The Effects of Stimulation Programs on the Development of High Risk Infants: A Review of Research

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Advances in medical technology, perinatal care, and neonatal intensive care have greatly increased the rate of survival for neonates born with a variety of medical problems and very low birthweights. The majority survive relatively sequelae free, although evidence still indicates that they remain at higher than normal risk for physical, mental, and social development. As the number of medical complications increases and birthweight decreases, the expectations for normal development become less promising. The kinds of stimulation the early postnatal environment provides have been identified as important factors in the infant's growth and development. The effects of providing patterned stimulation to infants in the neonatal intensive care unit have been investigated by many. Despite difficulties in comparing studies due to the variability of subjects used, and type, intensity, and duration of treatment, the overwhelming evidence indicates beneficial effects.

In the past 10 to 15 years the mortality rate for preterm infants weighing 1500 grams (3 lbs 5 oz) or less has decreased from approximately 85% to 50% or less (Fitzhardinge & Campbell, 1977; Lubchenco, 1980; Teberg et al., 1982). When preterm infants (up to 35 weeks gestation) of a birthweight above 1500 grams are included, the mortality rate has dropped from 35% in 1973 (Chase, 1973) to 7.2% in at least one major hospital (Chapman, 1978). Perelman and Farrell (1982) noted that according to national statistics 44% fewer neonates died in 1978 than in 1971.

While the survival rate has increased dramatically, the incidence of prematurity and low birthweight has not changed. In addition, the incidence of neurological and developmental problems in the population of small and ill preterms has not changed (Horwood, Boyle, Torrance, & Sinclair, 1982; Ment et al., 1982). As a result, much attention has been directed toward the early identification of infants at risk for problems in biological or psychological development.

The concept of an infant being “at-risk” is based on the infant's probability of manifesting any developmental delay or handicap, be it motor, cognitive, or psychosocial. A consensus of which factors should be considered and to what degree they must be evident in the neonate for one to suspect other than normal or optimal development is difficult to ascertain from research designs and materials written about infants. One reason may be that as medical and psychological techniques advance, those variables which cause developmental problems also change. Another

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may be the difficulty in isolating factors for study which contribute to developmental problems. Field (1979) noted that the singular event of prematurity is often clustered with other complications such as respiratory distress syndrome, infection, and jaundice, making controlled studies in the neonate difficult. Conversely, many factors, when occurring in isolation, are not very predictive of developmental problems. Parmelee and Haber (1973) credited Lilienfeld, Passmanick, and Knobloch with popularizing the phrase “continuum of reproductive causality,” which is a concept most researchers today accept. Such a continuum considers negative factors as cumulative, with some weighted more than others. At-risk infants are most frequently classified by low birthweight and size for gestational age. Additional risk factors often identified and studied include respiratory distress syndrome, socioeconomic status, anoxia, apnea, jaundice, infection, hyperbilirubinemia, and intracranial hemorrhage. As the number and severity of factors increase for the neonate, so does its risk for short- and long-term problems.

Advances in neonatal medical care, such as the creation of regional neonatal intensive care centers, monitoring of thermal and metabolic status, assisted ventilation, and early identification of developmental deficits have been credited with improving the chances of survival and decreasing adverse sequelae for many at-risk infants. The improving prognosis for such infants is reflected in characteristics of neonates studied. Follow-up studies reported in the sixties and early seventies reflected the still suspect future for infants born premature even without additional complications (Ravinovitch, Bibace, & Caplan, 1961; Rubin, Rosenblatt, & Balow, 1973; Strang, 1975; Weiner, 1968). Today, prematurity is not in itself considered cause for great concern, unless it is one of several symptoms such as being small for gestational age or respiratory distress syndrome.

Recent studies have frequently grouped neonates on the basis of subcategories for birthweight, with additional risk factors such as need for mechanical ventilation, asphyxia, levels of serum bilirubin, and socioeconomic status also identified. Birthweight categories examined include: (a) ≤ 2500 grams (5 lbs 8 oz), (b) ≤ 1500 grams, and (c) ≤ 1000 grams. Weight, relative to gestational age, is considered to provide a more accurate description than preterm or premature, thus the terms “appropriate for gestational age” and “small for gestational age” are classifications now being used. However, the generic terms “premature” and “preterm” are still frequently applied to studies of the above populations, especially in intervention research.

Reports by Drillien, Thomson, and Burgoyne (1980), Hoskins, Elliot, Shennan, Skidmore, and Keith (1983), Kimble, Ariagno, Stevenson, and Sunshine (1982), Lee (1977), Ment et al. (1982), Neligan, Kolvin, Scott, and Garside (1976), Simonds, Silva and Aston (1981), and Teberg et al. (1982) are representative of recent follow-up studies of children born within the range of the birthweights noted above. Like most investigators, these researchers were unable to or felt it less meaningful to examine birthweight alone. On many items no differences were reported between the high risk infants and normal children, and differences found were sometimes inconsistent across studies. Generally, however, it may be concluded that as birthweight decreased and frequency and severity of additional factors increased more problems were identified later in life.

At the upper end of the range of birthweights (≤ 2500 grams), Simonds and associates found no significant difference in behavioral and emotional factors between preterm low birthweight and normal children by school age. In contrast, Neligan and colleagues reported that their subjects who were born small for gesta-
tional age, scored lower than preterms, who scored lower than normal children on numerous cognitive, behavioral, and motor abilities. Lee found children ≤ 2268 grams to be significantly less skilled than normal weight children in perceptual-motor tasks at age 5 to 6 years. At the lower end of the birthweights studied, Teberg et al., Ment et al., and Hoskins et al., studied children born at ≤ 1500 grams, ≤ 1250 grams, and ≤ 1000 grams respectively. Teberg's group found 19 to 22% were two standard deviations below the mean on growth parameters, while 18% were less than normal neurologically, and 34% showed abnormal development at 1 to 3 years. Ment and associates found 28% had abnormal Bayley mental and motor scores at one year. Of the 106 infants Hoskins et al. studied, 68% survived to follow-up at 1 to 2 years. Of these, 13% had significant neurological or developmental handicaps such as cerebral palsy or spastic quadripareisis.

It is suggested that 80 to 90% of all high risk infants are sequelae free (Kennell & Klaus, 1982; Ment et al., 1982) and the outlook for survivors of neonatal intensive care units continues to brighten as diagnosis and treatment improves. However, being within the normal range does not rule out the possibility that a higher than expected number fall at the lower end of normal. In spite of the generally optimistic outlook, numerous studies and reviews indicate the low-birthweight infant remains at higher than normal risk for physical, mental, and social development.

A large body of evidence attests to the influences of the postnatal environment on subsequent infant development (Broman, Nichols, & Kennedy, 1975; Niswander & Gordon, 1972). Lodge (1976) noted that while individuals differ in their rate and pattern of behavioral development, there is evidence that high risk infants may be unusually susceptible to the impact of their immediate environment. Also, Als, Lester, and Brazelton (1979) cited examples suggesting that inhibition of various inappropriate stimuli, such as bright lights and loud noises, is more taxing in the less mature infant than in a full term baby.

The typical neonatal intensive care unit (NICU) provides constant bright lighting, continuous noise from mechanized monitoring and ventilating systems, and lacks attractive color variations. Handling is restricted mainly to medical and primary care needs with oral feeding usually omitted in favor of high caloric gavage feeding. This environment has been described both as one of sensory bombardment and sensory deprivation. A description of NICUs appearing recently is that of providing inadequate appropriately patterned stimulation. Few have actually documented the environment itself.

Gottfried et al., (1981) systematically measured physical and social parameters in a regional neonatal intensive care unit. Findings indicated illumination levels to be constant with the only variation being additional sunlight in the afternoons. Continuous sound levels resembled that of light traffic, reaching peak levels resembling large machinery sounds, and lasting 4 to 6 hours at a time. Speech was heard 92% of the time, radios 79%, and nonspeech sounds were continuous. During 46% of the time social interaction occurred, with the greatest portion resulting from medical procedures and talking, while least interaction resulted from bottle feeding, social touching, and rocking.

Jones (1982) conducted an elaborate study of two intensive care units focusing mainly on the neonate's psychosocial environment. Of the 26% of the time spent in contact with an adult in a day, 11% was for medical care and 11% general needs (e.g., linen change, washing). During this period simultaneous social interaction occurred 15% of the time. An additional 4% of contact time provided personal atten-
tion for the infant (e.g., soothing, rocking, talking to the infant). Of the staff-infant contact, 34% could be considered stressful, plus, due to the proximity of isolettes, frequent emergencies and major procedures affecting one infant, caused tension and stress in adjacent or all infants.

Lawson, Daum, and Turkewitz (1977) and Newman (1981) also measured the physical environment of the intensive care nursery. Both reported high and constant sound levels and Newman noted jerk and startle responses from the infants coinciding with noncontinuous louder sounds (such as closing incubator doors or replacing trash can lids). Handling occurred with less frequency than Gottfried and colleagues reported, but these investigators reported similarly that the greatest portion occurred due to medical procedures. Lawson et al. also recorded constant illumination levels.

Other attempts to quantify the neonatal intensive care unit environment concentrated on auditory levels (Bess, Peek, & Chapman, 1979; Committee on Environmental Hazards, 1974; League, Parker, Robertson, Valentine, & Powell, 1972). All reported very loud sound levels and louder intermittent noise. Though below present damage risk criteria for adults (Kryter, Ward, & Miller, 1966) this level refers to noncontinuous sound. It is not known if this level is appropriate for infants as well as adults.

Friedman and Vietze (1972) concluded from their review of the literature on learning that newborns can detect change in the external environment, can discriminate between stimuli, and have short-term memory for redundant events. Infants also are capable of initiating responses from the environment through their facial expressions, postures, and movements (Solkoff & Cotton, 1975; Watson & Ramey, 1972). The presence of such capabilities in the newborn for learning from and interacting with the environment suggests the importance of questioning the quality of the environment in which infants in intensive care units live.

The increased survival rates for preterm ill infants with continued higher than normal risk for subsequent development has resulted in a desire to improve the early environment for such survivors. Biological growth and maturation may well be determined genetically, but the environment is believed to be able to enhance or inhibit optimal development.

Studies investigating the effects of environmental manipulations on high risk infants have most frequently been referred to as infant stimulation programs. Such programs involve one or more sensory modality such as auditory, tactile, visual, kinesthetic, and vestibular. Treatments vary from hanging colorful mobiles in the isolette to placing newborns on oscillating water beds. With few exceptions, treatments are provided in a temporal sequence. Efforts are directed toward providing more optimal conditions for psychosocial, cognitive, and physical development.

Research on the effects of manipulating the environment for newborns in the NICU has been guided by two basic theories:

1. The NICU environment is vastly different from the highly patterned uterine environment and thus deprives the infant of the kinesthetic, tactile, and auditory stimulation it would normally have received in the third trimester.
2. The highly mechanized, noisy, and brightly lit NICU does not provide high risk infants with the nurturing environment the normal newborn receives during early postnatal growth and development.
Difficulties arise in comparing infant stimulation programs because criteria for inclusion, assessment instruments used, and sample sizes differ widely. Additional variations include length of program, frequency of treatment, and follow-up period. Most meaningful comparison therefore seems to be by stimulus mode.

**Auditory Stimulation**

Much is still unknown about fetal development during the last weeks in utero; as more is learned attempts to facilitate the preterm baby's transition may also improve. It is known that the unborn fetus can respond to sounds. Possibly the most frequent sounds heard come from the mother. Katz (1971) and Segall (1972) were the first researchers to use sound as a source of stimulation by playing recordings of the infant's mother's voice at regular intervals. Results were not consistent as Katz found more mature motor, tactual and visual functioning, increased muscle tension, and no change in irritability compared to controls, while Segall reported more soothing effects, i.e., greater attentiveness and decreased heart rates in response to a female or mother's voice. Few continue to study the effects of auditory stimulation alone (one exception being the ongoing research by Chapman, 1978, at the University of Toronto), but several include it in a more comprehensive multimodal approach (Barnard, 1981; Kramer & Pierpont, 1976; Schwartz, 1978).

**Tactile, Vestibular, and Kinesthetic Stimulation**

The effects of tactile and especially vestibular and kinesthetic stimulation have resulted in more systematically positive results. A difficulty in this research lies in separating the three modalities. It is hard to determine, for example, which stimulus soothed the crying infant who was picked up and held by an adult in the on-the-shoulder position, and perhaps all three contributed. Therefore they will be discussed together with an attempt to indicate the emphasis expressed by each research team.

Hasselmeyer (1964) was one of the first to investigate the effects of stimulation on premature infants, providing tactile and vestibular stimulation in the form of rocking and stroking. After 2 weeks, she found the handled infants cried less and passed less feces than control infants. Powell (1974) also provided manual handling by nurses and mothers. Freedman, Boverman, and Freedman (1966) rocked neonates in a rockerbox within the incubator, and Neal (1968) placed her premature infants in motorized hammocks. All reported some improvements in weight gain. Neal's "swingers" were more responsive to auditory cues, and displayed more mature visual and motor responses. Powell noted greater scores for stimulated infants at 4 months on the Bayley mental scales and at 6 months on Bayley behavior records.

Several studies involved stroking the preterm, small infant as a means of tactile stimulation. Freeman (1970) provided 5 minutes of stimulation, after feeding or on the hour, for 24 infants. Comparing them to 24 control subjects, she found improved weight gains for both experimental groups and decreased respiratory problems for

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1 For the sake of brevity, descriptive information regarding individual stimulation studies was kept to a minimum in the discussion that follows. Further information in the form of tables, organized by mode of stimulation, may be obtained by contacting the author.
those receiving stimulation after feeding. Studies by Solkoff, Yaffee, Weintraub, and Blase (1969), Solkoff and Matusczak (1975) and Kramer, Chamorro, Green, and Knudtson (1975) also provided stroking to preterm infants, though each utilized only five to eight experimental subjects. Improved social development, and more optimal growth and developmental scores were noted, though not with consistency. Adding passive limb movement to stroking stimulation, White and Labarba (1976) and Rausch (1981) found increased feeding intake and weight gain.

Rice (1977) utilized mothers to rock and massage their preterm infants providing extra tactile, kinesthetic, and vestibular stimulation during a 1 month postdischarge period. At 4 months, improved weight gain, neurological, and mental development were reported.

Korner's team of researchers (Korner, Forrest, & Schneider, 1981; Korner, Kraemer, Haffner, & Cosper, 1975; Korner, Ruppel, & Rho, 1982) began placing premature and ill infants on oscillating water beds as a means of imparting vestibular-proprioceptive stimulation as well as to hopefully provide other clinical benefits (preservation of fragile skin, softer head support, less energy necessary to cope with the impact of gravity). Relatively healthy preterms showed decreased apneic episodes while infants being treated with theophylline for apnea slept longer and were less restless and jittery. Infants being ventilated for respiratory distress syndrome showed greater alertness and spontaneous motor behavior, less irritability and hyperactivity, and better orientation.

Field et al. (1982) and Bernbaum, Pereira, Watkins, and Peckman (1983) provided pacifiers to preterms during tube feedings. They reported that infants provided with this stimulation for nonnutritive sucking had accelerated maturation of sucking reflex, required fewer tube feedings, gained more weight per day and were discharged an average of 6 to 8 days earlier than controls. One possibly negative effect Field's team noted was greater frequency of weak reflexes on the Brazelton scale at discharge time.

**Multimodal Stimulation**

The use of multimodal stimulation has been advocated by several investigators. For those who theorize that the preterm infant is deprived of the multivaried stimuli the womb provides, intervention would seem to have a greater likelihood of succeeding if it also provides multiple forms of stimulation.

A study by Kramer and Pierpont (1976) exemplified this approach. For as long as their preterm infants needed to be in an incubator, they received 1 hour of rocking on a water bed and listening to a tape of their mother's voice and music prior to each feeding. Increased weight gain and greater head circumference were reported. Barnard's study (1972) utilizing a rocking bed and heartbeat recording resulted in an increase in amount and length of quiet sleep and earlier development of distinct sleep states.

Rose and Bridger (1979) chose to combine body massaging with rocking and talking, to measure effects on performance of visual recognition and memory tasks. At 6 months the preterm stimulated infants performed as well as term controls while nonstimulated preterms did not.

Groom (1974) and McNichol (1974) studied infants ≤ 2500 grams and ≤ 36 weeks gestation age. Dividing them into four groups; one group received visual stimulation, a second a form of tactile or tactile/kinesthetic stimulation, a third received both visual and tactile, and the fourth was a control group. Groom
measured inhibition of the orienting reflex to repeated auditory stimulation and visual habituation finding no group differences when measured immediately or 42 weeks after treatment. McNichol noted the groups which received tactile stimulation were more attentive to novel stimuli and less attentive to familiar stimuli. Hayes (1978) retested some of Groom's and McNichol's subjects at 3 years of age finding no significant differences among any groups on the McCarthy scales. However, she also noted the mean cognitive index for control (normals) and prematures was significantly lower than standard scores, leaving a question as to the representativeness of the sample studied.

Several studies provided stroking, rocking, talking, and objects to look at or track in varying frequencies and intensities. Leib, Benfield, and Guidubaldi (1980) chose to hang a bright object in the infant's isolette, provide 5 minutes of rubbing during feeding when tube fed or rocking when bottle fed, and talk to the infant while feeding. An immediate effect was more efficient use of calories, and at 6 months better developmental states as measured by Bayley scales were reported.

Scarr-Salapatek and Williams (1973) provided visual, tactile, and kinesthetic stimulation to neonates in the hospital. In addition, they encouraged mothers to continue enrichment efforts after leaving the hospital by visiting the home weekly, providing demonstrations and toys. Four week assessments showed increased weight gains and higher scores on the Brazelton Neonatal Assessment Scale. The 1-year follow-up resulted in significantly better Cattell scores. Siqueland's (1973) multimodal "mothering" procedures included contingent stimulation for eye-opening. At 4 months, stimulated infants demonstrated significantly better performance on visual reinforcement control of sucking behavior and auditory reinforcement tasks. Schwartz (1978) trained parents to provide multi-varied stimuli (e.g., talking, singing, touching, holding, gaining eye contact) as they interacted with their infant. Short term results showed increased parental behaviors and visits to the intensive care unit. At 1 month postdischarge parents scored significantly better than controls on parenting behaviors and home environment items; infants were more alert with their parents and scored better on their Brazelton assessment.

Field, Widmayer, Stringer, and Ignatoff (1980) provided a training program for parents of preterm infants ≤ 2500 grams from birth to 8 months. Interventionists modeled sensorimotor and interaction exercises for parents every 2 weeks. At 4 months experimental infants were longer, had better Denver scores and temperament, and participated in more face to face interactions than controls. At 8 months, Bayley scores and temperament were better.

**Discussion**

Although the preceding review noted primarily the positive results reported, an effort was made to point out contradictory findings from similar studies. In some of the studies reviewed, additional assessments were made, but not mentioned in this report because they were nonsignificant and the variables measured were not of primary concern to the investigators.

Some studies seemed to report contradictory results of stimulation intervention, counting as positive effects both increased and decreased activity states (crying, alertness, eye contact and quiet state, better developed sleep pattern). It is important to bear in mind the goals of the investigators, type of stimulus and timing of applica-
tion of each. Depending on the relative state of the infants studied, each may be beneficial at various times. If the infant is fighting for survival, decreased jitteriness and longer sleep periods may be most important; if nearing discharge caregivers may look for alertness and increased eye contact. Initial weight gain was frequently reported, though usually effects were short-term. However, short-term weight gain at such a crucial period of physical growth may be very valuable. More consistently reported was improved performance on behavioral assessments. Assessment instruments varied with the age of the infant and investigator's preference including: The Bayley Scales, Brazelton Neonatal Assessment Scale, McCarthy Scale, Denver, and Cattell Infant Intelligence Scale.

Benefits reported are encouraging, but judgments concerning application of such interventions must be made carefully due to the variety of samples used. Results reported for one sample may not transfer to other newborns of different gestational ages, weights, and medical complications. Regarding her research with the use of waterbeds as stimulation, Korner (1981, p. 306) noted, "It is not now known whether waterbeds reduce apnea in infants other than those with a diagnosis of uncomplicated apnea of prematurity." The high risk population is a heterogenous one and many additional variables often not controlled for, are known to affect the development of infants, such as socioeconomic status, parental IQ, and medical history. Infants identified to have neurological problems or anatomical abnormalities often were excluded in order to control the sample. These infants may benefit most from programs of early intervention, but further investigation is needed utilizing such neonates.

Another difficulty in comparing results is the measurement of outcome. Results varied from weight gain and fecal passage to intelligence and social interaction. A more complete assessment battery or consistent use of measurement instruments would aid in determining what may and may not be expected from various intervention techniques.

Effects on parents and other family members are infrequently assessed, but they may actually be of real benefit. A calmer, more responsive, growing baby may ease the difficulties parents of such infants face, and increase their confidence in themselves as parents. Conversely, intervention studies in general have been accused of placing inordinate demands on family time and money. Such possibilities must also be addressed.

Short-term effects have more frequently been assessed than long-term even though they are sometimes thought to be less important. Barnard (1981) noted that few studies have actually followed treatment groups beyond infancy, leaving greater uncertainty of long-term effects. Such short-term effects as regaining birthweight faster, increasing formula intake, decreased irritability, and improved sleeping patterns may indirectly help to decrease time spent in the incubator, allow bottle feeding to begin earlier, result in fewer medical complications, and result in shorter stay in the intensive care unit. Field et al. (1982) noted such effects resulted in an average savings of $3,500 in hospital costs for experimental preterms. More such comparisons need to be made. Besides obvious health benefits and psychological benefits of returning home more quickly, savings in hospital expenses and staff time may be substantial.

Little is known about what actually constitutes sensory deprivation or overload for the preterm infant, although most investigators seem to assume that, as noted from studies with older individuals, both under- and overstimulation have a
disruptive and disorganizing effect on the physiological and psychological functioning of the organism (Frankenhauser & Johansson, 1974). Initial attempts have been made to quantify the neonatal intensive care environment, but guides for determining baseline information prior to intervention, effects of possible overstimulation, and the preterm's ability to cope with such stimulation are questions yet to be answered, but basic to an understanding of infant stimulation programs.

Continued research is needed to compare the effectiveness of various modes of stimulation, although some combination of modes rather than only one seems to be more effective. Parental involvement also seems to be warranted as early as possible. Medical staff rarely have extra time for rocking and other forms of individual stimulating attention. Parents may benefit as well as infants in being allowed to interact, respond to, and learn what to expect from their tiny infant while under the guidance of professional staff members.

Many treatment programs were very short-term, lasting 1 to 2 weeks. When success is to be based on effects measured during the early and middle childhood years, such as cognitive and social benefits, then longer intervention periods seem to be indicated. The probability that stimulation should be individualized and contingency-based also seems suggested. Interventions that soothe very early in life may help conserve energy needed for survival; attempts to arouse may facilitate feeding and learning at other times.

Summary

Premature and ill newborns are deprived of the last weeks or months in the womb as well as the chance to spend the first few weeks of life at home as do normal neonates. Paradoxically this same mechanical, sterile intensive care unit that has become so successful at saving the lives of such at-risk infants may also inhibit some aspects of development, both short- and long-term. By providing more natural nurturing, i.e., the temporal rocking patterns of the womb, tactile and auditory input, brightly colored mobiles, and gently passive arm and leg movements, attempts to alleviate this discrepancy may give the high risk infant a better start in life. Despite difficulties in comparing studies due to the variability of subjects used, type, intensity and duration of treatment, the overwhelming evidence indicates beneficial effects.

The success of infant stimulation research is beginning to have an impact. Some NICUs have made an effort to decrease inappropriate stimuli by cycling lighting and lowering noise levels. To increase appropriate stimuli, surroundings have been made more colorful and parent-infant contact is encouraged. The director of the University of Washington's Perinatal Nurse Specialist Program, (Blackburn, 1982) provided some guidelines for NICU staff. She encouraged the provision of visual and auditory feedback on infants' cues, gentle handling with gradual postural changes, social interaction during feedings, recognizing infants' stress signs, and teaching parents to interact appropriately with their infants. In order to hasten implementation of the effects demonstrated by many programs reviewed in this paper, clearer protocols, assessment, and follow-up procedures need to be established. Such programs have already had some effects on the quality of life for high risk infants by increasing awareness of their special needs and capabilities. The possibility that, before long, direct effects will be provided for a greater number of such infants seems promising as well.
References


Hasselmeyer, E.C. (1964). Handling and premature infant behavior: An experimental study of the relationship between handling and selected physiological, pathological, and behavioral indices related to body functioning among a group of prematurely born infants who weighed between 1,501 and 2,000 grams at birth and were between the ages of seven and twenty-eight days of life. *Dissertation Abstracts, 24*, 2874B-2875B. (University Microfilms No. 64-257)


