mortality rate among babies delivered in Ein Kerem was 9.1% compared to 14.0% in Mt. Scopus infants (OR = 0.62). Variables associated with mortality in the bivariate analysis included: maternal age 25–29 years, toxemia, gestational age, birth weight, SGA (decreased mortality) and Apgar score less than 7 at 5 minutes, RDS, pneumothorax, IVH, sepsis and necrotizing enterocolitis (increased mortality). In the multivariate analysis [Table 2] the presence of RDS was significantly associated with mortality, while maternal age of 25–29 years and advanced pregnancy duration were significantly associated with decreased mortality. The OR of dying following birth in Ein Kerem as compared to Mt. Scopus controlling for all the variables in the model decreased from 0.62 to 0.31 ($P = 0.03$).

The rate of severe IVH (grades III and IV) was 20.2% among infants born in Ein Kerem and 13.6% in Mt. Scopus babies (OR = 1.61). Variables that were associated with severe IVH in the bivariate analysis included: natural conception, low Apgar score at 1 minute, RDS and pneumothrax (higher incidence of IVH), advanced gestational age, birth weight, antenatal steroids (partial or complete course), and maternal hospitalization > 24 hours prior to delivery (lower incidence of IVH). In the multivariate analysis the presence of RDS was significantly associated with severe IVH, while advanced gestational age and exposure to antenatal steroids were protective [Table 3]. The OR of developing severe IVH following birth in Ein Kerem as compared to Mt. Scopus controlling for all the variables in the model decreased from 1.61 to 1.37 ($P = 0.42$).

The percentage of infants who survived more than 28 days and who developed BPD was 33.3% in Ein Kerem-born infants and 29.6% in Mt. Scopus babies (OR = 1.19). Variables that were associated with the development of BPD in the bivariate analysis

**Table 3.** Logistic regression of severe IVH on hospital, pregnancy duration, antenatal steroids and RDS

| | N | OR | 95%CI | *P* |
|---|---|---|---|---|
| **Hospital** | | | | |
| Mt. Scopus | 125 | 1 | | |
| Ein Kerem | 94 | 1.37 | 0.64–2.96 | 0.42 |
| **Pregnancy duration (wks)** | | | | |
| 24–27 | 78 | 1 | | |
| 28–29 | 76 | 0.35 | 0.14–0.84 | 0.02 |
| 30–38 | 65 | 0.25 | 0.08–0.73 | 0.01 |
| **Antenatal steroids** | | | | |
| No | 44 | 1 | | |
| Yes (including partial) | 175 | 0.40 | 0.17–0.94 | 0.04 |
| **RDS** | | | | |
| No | 118 | 1 | | |
| Yes | 101 | 2.47 | 1.10–5.57 | 0.03 |

**Table 4.** Logistic regression of bronchopulmonary dysplasia on hospital, pregnancy duration, abruptio placenta, type of delivery, Apgar score at 1 min. and RDS

| | N | OR | 95%CI | *P* |
|---|---|---|---|---|
| **Hospital** | | | | |
| Mt. Scopus | 114 | 1 | | |
| Ein Kerem | 89 | 0.86 | 0.38–1.97 | 0.73 |
| **Pregnancy duration (wks)** | | | | |
| 24–27 | 61 | 1 | | |
| 28–29 | 72 | 0.10 | 0.04–0.25 | <0.00001 |
| 30–38 | 70 | 0.06 | 0.02–0.18 | <0.00001 |
| **Abruptio placenta** | | | | |
| No | 147 | 1 | | |
| Yes | 56 | 3.17 | 1.32–7.58 | 0.01 |
| **Type of delivery** | | | | |
| Vaginal | 56 | 1 | | |
| Cesarean | 147 | 0.37 | 0.15–0.94 | 0.04 |
| **Apgar score at 1 min** | | | | |
| 0–4 | 27 | 1 | | |
| 5–6 | 40 | 0.13 | 0.03–0.50 | 0.003 |
| 7–10 | 136 | 0.15 | 0.05–0.48 | 0.001 |
| **RDS** | | | | |
| No | 119 | 1 | | |
| Yes | 84 | 4.91 | 2.04–11.81 | 0.0004 |

included: maternal age less than 25 years, low level of education, abruptio placenta, vaginal delivery, male gender, RDS, pneumothorax, sepsis, Apgar score less than 5 at 1 minute (higher incidence of BPD), advanced gestational age and birth weight, SGA, and toxemia (lower incidence of BPD). In the multivariate analysis, short pregnancy duration, abruptio placenta, vaginal delivery, 1 minute Apgar score less than 5, and the presence of RDS were all significantly associated with the development of BPD [Table 4]. The odds ratio of developing bronchopulmonary dysplasia following birth in Ein Kerem as compared to Mt Scopus, controlling for all the variables in the model, decreased from 1.19 to 0.86 ($P = 0.73$).

In a similar comparison between the two populations of infants surviving without severe intraventricular hemorrhage, pregnancy duration and the Apgar score at 1 minute were significantly associated with such intact survival (data not shown). The odds ratio of survival without severe IVH following birth in Ein Kerem as compared to Mt. Scopus controlling for the above variables was 1.105 (95%CI = 0.55-2.20, $P = 0.78$).

**Comparison between periods (1990–94 vs. 1996–2000)**

In a multivariate analysis comparing mortality of the two periods in Ein Kerem, short pregnancy duration and the presence of RDS were significantly associated with mortality (data not shown). The odds ratio for neonatal death during 1996–2000 as compared to 1990–94, controlling for the variables in the final model, was 0.23 (95%CI = 0.09–0.58, $P = 0.002$).

There was no statistically significant difference between the periods in Ein Kerem with regard to the evolvement of severe IVH or BPD (OR = 0.81, 95%CI = 0.35–1.91, $P = 0.63$, and OR = 1.39, 95%CI = 0.35–1.91, $P = 0.63$, respectively).

In a multivariate analysis comparing mortality in the two periods at Mt. Scopus, short pregnancy period and the presence of RDS were significantly associated with mortality (data not shown). The odds ratio for neonatal death during 1996–2000 as compared to 1990–94, controlling for the variables in the final model, was 0.46 (95%CI = 0.20–1.04, $P = 0.06$).

There was no statistically significant difference between the periods at Mt. Scopus with regard to the evolvement of severe IVH or BPD (OR = 1.64, 95%CI = 0.59–4.57, $P = 0.35$, and OR = 1.21, 95%CI = 0.46–3.13, $P = 0.70$, respectively).

We also analyzed the risk for severe IVH in the combined samples of the two study periods (21% during 1990–94, 16.4% during 1996–2000). The difference between the two periods, however, was not statistically significant ($P = 0.29$, Fisher's exact test)

**Surfactant administration**

During 1990–1994, surfactant administration to both populations was done only in Mt. Scopus. Thus, infants transferred from Ein Kerem to Mt. Scopus received surfactant only following arrival at Mt. Scopus. During the current study surfactant was also administered in Ein Kerem, and 36 of the 44 infants who were born in Ein Kerem and transported to Mt. Scopus received surfactant in Ein Kerem prior to their referral. Only 14 of the 28 infants born in Ein Kerem during 1990–94 who received surfactant survived (50%), whereas survival of 86.4% (38 of 44) of such infants was experienced during the current study ($P = 0.001$, Fisher's exact test). The odds ratio for mortality, adjusted for gestational age category, among infants receiving surfactant during 1996–2000 compared with those delivered during 1990–94 was 0.18 (95%CI = 0.06–0.57, $P = 0.004$).

Survival of infants receiving surfactant and born in Mt. Scopus was 57.7% during 1990–94 and 73.2% during 1996–2000 ($P = 0.286$). The odds ratio for death, adjusted for gestational age category, among infants receiving surfactant during 1996–2000 compared with those delivered during 1990–94 was 0.27 (95%CI = 0.07–0.95, $P = 0.041$). There was no statistically significant difference between the periods with regard to surfactant administration and the evolvement of severe IVH or BPD.

## Discussion

Recent studies evaluating the impact of neonatal care on mortality of very low birth weight infants have witnessed a significant decline in mortality rates during the last few decades. The observed trend was attributed mainly to the increasing numbers of premature infants delivered in hospitals providing intensive care [1-4]. Comparing the overall mortality of our two hospitals during the two periods showed a reduction from 22.2% during 1990–94 to 11.8% during 1996–2000 among infants with birth weights of 750–1250 g. The increase in survival rate, though apparent in the two hospital populations, was higher among the outborn infants. In contrast to many other reports, the mortality rate among the outborn premature infants in our recent study was lower than among the inborn ones. Contrary to our practice during 1990–1994 when surfactant was administered only upon arrival in the NICU, pre-transport surfactant administration was commonly practiced during the current study period. Mildenhall and co-authors [13] examined the safety of synthetic surfactant use before preterm newborn transport and found that increased respiratory benefit was apparent in those who received pre-transport surfactant with no intratransport complications. It is feasible that its early administration accounted, at least in part, for the improved survival of the referred infants.

The overall incidence of severe intraventricular hemorrhage in both hospital populations decreased moderately from 21% during 1990–94 to 16.4% during the recent study period. A significant change between the periods was not observed, however, when the incidence of severe IVH was adjusted for the other variables in the logistic regression analyses of each hospital or when combined. It is quite well established that antenatal steroid administration is protective against intraventrucular hemorrhaging [14]. A protective association was also found in our present and previous studies. We assume that the lower overall incidence of IVH during the recent period could be at least partially attributed to the more common administration of antenatal steroids practiced in both hospitals. As in the previous study, IVH was more common among the outborn population, though the difference was not statistically significant. It is possible that the increased survival rate of the outborn infants was associated with increased incidence of IVH. The rate of infants surviving without severe IVH was similar in the outborn and inborn populations.

The finding that the survival rate was higher in outborn infants than in inborn babies but that there was no significant difference between the two hospital populations in intact survival without severe IVH suggests a higher percentage of surviving infants with severe IVH among the outborn babies than among the inborn ones.

In our system, decisions regarding continuation of intensive care of infants with severe brain damage are made in collaboration with parents, and the level of aggressive treatment is not lowered without parental consent. Since religiously Orthodox Jewish families, who tend to insist on continuation of aggressive treatment in all conditions, constitute a higher proportion of the outborn than the inborn population, we speculate that this parental attitude may serve as another contributing factor for the higher percentage of surviving infants among the outborn population. This issue, however, was not methodologically analyzed in the present study.

There was no decrease in the rate of BPD along the years and comparing the two hospital populations did not reveal any difference. The initial reports on bronchopulmonary dysplasia related to infants who suffered from severe RDS and developed chronic lung disease following exposure to high pressure ventilation and oxygen. In recent years infants of younger gestational age are rescued who often require only mild to moderate ventilatory support secondary to the advent of antenatal steroids, surfactant administration and modern strategies of mechanical ventilation. Despite the milder initial course, the incidence of chronic lung disease of prematurity has not declined. It was thus suggested that whereas in the past, BPD was caused mainly due to barotrauma and oxygen toxicity, recent cases are more pathognomonic of lung maldevelopment often occurring secondary to the exposure to intrauterine infection and the consequent fetal inflammatory reaction [15,16]. Comparing the results of the present study with our results in 1990–1994, for each hospital separately, similarly revealed a marked decrease in mortality rates but no significant change in the incidence of severe IVH and BPD.

Only a very few maternal transports occurred during the study periods and these were conducted at the discretion of the attending obstetric and neonatal physicians and not necessarily according to the case complexity. The possibility of a significant selection bias due to this factor is therefore minimal, in our opinion, but cannot be ruled out.

Various studies have indicated that survival rates of preterm newborns correlate with the level of care at the hospital of birth [4]. In our system, pediatric residents of Ein Kerem receive their neonatal training at Mt. Scopus, and our neonatologists rotate between the two hospitals. Neonatal care in the referring hospital includes initial workup, commencement of antibiotic therapy as needed, central lines insertion, and respiratory and cardiovascular stabilization prior to and after surfactant administration. Thus, the medical expertise is shared in both institutions, which is probably the main reason for the improved outcome of infants born in the referring hospital.

It is therefore suggested that since a substantial number of premature deliveries occurs in level I and level II nurseries, improvement of perinatal care by incorporating neonatal training and practice with a tertiary center program may improve the outcome of their very low birth weight infants.

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