Rocking waterbeds and auditory stimuli to enhance growth of preterm infants

Preliminary report

In this study certain features of intrauterine environment were simulated. Preterm infants were placed on waterbeds, gently rocked, and exposed to auditory stimuli. The stimulated group exhibited significantly better growth for weight, head circumference, and biparietal diameter of the head than did the control infants. Healthy preterm infants placed on rocking waterbeds and exposed to auditory stimuli had growth characteristics comparable to fetuses during the thirty-second to the thirty-sixth week of gestation.

Lloyd I. Kramer, M.D.,* *Falls Church, Va.,* **and Mary Ella Pierpont, M.D., Ph.D.,** *Washington, D.C.*

AFTER BIRTH, every infant must make significant adaptations to extrauterine life. Preterm infants frequently fail to make these adjustments smoothly and often demonstrate developmental problems.[1]

The standard nursery incubator provides the infant warmth, cleanliness, and a minimum of handling. It does not provide the same vestibular, auditory, and proprioceptive stimuli present in the normal intrauterine environment. Such stimuli may be essential for normal development of preterm infants. This concept is supported by studies of young monkeys subjected to sensory deprivation. Monkeys raised with stationary surrogate mothers exhibited rocking, minimal exploration, decreased social interaction, and passive-aggressive behavior.[2, 3] Similarly, human infants raised with limited maternal contact exhibited many of the same abnormal behaviors as monkeys raised with surrogate mothers.[4]

In this study an attempt was made to simulate certain aspects of the intrauterine environment. Preterm infants were placed on waterbeds, gently rocked, and exposed to auditory stimuli. These infants were then assessed weekly to determine whether this special setting influenced their development in comparison to control infants.

From the Department of Pediatrics, Georgetown University Medical School, and the Department of Pediatrics, The Fairfax Hospital.

**Reprint address: The Fairfax Hospital, 3300 Gallows Road, Falls Church, Va. 22046.*

MATERIALS AND METHODS

Twenty healthy preterm infants of less than 34 weeks gestation, born between September 1, 1974, and May 16, 1975, at The Fairfax Hospital, were randomly assigned to either a stimulated or control group. Gestational age was determined by the method of Dubowitz and associates.[5] Infants were excluded from the study if (1) they were not appropriate for gestational age in length, weight, or head circumference; (2) their clinical course became too complex; or (3) they could not tolerate oral feedings by one week of age.

Abbreviations used	
dB:	decibel
A-P:	anterior-posterior

The control group (nine infants) received standard nursing care in incubators. The stimulated group (eleven infants) received a special program begun two through seven days after birth and lasting for the duration of stay in the incubator. The program included: (1) placement of the infant on a waterbed; (2) mechanical rocking of the waterbed one hour prior to each feeding; and (3) playing of a taped simulated heartbeat (72 beats/minute) and a woman's voice (74 to 84 dB) during the rocking period. Parental visiting and maternal interaction were not restricted for either group.

All weekly measurements were made by one investigator who was unaware of the progress of the infants and

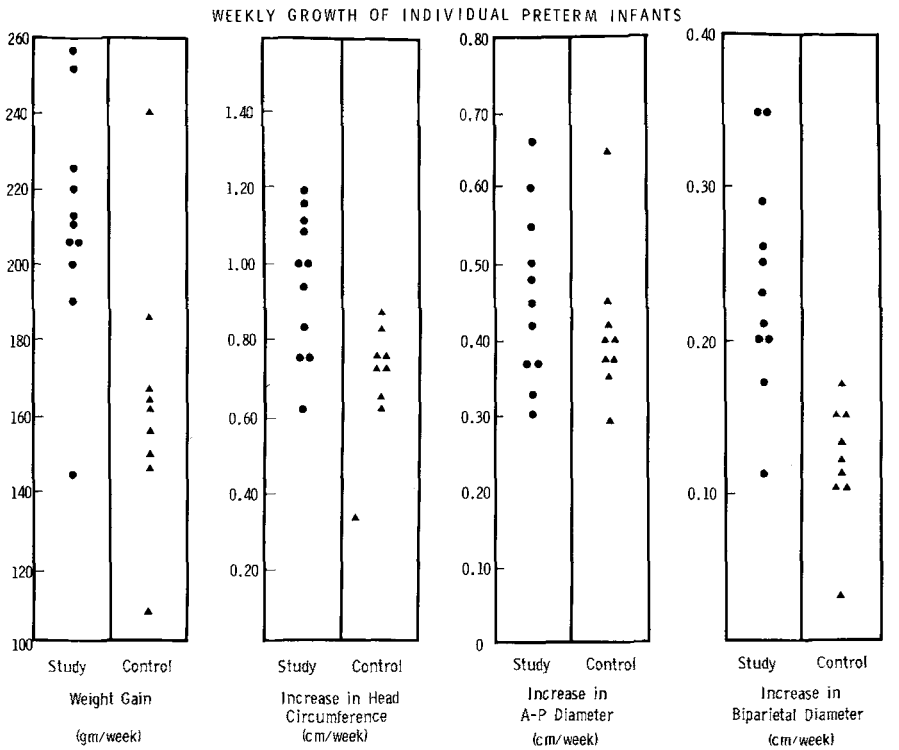

Fig. 1. Comparison of growth between stimulated (study) and control groups.

had no responsibility for their care. Measurements of growth included weight, head circumference, and anterior-posterior and biparietal diameters of the head. The latter two measurements were obtained using calipers. Weekly weight gain was averaged from the infant's lowest and highest weight between 32 and 36 weeks of gestation. Neurologic status of the infants was determined by the neuromuscular determinants of the Dubowitz scale. Behavior was evaluated by the Brazelton neonatal assessment scale.[6]

Waterbeds made of heavy gauge vinyl were designed specifically to fit the plastic trays of the Isolette incubator. Waterbeds were not used in incubators with heating coils below the tray since overheating could occur. Each waterbed was filled with warmed tapwater of the same temperature as the incubator to avoid dangerous heating or cooling of the infant. Waterbed temperature was maintained by the ambient temperature of the incubator. Gentle head-to-foot rocking of the waterbed was accomplished by alternately inflating and deflating a test lung 25 to 30 times per minute with an inexpensive demand valve utilizing compressed air.

RESULTS

Characteristics of the infant groups are shown in Table I. In addition, both groups were compared with respect to maternal demography (including age, parity, gravidity, and duration of labor). Significant differences between the two groups were not found for any of the features examined (student t).

Weekly increases in weight, head circumference, and A-P and biparietal diameter of the head for each infant showed that the control and stimulated groups have significantly different growth patterns (Fig. 1). In addition, the stimulated group nippled earlier, ate better, and were more active than the control group. Stimulated infants on waterbeds gained significantly ($p < 0.01$) more weight each week (211 ± 30 gm/wk) than did the control infants (165 ± 35 gm/wk). Increases in the head circumference were noted to be significantly larger ($p < 0.01$) for stimulated infants (0.95 ± 0.19 cm/wk) than for the control infants (0.69 ± 0.07 cm/wk). Furthermore, the biparietal diameter of the stimulated infants (0.23 ± 0.07 cm/wk) increased more rapidly ($p < 0.001$) than that of the control infants (0.12 ± 0.03 cm/wk). The two groups were not significantly different in growth of the A-P diameter of the head.

Neurologic and behavioral features were assessed weekly. Both stimulated and control groups demonstrated similar maturation in all areas and were indistinguishable using either the Dubowitz method or the Brazelton neonatal assessment scale.

DISCUSSION

The normal intrauterine environment is a complex setting in which the healthy fetus thrives. Many different

types of stimulation are experienced by the fetus during his maturation. Tactile, vestibular, and proprioceptive stimulation are provided in utero by the variety of maternal and fetal movements.[7] Auditory stimuli consist of low-pitched, variable sounds (85-95 dB) that originate from the maternal cardiovascular and digestive systems.

In contrast, the typical extrauterine environment of preterm infants is a nursery incubator providing: (1) tactile and proprioceptive stimulation unlike that experienced in utero; (2) a constant machinery hum of 77 dB; and (3) minimal vestibular stimulation. Exposure to this environment for an extended period of time may not be beneficial to the developing preterm infant.

Waterbeds have been used successfully in our nursery since 1971. They have proved useful in many clinical situations: birth-related injuries, avoidance of skin irritation and pressure sores, postoperative care, and temperature stabilization of small preterm infants. Infants have been on waterbeds for as long as two months without complications related to the use of the waterbed.

The measurements of weight gain and head growth for preterm infants raised on waterbeds were compared to the expected fetal growth between 32 and 36 weeks' gestation. The average weight gained by healthy fetuses (216 gm/wk)[8] was nearly attained by the stimulated group (211 ± 30 gm/wk) in contrast to the gains of the control infants (165 ± 35 gm/wk). Similarly, fetal head growth (0.85 cm/wk)[8] was more closely paralleled by the stimulated group (0.95 ± 0.19 cm/wk) than by the control infants (0.69 ± 0.07 cm/wk). More significantly, ultrasonic measurements of fetal biparietal head growth (0.20 cm/wk)[9] were nearly the same as those of our stimulated group (0.24 ± 0.07 cm/wk). In contrast, the control infants showed comparatively little biparietal head growth (0.12 ± 0.03 cm/wk).

The above data confirm that preterm infants raised on firm mattresses have narrower heads than infants raised on waterbeds. It appears that waterbeds support the soft head of the preterm infant, mold to the head shape, and offer less direct constraint to the normal growth process. As a result the preterm infants raised on waterbeds developed larger, more rounded heads.

Recently, it has been suggested that compression of the superior sagittal sinus may increase intracerebral venous pressure.[10] Such compression may occur when preterm infants are placed on firm mattresses and may contribute to an increased incidence of intracranial hemorrhage. Further observation is necessary to determine whether placing sick preterm infants on waterbeds will decrease the incidence of intracranial hemorrhage.

The study presented here shows that preterm infants who were placed on waterbeds and received additional stimulation had significantly improved growth as compared to that of the control infants. In addition, these stimulated infants closely matched expected fetal growth for the same gestational period. Further studies, presently underway, will attempt to evaluate the significance of these findings.

Table I. Infant's characteristics of stimulated and control groups

Characteristics	*Stimulated (n = 11) (Mean ± SD*)*	*Control (n = 9) (Mean ± SD)*	*Statistical significance (p)*
Birth weight (gm)	1552 ± 226	1683 ± 129	NS†
Birth gestational age (wk)	32.0 ± 1.8	32.7 ± 1.5	NS
Apgar 1 minute	6.6 ± 2.4	5.2 ± 2.2	NS
Apgar 5 minutes	8.0 ± 2.3	8.1 ± 1.4	NS
Highest percent oxygen	36.2 ± 20.9	35.0 ± 16.3	NS
Duration oxygen therapy (hr)	28.5 ± 41.0	33.4 ± 48.0	NS
Highest total bilirubin (mg/dl)	8.9 ± 2.4	9.7 ± 1.9	NS

*Standard deviation.
†Not significant ($p > 0.05$).

REFERENCES

1. Drillien CM: The incidence of mental and physical handicaps in school age children of very low birth weight, Pediatrics **39**:238, 1967.
2. Harlow H: The nature of love, Am Psychol **13**:673, 1958.
3. Mason WA: Early social deprivation in the nonhuman primates: Implications for human behavior in environmental influences, *in* Glass DC, editor: Environmental influences, New York, 1968, Rockefeller University Press, p 70.
4. Sayegh Y, and Dennis W: The effect of supplementary experiences upon behavioral development of infants in institutions, Child Dev **36**:81, 1965.
5. Dubowitz LM, Dubowitz V, and Goldberg C: Clinical assessment of gestational age in the newborn infant, J PEDIATR **77**:1, 1970.
6. Brazelton TB: Neonatal behavioral assessment scale, Clinics in developmental medicine, no. 50, Philadelphia, 1973, JB Lippincott Company.
7. Grimwade JC, Walker DW, and Wood C: Sensory stimulation of the human fetus, Aust J Ment Ret **2**:63, 1970.
8. Usher R, and McLean F: Intrauterine growth of live-born Caucasian infants at sea level: Standards obtained from measurements in 7 dimensions of infants born between 25 and 44 weeks of gestation, J PEDIATR **74**:901, 1969.
9. Hellman LM, Kobayashi M, Fillisti L, Lavenhar M, and Cromb E: Sources of error in sonagraphic fetal mensuration and estimation of growth, Am J Obstet Gynecol **99**:662, 1967.
10. Newton TH, and Gooding CA: Compression of superior sagittal sinus by neonatal calvarial molding, Radiology **115**:635, 1975.