

Physical therapy for promotion of developmental progress and motor skill acquisition in children with developmental delays birth to five years of age.

Author, Title, Journal, Year	Purpose, Design	Subjects	Intervention	Outcome Measures	Results	Conclusions	Importance to PICO question
Resnick et al Developmental Intervention for Low Birth Weight Infants: Improved Early Developmental Outcome. Journal of Pediatrics. July 1987	Prospective longitudinal study designed to evaluate the effects of a multidisciplinary infant development program (IDP) on the mental and physical development of low birth weight infants (<1800g). Randomized, prospective longitudinal study, multiphasic and sequential developmental interventions, and an independent longitudinal evaluation to compare development in treated infants compared to controls.	255 low birth weight infants (500-1800g) treated at Univ Florida NICU, no statistical difference between groups, randomization by odd or even hospital numbers n=107 infant development program group n=114 control group	IDP infants were treated during responsive states twice daily for 20 minutes. Treatment consisted of 25 activities including tactile and deep muscle stimulation, gentle head to toe massage, passive range of motion, oral stimulation, auditory stimulation, vestibular stimulation, visual stimulation, and/or personal social development. Parents were provided with counseling, education and communication skills training. The post-discharge in-home IDP treatment consisted of 2x/month visits until the child was 2years. Control group infants received conventional care during hospitalization and after discharge. Referrals for health care or developmental services were given to infants regardless of treatment group allocation.	Development was assessed at 1 and 2 years of age (+or- 3mo) Bayley Scales of Infant Development (Mental and Psychomotor Index)	The prevalence of developmental delay was 4% for the IDP group at 1 and 2 year follow-up and for the control group 18% at 1 year and 2 years the prevalence of developmental delay was 26% for the control group (p<0.05). Of 19 IDP infants 0 were delayed at 1 or 2 years of age, of the 22 control infants 6 were delayed at 1 year and 2 years (p<0.05). At 1 year, the IDP group had significantly higher mental and physical developmental scores than control infants (p<0.05) and at 2 years (p<0.05).	The results of this study support a family-centered model of early developmental intervention, based on prevention of developmental problems related to low birth weight rather than a remediation approach when deficits become apparent late in infancy. The infant developmental program group had significantly higher scores on the mental and physical development indexes at 1 and 2 years of age and significantly lower prevalence of developmental delay compared to the conventional care group.	The outcome for the infant development program group represented a significant reduction in the prevalence of developmental delay for low birth weight infants.
Cameron et al. The Effects of an Early Physical Therapy Intervention for very Preterm, Very Low Birth Weight Infants: A Randomized Controlled Clinical Trial. Journal of Pediatric Physical Therapy. 2005	To investigate motor performance of very preterm (VPT) infants with very low birth weight (VLBW) assigned to treatment or non-treatment group compared to full-term control group. Randomized controlled trial.	72 VPT <32weeks and VLBW <1500g infants recruited, treatment group n=28, nontreatment n=32, and 14 full-term control group infants recruited for comparison at 4 months old.	Treatment: daily PT (M-F) to facilitate motor development from birth to 4months corrected age; maximum treatment duration 10minutes, included techniques to promote symmetry, muscle balance, and movement using postural support and facilitation techniques, parents instructed on home activities. After discharge infants received treatment once or twice monthly with 40mins treatment and 20mins parent instruction Nontreatment: no developmental PT interventions	At 4months, AIMS Alberta Infant Motor Scale used to measure motor development in preterm and full term infants. Treatment group infants assessed weekly with the LAPI Longitudinal Assessment of the Preterm Infant	Both preterm groups had greater median percentile ranks (nontreatment 72.5%, treatment 65%) on the AIMS compared to full term controls (50%) at 4-month assessment. No significant difference between groups' performance on AIMS at 4-month assessment (p=0.191). Preterm normal development infants performed better on AIMS compared to full term controls not statistically significant (p=0.10). Comparison of the number of infants with CP who scored less than or equal to 10 th percentile at 4months approached but did not reach significance (p=0.09).	At 4months of age, a significant difference in motor performance scores on the AIMS may not be observed after developmental physical therapy intervention for VPT and VLBW infants. However, the intervention may reduce the number of infants with motor delay at four months.	This study provides promising results that the greatest treatment effect in motor development was exhibited in the group of infants at highest risk for motor delay who were receiving early motor experiences and neonatal motility.
Piper et al. Early Physical Therapy Effects on the High Risk Infant: A Randomized Controlled Trial. Journal of Pediatrics. August 1986.	To assess the role of PT in the treatment of infants at risk for neuromotor delays and to evaluate the impact of early treatment on prevention or minimization of future handicaps. Prospective, randomized controlled trial. IV: early PT or conventional follow-up care (control) DV: change in neurologic status, motor, and overall development and physical growth	115 infants from 2 hospitals neurologically at risk (<1500g at birth, birth asphyxia, seizures, or CNS dysfunction). Stratified by prognosis and birth weight and block randomized.	Early PT: treatment began at term, infants treated 1hr/week individual PT session 3months, months 4-12 infants seen 1hr/ 2 weeks; Treatment session: individualized PT 30mins and 30mins teaching parents handling, positioning, and stimulation techniques based on NDT; parents provided with weekly treatment plan and asked to record their participation. Conventional Follow-Up Care: Infants did not receive treatment intervention. Allowed to receive PT if referred by MD.	Administered at 12 months by independent evaluators including measures of neurologic status, motor and overall development, and physical growth. Wolanski Gross Motor Evaluation, Wilson Developmental Reflex Profile, Milani-Comparetti Motor Development Screening Test, Griffiths Mental Development Scale, Neurological Examination of the Collaborative Perinatal Project	3-way ANOVA found no significant main group effect for any dependent variables; experimental children did not significantly differ from control children on any measured outcomes at 12 months. Children who weighed <750g at birth performed consistently more poorly at 12months than heavier peers, were smaller, had smaller head circumference and slower motor development and lower locomotor and personal social development quotients.	This study was unable to provide statistical evidence to support early PT to prevent neuromotor dysfunction or promote motor development in at risk infants. The experimental group did not have significantly better performance on any area of development compared to the conventional care control group.	This study provides an example of possible statistical results for an early PT intervention. The method for controls was not well defined because the control subjects could have received similar interventions which were not documented or described. The intervention may have been too infrequent to develop a treatment effect.
Blauw-Hospers CH and Hadders-Algra M. A Systematic Review of the Effects of Early Intervention on Motor Development. Developmental Medicine and Child Neurology.	To conduct a systematic review of studies on intervention starting early in life in children at high biological risk for developmental disorders. The authors particularly attempted to identify elements that contribute a beneficial effect on motor development.	Systematic review on the effect of early intervention (birth to corrected age 18months) on motor development in infants at high risk for or with developmental disorders. Thirty-six articles were	The most frequent NICU interventions included NIDCAP protocol and Kangaroo Care. In post-NICU studies NDT approaches were most commonly used. Of the 17 NICU studies, one demonstrated significantly positive effect on motor outcome based on NIDCAP treatment (stress reduction in with sensory stimulation). The other NICU study to demonstrate significantly	The outcome measures used in the studies were categorized as either neuromotor or tests with a general description of child's developmental level. The Bayley Scales of Infant Development were most frequently used as the outcome measure for both neuromotor (Physical	Of the 8 interventions between NICU discharge and nine months, four studies used neurodevelopmental therapy but there were not significant effects of this form of intervention on motor development. Two studies in this category used general sensory stimulation, general motor-development	Research regarding early intervention for children at risk for developmental disabilities is inconclusive. Studies reviewed were very heterogeneous; large variation existed in participant numbers, intervention methods, outcome measures, and time at which interventions were begun. Of the studies conducting interventions in the NICU the results suggested that NIDCAP	Preterm infants may benefit most from NIDCAP protocols that mimic the intrauterine environment. After term age children may benefit from interventions with specific motor training programs such as training locomotor movements on a

June 2005.		divided into categories by age groups (interventions initiated in the NICU, interventions initiated between NICU discharge and 9 months, interventions initiated after 9 months, and those that began sometime after NICU discharge). Most articles were RCTs.	positive results aimed at improving the infant's general development level by a developmental program (general sensory stimulation, stimulation of motor development, passive handling techniques, and enhancing parent-infant interactions). Of the 8 interventions between NICU discharge and nine months, four studies used neurodevelopmental therapy but there were not significant effects of this form of intervention on motor development. Two studies in this category used general sensory stimulation, general motor-development stimulation and either enhanced parent-infant interaction or passive handling techniques to reach statistically significant improvements in motor development. Of the six studies whose interventions began 9-18months after NICU discharge, one study using specific motor training for infants with Down syndrome achieved a significant positive effect. Another study found better motor development results with general infant stimulation received than with NDT. Of the 3 studies with interventions beginning between NICU discharge and 18months, two evaluated the effects of NDT. The study of short term effects of NDT had non-statistically significant results however, a less intensive NDT intervention over 6months found a positive effect of intervention on development.	Developmental Index) and developmental (Mental Development Index). Fifteen neuromotor outcome measures were utilized and seven outcome measures were categorized as developme Most of the studies evaluated the effect of intervention on motor performance during the intervention, at the end of intervention, and a few months to a year or more after the intervention.	stimulation and either enhanced parent-infant interaction or passive handling techniques to reach statistically significant improvements in motor development. Of the six studies whose interventions began 9-18months after NICU discharge, one study using specific motor training for infants with Down syndrome achieved a significant positive effect. Another study found better motor development results with general infant stimulation received than with NDT. A low methodological quality study using general programs found a beneficial effect on stimulating motor development. Of the 3 studies that used interventions beginning between NICU discharge and 18months the study of short term effects of NDT wasn't able to find statistically significant results and the general PT program didn't find a significant effect. A less intensive NDT intervention that lasted 6months found a positive effect of intervention on development. 13 studies achieved significant positive effects.	has a temporary beneficial effect on motor development of infants at high risk for developmental disorders. Kangaroo Care, as suggestive by the NICU studies, does not improve motor outcome. Using the results of the Post-NICU studies, it is suggested that NDT during the first years of life does not have a measureable positive effect on motor development. The Post-NICU interventions using developmental programs, developmental program with treadmill training or conductive education, or conductive education with NDT resulted in significant positive effects. There is evidence to support that specific developmental training and general development programs that teach parents to enhance parent-infant interactions result in positive effects on motor development. The final conclusions were that interventions for children at risk for developmental disabilities must be adapted to the infant's age.	treadmill and generalized developmental programs.
Arndt SW, Chandler LS, Sweeney JK, Sharkey MA and McElroy JJ. Effects of a Neurodevelopmental Treatment-Based Trunk Protocol for Infants with Posture and Movement Dysfunction. Journal of Pediatric Physical Therapy. Spring 2008	To evaluate the efficacy of an NDT-based sequenced trunk activation protocol for change in gross motor function of infants aged 4 to 12 months with posture and movement dysfunction. A repeated measures randomized block design was used in this study. Infants who received a dynamic co-activation trunk protocol were compared with a control group who received a parent-infant interaction and play protocol.	Purposive sample of 10 (n=5 sequenced trunk co-activation protocol and n=5 play group) infants, 4-12months with gross motor delays, parental consent, and physician referral, posture and movement dysfunction (<5% AIMS)and one MAI criteria. The parent-infant group was used to control for attention, maturation and environment.	Infants in either group received 10 one-hour sessions over 15days in addition to their routine ongoing health services. The sequenced trunk activation intervention sessions emphasized transitional activities, facilitation of dynamic co-activation, weight shifting, and trunk rotation. Infants in the parent infant play group received enriched activities delivered by their parents and guided by a licensed child life specialist. The aim of the parent infant play was parent-infant interaction and enriched directed play for visual, tactile, auditory, social, cognitive, emotional and communication developmental skills. Age appropriate motor skills were inherently encouraged including head control, weight shifts in prone, reaching and sitting. Parents could also participate in experiential exercise activities that corresponded with activities of daily living and also parent-to-parent sharing and problem solving.	The Gross Motor Function Measure was administered at pretest, posttest and three-week follow-up by a reliable rater who was masked to group assignment.	The STA within-group mean GMFM scores were significantly different over time (p=0.01). The PIP group experienced a positive trend in their GMFM scores pretest to postintervention. The change of mean GMFM scores between groups was significant (p=0.048) from pretest to posttest in favor of the STA group. No significant difference was found for the STA or PIP groups between posttest and 3 week follow. The between-group difference of the mean GMFM change group scores, pretest to 3 week follow up was not significant (p=0.11). Infants in the NDT based STA group made a mean change of 13.3 on the GMFM and the PIP group made a mean change of 5.1 at the end of the intervention.	A short duration, high frequency NDT-based infant protocol focused on dynamic co-activation of trunk flexors and extensors and specifically sequenced trunk movements significantly improved gross motor function in infants with posture and movement dysfunction compared to a nonindividualized parent infant play protocol that only indirectly assessed the trunk. Motor gains from the intervention were maintained for three weeks following the conclusion of the treatment. Providing attention through guided, enriched play activities and interaction with social support did not significantly improve infant motor performance during the same time period. The infants with posture and movement dysfunction made gains that seemed to be the result of the short-duration, high-frequency, sequential trunk activation interventions provided by pediatric therapists specializing in the NDT approach for infants.	The NDT-based protocol for co-activation of the trunk in infants with posture and movement dysfunction was statistically and clinically significant in the groups involved in this study as compared to the parent infant play protocol. The conclusions of this research article are in support of better developmental progress in posture and movement as a result of specialized neurodevelopmental treatment which can be delivered by a physical therapist as opposed to the general play-based care some infants receive from general early intervention therapists.
Mahoney G, Robinson C and Fewell R. The Effects of Early Motor Intervention on Children with Down Syndrome or Cerebral Palsy: A Field-Based Study. Journal of Developmental and Behavioral Pediatrics. 2001	To investigate the effects of two models of motor interventions, NDT and developmental skills therapy, on the development of children with Down syndrome and cerebral palsy. Study design was a field-based investigation of two interventions. No randomization.	Subjects were recruited from nine clinical sites (4 NDT, 5 developmental treatment) across six states. 50 children participated 28 (NDT, 11 DS, 17 CP) and 22 children at DevS sites (16 DS, 6 CP). Children received services at an average age of 6.5months and	Children received ~ 40 sessions of motor intervention services during the one year study period. Children in the NDT group received slightly higher number of sessions but the difference was not significant. The majority of developmental therapy sessions lasted greater than 45 minutes whereas the majority of NDT sessions lasted 31-45 minutes. NDT sessions occurred more often in classrooms and clinics whereas developmental therapy occurred most often at children's homes. The NDT sessions were more likely to focus on specific	The subjects' motor functioning was assessed at entry into the research study and after 1 year of motor intervention treatment. Videotaped observational measures were made at pretest and posttest data collection to assess quality of movement. Bayley Scale of Motor Development, Peabody Developmental Motor Scales, adapted Toddler Infant Motor Evaluation, and videotaped	The results suggest that children with DS and CP made equivalent rates of developmental growth during the intervention; there were no significant differences between the treatment groups in the rate of development attained; and neither treatment model had a differential effect on the basis of the children's diagnosis. There were significant intervention effects (pretest to posttest) for each of the seven movement	Field-based motor intervention studies may have limited effects. The researchers believe their study may have failed to find intervention effects because of relatively small sample size thus limiting the sensitivity of the statistical procedures. The results should caution healthcare providers and consumers that functional skill training may not, in itself, enhance the effectiveness of motor intervention procedures. The authors conclude the data analysis show there is a critical need for random-assignment and multisite trials to investigate the	Higher intensity, more frequent treatment sessions may produce significant changes in rate of gross motor development acquisition for infants and children at risk for neurologic problems and motor delays.

		began participating in this study at an average age of 14months and then observed for 1 year.	motor skills and issues related to children's tone or posture and alignment; whereas, developmental therapy sessions were more likely to focus on children's play and general motor activity. Mothers whose children received developmental therapy reported more family support services (child information, educational activities, and systems engagement) than those who received NDT.	observation were conducted.	dimensions assessed. Therefore regardless of diagnosis or treatment model, quality of movement ratings were higher after 1 year of intervention than they were at the beginning of the study. Statistically significant differences indicate the children in the high intensity group made motor development gains averaging close to 7 months in approximately 12 months of intervention, whereas children in the low intensity group made gains averaging about 5months in 12 months of intervention.	issues of age of onset and intensity of services. In future studies parent instruction and supervised practice as part of the intervention is necessary.	
Jenkins JR, Sells CJ, Brady P, Down J, Moore B, Carman R and Holm R. Effects of Developmental Therapy on Motor-Impaired Children. Physical and Occupational Therapy in Pediatrics. December 1982	To gather preliminary data on the questions of efficacy and service levels by systematically varying the frequency that children received treatment. Specifically, the effects of treatment given once a week, three days a week, and an untreated control condition were examined. RCT with 3 groups, treatment once weekly, treatment 3 times weekly and control group (no treatment)	45 children (groups n=15 each), 3-15yo, with nonspecific but significant delays in development. Included if > 40 on the PS and considered significantly motor delayed by a pediatrician and PT. Children with CP, MD or other neuro disorders were excluded. Control subjects received therapy at the end of the study.	Students in the Treatment 1 group received therapy 1x/week for the duration of the study, students in the Treatment 3 group received therapy 3x/week, and students in the control group did not receive therapy during the treatment phase. Evaluating therapists were blind to the students' group assignment and subjects in T-1 and T-3 were randomly assigned to one of three treating therapists. Therapy sessions were conducted individually, over a 15 week period. Therapy sessions were 40 minutes and consisted of developmental therapy based on SI and NDT therapy. Individual therapy goals and objectives were made based on pretest performance on the PS and PDMS and refined throughout treatment. Therapy activities were designed to focus on gross motor behaviors, eye-hand coordination, develop normal responses to sensory stimulation and improve postural responses.	The PDMS and videotaped postural response measures were administered to all experimental and control subjects prior to the initiation of the intervention and again after the conclusion of the intervention.	Significant between group differences were observed on gross motor gains ($p=0.019$). Gains between the two treatment groups did not differ but were both significantly greater than the control group's ($p<0.05$). Group differences on the fine motor scale did not attain statistical significance ($p=0.084$). Treatment effects for gross motor were significant ($p=0.02$) but were not significant for fine motor ($p=0.09$). All three groups made significant gains from pre- to post-testing.	The study had results that showed significant improvement in gross motor skills for the groups receiving developmental treatment once or three times weekly compared to the control group. There was not a significant effect of treatment intensity on the outcome because both of the treatment groups made similar gains in motor skills.	This research applies to children with a variety of nonspecific but significant developmental delays. The intervention was able to provide statistically significant improvements in gross motor skills for children utilizing this form of intervention.
Mayo N. The Effect of Physical Therapy for Children with Motor Delay and Cerebral Palsy. American Journal of Physical Medicine and Rehabilitation. 1991.	Mayo designed a randomized controlled trial to compare the changes in development, over a 6-month period, of children receiving weekly intensive NDT versus a basic monthly NDT intervention.	29 children (<2 yo) met criteria and had parent consent to participate. 17 subjects received the intensive weekly NDT protocol and 12 subjects received the basic monthly NDT protocol. Children were excluded if they had additional chronic diseases, obvious profound mental retardation, genetic disorder or degenerative CNS lesion, sibling with a handicap, and those receiving or previously received occupational therapy.	One group received an intensive neurodevelopmental therapy protocol consisting of weekly sessions and the second group received a basic monthly neurodevelopmental therapy protocol. Both groups' interventions took place over 6 months and each treatment session was one hour in duration. Subjects and families for both groups received an individualized home program (positioning, handling and stimulation techniques) with instruction by the therapist and a booklet of written descriptions and photograph illustrations for future reference. The subjects motor development was assessed at entry into the study and at the end of the six month intervention period.	Motor development was assessed on entry into the study with the seven instruments (Wolanski Gross Motor Evaluation, Gesell and Amatruda Inventory, Bayley Fine Motor and Mental Scale, reflex activity, postural reactions, and abnormal movement scale). After the six month intervention period each subject was reassessed with the seven instruments. The outcome measure evaluators were blind to the group allocation of the subject.	The group receiving intensive weekly NDT responded considerably better, on average, than the group receiving basic monthly NDT, taking into account the effects of the child's age, mother's education, and preterm or term gestation status of the infant at birth. The difference between final and initial aggregate index scores for the intensive group was 173.4 a percent proportional change of 50.2% and for the basic group 159.5 a percent proportional change of 38.0%. The estimated regression coefficient for intensity of treatment is equivalent to the difference between the mean adjusted outcome of the intensive group and the mean adjusted outcome of the basic group and when related to its standard error (10.5), yielded a t statistic of 3.49 (24 df, $p=0.0019$).	This research study is positive support for the benefit of intensive neurodevelopmental treatment compared to less frequent physical therapy interventions for children with motor delay. Further research is warranted to understand the efficacy of NDT as a school of treatment interventions.	I believe the intensive treatment protocol is promising and worth considering for application to patient cases.
Schreiber J. Increased Intensity of Physical Therapy for a Child with Gross Motor Developmental Delay: A Case Report. Physical and Occupational Therapy in	To describe the gross motor skills of a child with gross motor delay before and after an episode of increased frequency of physical therapy. Case report with one 31-month old child.	The case report was based on a 31-month old girl with a diagnoses of 18p-, a chromosomal abnormality. The child began PT at 4 months of age (unable to roll, prone on	PT 1hour/week at 4-10months old (and weekly intervention with a developmental specialist). Handling, positioning, and activity suggestions were emphasized during treatment. For the child's 10th-28th months the frequency of physical therapy was reduced to 1x/2weeks, 1 hour PT sessions focused on increasing movement opportunities on the floor,	The outcome measures were administered eight weeks before, one week before, and two weeks following the increased frequency of physical therapy. Peabody Developmental Motor Scales - Gross Motor Scales, Gross Motor Function Measure, and	Minimal changes on the PDMS (pre-test 98, 1 week prior to increased frequency =100, 2 weeks after increased frequency 106. The child showed improvement on the GMFM corresponding to the four week period of increased physical therapy especially on lying/rolling and	A targeted increase in physical therapy frequency may be appropriate for some children receiving early intervention services. In this child increased frequency of physical therapy over four weeks corresponded to increased gross motor progress; however cause and effect cannot be drawn due to the nature of a case report design.	Physical therapy interventions delivered 1 hour per week or 1 hour every two weeks may be enough to cause clinically meaningful changes in patients similar to this patient. This is good news, when viewed in the context of my

Pediatrics. 2004		forearms, impaired head and trunk control, inability to sustain head in midline when upright). At 28 months the child was able to sustain independent sitting on the floor or bench, sustain standing when at a support surface, cruise a few steps in each direction, and take several steps with both hands held.. Independent mobility consisted of rolling short distances and the child preferred to be carried.	sustaining and transitioning into and out of prone on elbows, sitting, kneeling, and standing. Hands-on techniques were selected to encourage weight shifting and movement transition with progression to use of verbal and environmental cues only. The mother was provided ongoing suggestions for appropriate activities and positions for her child prior to and during the time period of the case report study. The child received PT 1x/2weeks for 18months during which her progress in gross motor skills were minimal. The child tolerated sessions with good behavior and endurance and demonstrated decreased fear of challenging movements. The child demonstrated increased independent movement initiation and exploration and physical therapy was increased in frequency for four weeks.	Goal Attainment Scaling were used to measure the child's motor performance.	crawling/kneeling gross motor activities. On the GMFM she improved in areas such as independent mobility, standing balance and control and ambulatory capabilities. Subjective reports from the mother and a separate developmental specialist were positive including statements that the child was more active, mobile, independent, and steadier when standing and walking following increased PT intensity. Based on the Goal Attainment Scaling scores the child had improvement in the desired skills. After the increased intensity period the child consistently removed one hand from double hand support to play with a toy, transferred from standing to sit on the floor with graded control and walked 30ft with one hand held.		Capstone project where there is a small number of therapists to treat a large number of patients.
Als H et al. Individualized Behavioral and Environmental Care for the Very Low Birth Weight Preterm Infant at High Risk for Bronchopulmonary Dysplasia: Neonatal Intensive Care Unit and Developmental Outcome. 1986	To test modifications to care-giving procedures in accordance with behaviorally identifiable individual needs of high-risk infants to improve respiratory and functional states of the infant. The study design utilized a two phase control and experimental design.	Two groups of eight consecutively inborn infants were selected who met criteria: birth weight <1,250g, mechanical ventilation within 48hrs, mechanical ventilation >24hours, 60% oxygen >2hrs, no chromosomal/genetic anomaly, no maternal illness or infant infection, singleton,	The control phase was conducted over the first year of the study. Infants were identified by day 2 and observation taken on day 10, 20, and 30 after birth, at 36 and 40 weeks post conception. Post discharge follow up conducted at 1,3,6, and 9 months (post-EDC). The experimental phase infants were observed on the same schedule with the addition of clinical behavioral description reports prepared at each observation highlighting infant reactions to stress and opportunities to modify caregiving. Observations began 20 minutes before care-giving for baseline assessment, through care-giving episode/manipulation, and 20 minutes post-manipulation observation to assess return to baseline or continued stress. Full observation lasted from 1.5hours-3hours. Behavioral observations were assessed and recorded on a sheet in a format similar to that of the Assessment of Preterm Infant's Behavior. Transcutaneous oxygen level, heart rate, respiratory rate, and behavioral activity were recorded every 2 minutes. Behavioral categories included autonomic reactivity and visceral signals, motoric movements and postures or extremity trunk and face, level of consciousness, and body and head position.	Effectiveness of the individualized behavior based caregiving modifications were assessed in terms of medical outcome during NICU stay and developmental outcome at 1,3, 6, and 9 months post-EDC and discharge. Outcome variables included: average weight gain per week, postconception age at discharge, days in hospital, days on respirator, days requiring oxygen, days elapsed before complete bottle or breast feeding success. Assessment of infants at 1month included the Assessment of Preterm Infant Behavior and at 3, 6, and 9 months the Bayley Scales of Infant Development and growth measurements of weight, height and head circumference. At 9 months a 15minute play with parent observation was recorded (Kangaroo Box Paradigm).	The two groups of subjects were comparable in initial severity of illness and demographic background and did not differ significantly prior to treatment. Substantial and statistical significant group differences were observed in days on respirator (reduced 25 days, p<.01), days requiring oxygen therapy (reduced 33 days, p<.05), and days to complete a successful bottle or breast-feeding session (reduced 29 days, p<.01). On 1month post-EDC APIB significant differences between intervention and control groups were observed in ability to cuddle and inhibit crawl (p<.02), tone, motor maturity and balance of posture (p<.05), less stress indicators (p<.02), better normal reflexes (p<.05) and thus at 1month post-EDC the intervention infants were better organized on APIB items. On the Bayley Scales, the Mental Development Index demonstrated highly significant group difference at all age points (p<.0001) favoring the intervention group and Psychomotor Development Index favored experimental infants at all age points (p<.04). There were no significant group differences in weight, height, and head circumference at 3, 6, 9mos. Differences ranging from p=.05 to .001 were observed for the Kangaroo Box Paradigm sessions favoring the intervention infants.	The authors conclude a substantial improvement was observed in the medical status during NICU stay and in developmental outcome for the experimental group. Improvements included shorter time on the respirator, increased FIO ₂ and earlier success in completing bottle or breast-feeding. Substantial improvement in behavior and developmental functioning continued in the experimental group after discharge particularly in self-regulatory functioning at 1 month (APIB) and in overall mental functioning and psychomotor performance (Bayley Scales, MDI and PDI at 3, 6, and 9 months). The authors hypothesize that developmentally appropriate input may be associated with improved cortical development and better mental and motor functioning.	Physical therapy interventions for the very young infant that are based in Newborn Individualized Care and Assessment Program principles may provide significant improvements in the mental and motor function of the at risk infant.
Als H et al. Individualized Developmental Care for the Very Low Birth Weight Preterm Infant: Medical and Neurofunctional Effects 1994	To investigate the effectiveness of individualized developmental care in reducing medical and neurodevelopmental sequelae for very low birth weight infants. A randomized controlled	38 singleton, preterm infants, without congenital abnormalities, weighing less than 1250g, born before 30weeks gestation, mechanically	Care was provided by individualized developmental care trained nurses who observed and documented infant's behavior within 12 hours of admission and subsequently every 10 th day. Observations were systematically recorded for 20 minutes before necessary medical or caregiving	Medical outcome was assessed including average daily weight gain, days requiring ventilation, oxygen, gavage tube feeding and hospitalization, severity of retinopathy of prematurity,	There was not a statistically significant difference between the groups prior to the intervention. Infants in the experimental group had significantly shorter duration of ventilation and supplemental oxygen support, earlier oral feeding,	The authors concluded very low birth weight preterm infants may benefit from individualized developmental care in the neonatal intensive care unit in terms of medical and neurodevelopmental outcome.	The results of this research suggest that Newborn Individualized Developmental Care and Assessment Program based interventions are significantly helpful to

	trial design was used in a newborn intensive care unit.	ventilated within 3 hours of delivery and for more than 24 hours were randomly assigned to a control or an experimental group from a group of 43 eligible consecutively born/admitted infants.	activity, throughout the duration of the activity, and for 20 minutes following the caregiving activity. A list of 91 behaviors including: autonomic, motor, and state organization behaviors were monitored every 2 minutes (greater than 85% interrater reliability). Behaviors were conceptualized as stress and regulatory behaviors and interpreted as indexes of the infants' current vulnerabilities and strengths. Based on regular observation of the infant, developmental care recommendations and ongoing clinical support were given to the parents and nurses. The control group received standard care including uniform shielding of incubators with a blanket cover, use of clothing, and 24-hour visitation policy for the parents.	bronchopulmonary dysplasia, pneumothorax, and intraventricular hemorrhage, pediatric complications, age at discharge and hospital charges. Neurodevelopmental outcome was assessed using the Assessment of Preterm Infants' Behavior scale, quantified electroencephalography (2 weeks post due date), and Bayley Scales of Infant Development and Kangaroo Box Paradigm (9 months after due date).	reduced incidence of intraventricular hemorrhage, pneumothorax and severe bronchopulmonary dysplasia; improved daily weight gain; shorter hospital stays; younger ages at hospital discharge; and reduced hospital charges compared to the infants in the control group. At 2 weeks post due dates the experimental infants also showed improved autonomic regulation, motor system functioning, self-regulatory abilities, and visual evoked potential measures. At 9 months the experimental group showed improved Bayley Mental and Psychomotor Developmental Index scores as well as better Kangaroo Box Paradigm scores when compared to the control group infants.		the young infant at risk for medical complication.
Als H et al. A three-center, randomized, controlled trial of individualized developmental care for very low birth weight preterm infants: medical, neurodevelopmental, parenting and caregiving effects 2003	A three-center randomized controlled trial was designed to investigate the medical, neurodevelopmental and parenting effects of individualized developmental care.	A total of 92 preterm infants (from 234 eligible), weighing <1250g, <28wks gestation, mechanical ventilation within first 3 hours and lasting >24hrs, absence of chromosomal or medical anomalies, singleton, and family with English comprehension participated in the study.	Control group infants received routine care including some degree of shielding of incubators, sound containment, use of breast milk and referral to occupational and physical therapy and community intervention (Kangaroo care was used at one facility). Experimental group infants received Newborn Individualized Developmental Care and Assessment Program treatment to diminish stress and enhance strengths. Weekly neurobehavioral reports described the infants' current behavioral functioning and suggested ways to promote stability and competence. Infant behaviors were observed and assessed every 2 minutes for approximately 1 hour during medical or caregiving activities. Behaviors were recorded as relative stress and regulatory behaviors and interpreted as indices of the infant's vulnerabilities and strengths.	Outcome measures included medical, neurodevelopmental and family function as well as quality of care. Medical outcomes included days on respirator, days on oxygen therapy, parenteral feeding, average daily weight gain, weight, height, and head circumference, severity of bronchopulmonary dysplasia/IVH/enterocolitis/ROP, age at discharge, days in NICU, steroid use, and hospital charges. At 2 weeks post-EDC the Assessment of Preterm Infants Behavior, Mother's View of the Child, and Parenting Stress Index were administered. NICU environment parameters (light, sound and activity) and 11 caregiving parameters (measured on a 5pt scale) were measured every 6 months for 3 children of each group.	No significant differences existed between the control and experimental groups prior to intervention. There were significant differences among sites (see Table 1-3). Experimental group infants showed significantly improved medical outcome: fewer days of parenteral feeding, shorter transition to full enteral feeding, better average daily weight gain, younger age at discharge, fewer days in ICU, lower hospital charges, fewer cases of NEC, better growth (weight, height, head circumference) at 2 weeks post-EDC. Experimental infants performed significantly better on the APB, were better modulated in autonomic and motor system regulation, better self-regulation and required less facilitation. Significantly more favorable scores were observed for the experimental group mothers on the MVC and perceived their children as better regulated, more gratifying, and rated themselves as more competent. No group differences were observed in NICU light, activity, and sound. The 11 caregiving behaviors contributed to more favorable results in the experimental group.	The authors concluded that very low birth weight infants and their parents, across diverse settings, may benefit from individualized developmental care. Improved outcome was found in terms of transition to independent feeding, better weight gain, and shorter periods of time in the hospital before discharge, reduced hospital charges and improved neurobehavioral outcome. This research was the first to demonstrate enhanced NICU caregiver sensitivity to the experimental group infants' cues believed to contribute significantly to infants' improved outcome. The large sample and multicenter nature of this research demonstrates the robustness of the developmental care approach and the consistency and reliability with which such care can be implemented, with appropriate training and interdisciplinary developmental professionals.	This research is very supportive of the Newborn Individualized Care and Assessment Program. It demonstrated the results in large samples and in a variety of areas/regions. The observed improvements were related to the caregiver sensitivity and individualized approach which suggests these principles are effective and can be integrated into the plan of care and caregiving practices of medical professionals well.
Spittle A et al. Early developmental intervention programs post hospital discharge to prevent motor and cognitive impairments in preterm infants. 2007	The objective of this Cochrane report was to review the effectiveness of early developmental intervention post-discharge from hospital for preterm (<37 weeks) infants on motor or cognitive development through infancy, preschool age and school age.	In order to be included studies must be RCT or quasi-RCT of early developmental intervention programs begun <12 months of life for infants <37 weeks with out major congenital anomalies.	A total of 16 studies were included for 2,379 randomized patients. The focus and intensity of the intervention varied as did the length of follow up. Types of interventions included: physical therapy, occupational therapy, psychology, neurodevelopmental therapy, parent-infant relationship enhancement, infant stimulation, infant development, developmental care and early intervention education.	Cognitive and motor outcome measures included: [0-2] Bayley Scales of Infant Development, Griffiths Locomotor, Test of Infant Motor Performance, Alberta Infant Motor Scale, Peabody Developmental Motor Scale [Preschool 3-<5]; Stanford-Binet Intelligence Scale, McCarthy Scales of Children's Abilities, Preschool and School age Movement ABC, Bruininks Osertsky, Griffiths Locomotor; [5-	Meta-analysis concluded intervention improved cognitive outcomes at infant age (p<.0001) and preschool age (p<.0001) but not at school age (p=.71). The size of the effect for early intervention on cognitive outcomes is considered clinically significant. Interventions that focused on the parent-infant relationship, along with infant development, have the greatest impact on cognitive development. There was little evidence to suggest early intervention improved motor outcomes in short, medium or long term.	The authors conclude early intervention programs for preterm infants have a significant positive impact on cognitive outcomes in infancy and preschool age (the short to medium term). Further research should be conducted to determine which intervention protocols are best for improving cognitive and motor outcomes and the long term benefits of the protocols.	Due to the variability of the interventions it is difficult to make a generalization about the effectiveness of early developmental intervention programs. The review provided support for early intervention programs which can improve cognitive outcomes in short to midterm however additional research will have to be undertaken to understand effects on motor outcomes.

				17yr] Wechsler Preschool and Primary Scale of Intelligence, Wechsler Intelligence Scale for Children IQ Test , Kaufman Assessment Battery for Children, Griffiths Menta Development Scale, British Abilities Scale			
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