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ORIGINAL ARTICLE

Prevention of postpartum smoking relapse in mothers of infants in the neonatal intensive care unit

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Objective: Approximately 40% of women who smoke tobacco quit smoking during pregnancy, yet up to 85% relapse after delivery. Those who resume smoking often do so by 2 to 8 weeks postpartum. Smoking mothers are more than twice as likely to quit breastfeeding by 10 weeks postpartum. The hospitalization of a newborn, while stressful, is an opportunity to emphasize the importance of a smoke-free environment for babies. Supporting maternal-infant bonding may reduce maternal stress and motivate mothers to remain smoke free and continue breastfeeding. The objective of this study was to reduce postpartum smoking relapse and prolong breastfeeding duration during the first 8 weeks postpartum in mothers who quit smoking just before or during pregnancy and have newborns admitted to the Neonatal Intensive Care Unit (NICU).

Study Design: This study was an Institutional Review Board-approved prospective randomized clinical trial. After informed consent, mothers of newborns admitted to the NICU were randomized to a control or intervention group. Both groups received weekly encouragement to remain smoke free and routine breastfeeding support. Mothers in the intervention group were also given enhanced support for maternal-infant bonding including information about newborn behaviors, and were encouraged to frequently hold their babies skin-to-skin.

Result: More mothers were smoke free (81 vs 46%, $P<0.001$) and breastfeeding (86 vs 21%, $P<0.001$) in the intervention than in the control group at 8 weeks postpartum.

Conclusion: Interventions to support mother–infant bonding during a newborn's hospitalization in the NICU are associated with reduced rates of smoking relapse and prolonged duration of breastfeeding during the first 8 weeks postpartum.

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Introduction

The detrimental effects of prenatal tobacco exposure have been well documented. Considerable public attention has been focused on smoking cessation before conception and during pregnancy.[1] Although a significant number of smoking women quit smoking during pregnancy, up to 85% resume smoking following delivery of their babies, often within 2 to 8 weeks postpartum.[2,3] Reasons given for smoking relapse are multifaceted and include stress and depression.[4]

Having a baby in the Neonatal Intensive Care Unit (NICU) is a stressful experience for parents of newborns. In addition to concerns about the health of their babies, normal mother–infant bonding is interrupted. Studies have demonstrated that when parents learn to understand the meaning of their newborn's behavioral cues, they report decreased levels of stress with their NICU experience.[5,6]

Mothers who smoke tobacco after delivery are more than twice as likely not to be breastfeeding at 10 weeks postpartum.[7,8] The value of human milk for all infants, especially for premature infants, has been well established.[9,10] Providing breastmilk and breastfeeding their hospitalized infant can be very challenging for mothers and many give up after only a short time. Supporting a mother's efforts to remain smoke free after the birth of her baby may be a way to prolong the duration of breastfeeding.

Although mothers who continue to smoke at the time their babies are admitted to intensive care units, are often referred to local smoking cessation programs for pregnant and postpartum mothers, support for mothers who quit smoking during pregnancy is not usually provided. Our clinical trial was designed to encourage these mothers to remain smoke free.

We hypothesized that providing enhanced support for mother–infant bonding during a newborn's hospitalization in the NICU would reduce maternal stress as well as postpartum depression, lead to decreased rates of postpartum smoking relapse and increase duration of breastfeeding during the first 8 weeks postpartum in mothers who quit smoking during or just before pregnancy.

Methods

Design and sample size

We designed a prospective randomized clinical trial, which was approved by the Loma Linda University Medical Center Institutional Review Board. Sample size was powered to detect a 50% decrease in smoking relapse between groups and was originally estimated to require 128 mothers with 80% power ($P<0.05$). An interim analysis was prospectively planned and performed after 10 months of enrollment. At the interim analysis, 54 mothers had been enrolled, and a significant difference in primary outcomes was found between groups; thus, enrollment was discontinued.

Participants

Mothers of infants admitted to the NICU at Loma Linda University Children's Hospital, in Loma Linda, CA, USA, who had a history of tobacco use during or within 1 year before pregnancy but who were not currently smoking, were invited to participate in the study. Exclusion criteria included mothers whose infants were admitted at greater than 1 week of age or whose length of stay was anticipated to be less than 1 week, mothers who had never smoked, who had quit smoking greater than 1 year before pregnancy, who were currently smoking at the time of delivery, who used illicit drugs, who were unavailable (due to factors such as incarceration, adoption or surrogacy) or who did not speak English (Figure 1).

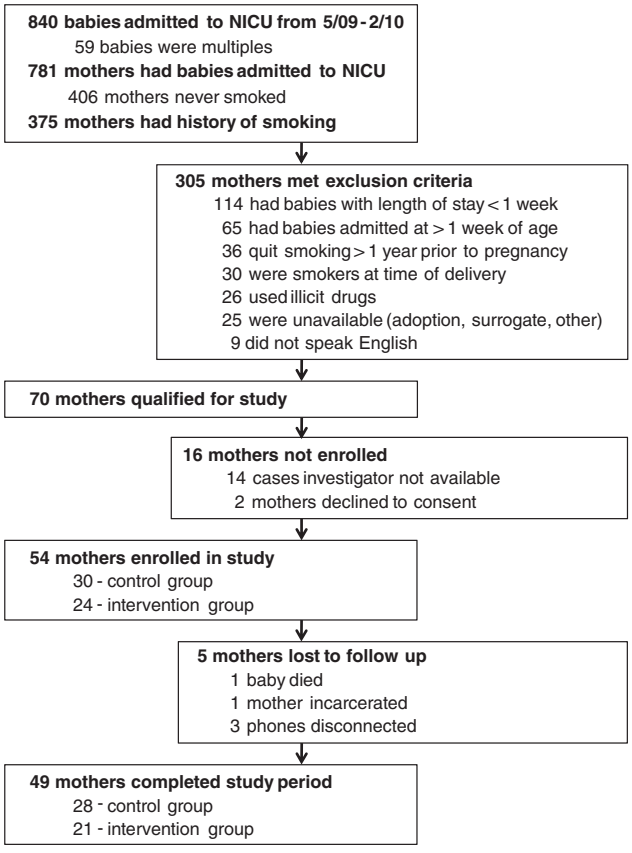

Figure 1 Enrollment population.

Recruitment, informed consent and randomization

Mothers were contacted upon admission by a research nurse who asked about their current smoking status and history of tobacco use. Mothers who qualified were given an explanation of the study by a research neonatologist and invited to participate. After obtaining informed consent, mothers were randomized to the control or intervention group. Randomization was done by converting a computer-generated randomization table into sealed, sequentially numbered and opaque patient assignment envelopes. The envelopes were opened by the investigator at the time when consents were obtained.

At the time of study enrollment, a smoking history was taken by the primary investigator and the mother's plan for remaining tobacco free was discussed. All mothers enrolled in the study, regardless of group assignment, were given handouts about the dangers of secondhand smoke exposure for infants. At least once a week during their infant's hospitalization, a study neonatologist encouraged each mother in the study to remain smoke free for her own and her baby's health. This was accomplished using the principles of motivational interviewing (such as open-ended questions, reflective listening and affirmations).[11] All mothers were also given routine NICU lactation support for breastfeeding and a handout about the benefits of breastfeeding.

Fathers who smoked were encouraged to join a smoking cessation program and were offered information about nicotine replacement to assist them in smoking cessation.[12] Encouragement was given for a 'family effort' to create a smoke-free environment for baby following discharge from the hospital.

Study intervention

Mothers randomized to the intervention group received enhanced support in bonding with their newborn infants. Mothers received information about newborn behavioral cues using books, DVDs and handouts. These materials were purchased specifically for the study and were not available to mothers in the control group. The materials varied depending on the gestational age of each baby. Resources given to mothers of premature infants in the intervention group included: (1) *Prematurely Yours*[13]—a 15 min video viewed in the NICU with the primary investigator, (2) *No Matter How Small*[14]—a DVD given for home viewing, (3) *Understanding My Signals*[15] and *My Special Start*[16]—two booklets for home reading. Resources given to mothers of term infants in the intervention group included: (1) *The First Years Last Forever*,[17] *Amazing Talents of the Newborn*[18]—15 min of excerpts from DVDs viewed in the NICU with the primary investigator, (2) *Keys to Caregiving*[19]—a set of five handouts for home reading and (3) *From Birth to Reality*[20]—a book for home reading. Mothers in the intervention group also received encouragement to have frequent and prolonged skin-to-skin contact with their babies.

Assessment tools

The primary outcome of this study was mother's smoking status at 8 weeks postpartum. Smoking status was evaluated by three methods: (1) mother's report (2) CO-oximetry and (3) salivary cotinine levels. Once a week each mother enrolled in the study was asked by the primary investigator whether she was still smoke free or had resumed smoking. Once a week, during babies' hospitalizations, maternal carboxyhemoglobin saturations were measured using a non-invasive transcutaneous carbon monoxide monitor (Masimo, Irvine, CA, USA). The presence of carboxyhemoglobin was used as an indicator of tobacco exposure within the prior 6 h.[21,22] At the end of the study (8 weeks postpartum), mothers were asked to provide a saliva sample for cotinine levels (NicAlert, JANT, Encino, CA, USA) to confirm the presence or absence of tobacco use within the prior 48 h.[23,24]

Secondary outcomes included breastfeeding status, measures of depression (at beginning and end of study) and parental stress (at the end of the study). Breastfeeding status was evaluated weekly by mother's report to the primary investigator. The Edinburgh Postnatal Depression Scale[25] was used to assess depression. The Parenting Stress Index[26] (short form) was used to evaluate parental stress.

Analysis

Analyses of smoking and breastfeeding status were by 'intention to treat' and done by Kaplan–Meier log-rank survival table using time to event as the time variable, smoking relapse intervention as the exposure variable and smoking relapse and breastfeeding duration as outcome variables. Because of demographic differences between the two groups, the Kaplan–Meier analysis was repeated controlling for each of the demographic discrepancies. Student's *t*-test or Mann–Whitney U was used to compare differences between the groups for numeric variables. χ^2 or Fisher's Exact test was used to analyze categorical or nominal variables. Cox regression analysis was utilized to determine the effects of birth weight and length of stay on the outcomes. Analysis was done using SPSS v 17 (SPSS, Chicago, IL, USA).

Results

Subjects

In all, 44 mothers were enrolled in the study between May 2009 and February 2010 (30—control, 24—intervention, Figure 1). Five mothers were lost to follow up (two control, three intervention). In all, 49 mothers completed the 8-week study period (28—control, 21—intervention). More mothers in the intervention group had private insurance ($P = 0.02$, Table 1). No other significant differences in maternal demographics were found between groups. No significant differences in infant demographics were found between groups.

Table 1 Maternal demographics

Category	*Control* (n = 28)	*Intervention* (n = 21)	P
Age (years, mean (s.d.))	24 (5)	24 (5)	0.99
Ethnicity (%)			0.55
Caucasian	68	67	
Hispanic	14	19	
African-American	18	9	
Other	0	5	
Education (%)			0.32
High school/vocational	86	81	
College graduate	14	19	
Insurance (%)			0.02[a]
Medicaid	82	52	
Private	18	48	
Social support			0.92
Partner (% yes)	82	81	
Smoking history			
Years smoked (mean, (s.d.))	7 (5)	5 (4)	0.14
When quit smoking (%)			0.85
Just before pregnancy	35	33	
1st trimester	57	52	
2nd trimester	4	5	
3rd trimester	4	10	
Smoker in home (% yes)	32	48	0.27

[a]Significant difference between groups.

Table 2 Infant demographics

Category	*Control* (n = 28)	*Intervention* (n = 21)	P
Gender (% male)	54	57	0.80
EGA (weeks, mean (s.d.))	36 (3)	34 (5)	0.18
Pre-term (%)	46	57	0.46
Birth weight (g, mean (s.d.))	2727 (941)	2517 (956)	0.08
CRIB score (median (range))	3 (9)	2 (11)	0.26
Mechanical ventilation (% yes))	71	76	0.71
Length of stay (days, mean (s.d.))	25 (28)	43 (42)	0.08
Discharge weight (g, mean (s.d.))	3232 (789)	3285 (945)	0.83

Abbreviations: CRIB, clinical risk index for babies; EGA, estimated gestational age. Preterm, <37 0/7 weeks gestational age.

There was a trend for babies of mothers in the intervention group to have lower birth weights ($P = 0.08$) and longer lengths of stay ($P = 0.08$, Table 2).

Assessments of smoking status

Mothers were considered to have resumed smoking if they self-reported smoking resumption or if they had a positive salivary

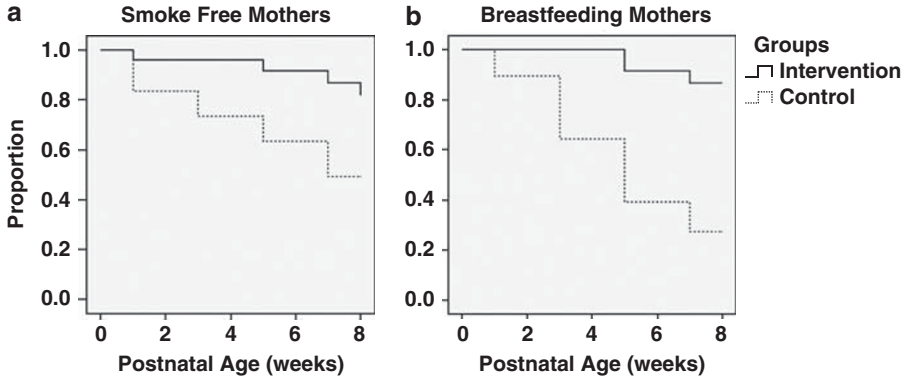

Figure 2 (**a**) Proportion of smoke-free mothers by postpartum weeks. Significantly more mothers in the intervention group (solid line) were smoke free at 8 weeks postpartum compared with mothers in the control group (dotted line), $P<0.001$, Kaplan–Meier survival. (**b**) Proportion of breastfeeding mothers by postpartum weeks. Significantly more mothers in the intervention group (solid line) were breastfeeding at 8 weeks postpartum compared with mothers in the control group (dotted line), $P<0.001$, Kaplan–Meier survival.

cotinine level of 1 to 6 on the NicAlert test at the end of the study. Salivary cotinine levels were obtained from 67% of mothers who completed the study. A total of 45% of samples obtained were from mothers in the control group and 55% were from mothers in the intervention group. Salivary cotinine levels were assessed by an investigator who was unaware of group assignment. A 94% agreement was found between salivary cotinine level and mother's reported smoking status (smoker or non-smoker). Two mothers denied smoking relapse but had positive salivary cotinine tests so were counted as having relapsed.

Carboxyhemoglobin saturations for individual mothers were not found to consistently correspond to their smoking status. However, mean carboxyhemoglobin levels of mothers who had resumed smoking were significantly higher than those of mothers who had remained smoke free ($2.99 \pm 2.88\%$ vs $1.56 \pm 1.38\%$, $P = 0.003$).

Primary outcome

There was a significant decrease in smoking relapse rate at 8 weeks postpartum in the intervention compared with the control group (81 vs 46%, $P<0.001$, Figure 2a). This difference was observed beginning at 6 weeks postpartum. To evaluate whether differences in source of insurance affected the survival curves, a Kaplan–Meier survival analysis was done controlling for source of insurance. The decrease in smoking relapse in favor of the intervention group remained significant ($P = 0.022$). The Kaplan–Meier survival analysis did not single out birth weight or length of stay as significant variables affecting the difference in smoking relapse rates between groups.

Secondary outcomes

There was a significant increase in the number of mothers who continued to breastfeed at 8 weeks postpartum in the intervention compared with the control group (86 vs 21%, $P<0.001$, Figure 2b). This difference was observed beginning at 2 weeks postpartum. To evaluate whether differences in source of insurance affected the survival curves, a Kaplan–Meier survival analysis was done controlling for source of insurance. The increase in the number of mothers who continued to breastfeed remained significant ($P<0.001$). Kaplan–Meier survival analysis did not single out birth weight or length of stay as significant variables affecting the difference in rates of mothers who continued to breastfeed between groups.

Analyses of maternal depression and parental stress screenings were done by an investigator who was unaware of group assignment. There were no differences in depression screening scores between the control and intervention groups at either the beginning (8 ± 6 vs 8 ± 4, $P = 0.92$) or the end (5 ± 4 vs 6 ± 3, $P = 0.19$) of the study period. There were no differences in parental stress screening scores (measured at the end of the study period) between the control and intervention groups (26 ± 7 vs 26 ± 8, $P = 0.96$).

Discussion

In mothers who quit smoking during or just before pregnancy, providing support for maternal–infant bonding during a newborn's hospitalization in the NICU results in reduced rates of postpartum smoking relapse and prolonged duration of breastfeeding during the first 8 weeks postpartum. There is a growing awareness that mothers who quit smoking during pregnancy remain at high risk for smoking relapse during the postpartum period.[27] Government agencies have emphasized the need for more research on prevention of postpartum smoking relapse, and our results indicate that this can be a worthwhile endeavor.[28]

Although smoking cessation is encouraged during prenatal visits, pediatricians may not be aware of mothers' smoking histories. If they are aware, they may incorrectly assume that

as a mother successfully quit smoking for several months during pregnancy, she is no longer at risk for relapse. This assumption has been shown to be incorrect.[2,3] The immediate postpartum period is a critical time to support a mother who quit smoking during or before pregnancy by congratulating her for protecting her baby from the harmful effects of tobacco during prenatal development and encouraging her to continue providing a smoke-free environment for her child.

The hospitalization of a newborn in the NICU, while filled with significant stress for parents, provides a unique 'window of opportunity' to address parental smoking issues. Studies show that the hospitalization of a child with a respiratory-related illness is a time when parents are particularly open to discussions about smoking and its effect on their children's health.[29,30] A study of parents of babies treated in the NICU found that more than half of smokers were willing to receive counseling for smoking cessation. Interventions by health care providers in the NICU are positively associated with increased parental understanding of the health risks of smoking to their infants and increased their motivation to quit.[31] Winickoff *et al*.[32] have demonstrated the feasibility of implementing a strategy aimed at reducing smoking among parents during the postpartum hospitalization. Our study provides further evidence that the postpartum period is a time when mothers with a history of smoking may be responsive to encouragement and support to remain smoke free.

Providing knowledge about normal newborn behaviors increases a mother's sense of competence during interactions with her baby and supports her role as mother and protector of her infant. Parenting interventions have been successfully adapted for use with at-risk parents, including those with addictive behaviors.[33] Drug-abusing mothers who receive parenting interventions have better success in achieving abstinence from drug use.[34,35] Focusing on the quality of relationship between mother and child (rather than cognitive approaches) is characteristic of programs that demonstrate the most promise in outpatient-parenting interventions for substance-abusing mothers.[36]

When a newborn is hospitalized, the mother's role of primary nurturer for her baby is suddenly usurped by the need for intensive medical interventions. Mothers may incorrectly assume that they are no longer needed in the care of their hospitalized baby. When coupled with the stress of hospitalization and separation from their newborns, this misconception may lead mothers to abandon their protective roles and resort to methods of reducing stress that have worked in the past, such as smoking.[37] By strengthening mother–infant bonds and supporting a mother's role as protector and nurturer of her baby during her newborn's hospitalization, we may empower her to continue protecting her baby from the effects of tobacco.

Previous studies have found an association with postpartum smoking and decreased duration of breastfeeding.[7,8] Weiser *et al*.[38] provides evidence that postpartum smoking is associated with both failure to initiate breastfeeding and, if initiated, earlier weaning. Our study also demonstrates significantly earlier weaning in mothers who resumed smoking. Mothers who received enhanced support for mother–infant bonding continued to breastfeed their babies longer. As breastfeeding stimulates release of hormones (such as prolactin and oxytocin) that support maternal–infant bonding, perhaps breastfeeding and the additional support for mother–infant bonding are mutually reinforcing.[36,39,40]

Our study did not find a significant difference in stress and depression between groups. These results could indicate that our intervention had no effect on maternal stress or depression. However, it is possible that the number of subjects was not large enough or that the assessment tools we used were not sensitive enough to detect a difference between groups. Discovering and implementing effective ways to reduce stress and postpartum depression in mothers of hospitalized newborns could have many benefits for mothers, babies and families, and warrants further research.

The conclusions of this study may be limited by sample size, population dynamics and resources; however, the results are highly significant. Because significant differences were found in maternal source of insurance ($P = 0.02$), covariant analysis was done with source of insurance as a covariable. The differences between groups for both smoking relapse and breastfeeding duration remained significant. There was a trend for lower birth weights and higher lengths of stay in the NICU for babies of mothers in the intervention group ($P = 0.08$). Kaplan–Meier survival analysis did not single out birth weight or length of stay as significant variables affecting the difference in rates of smoking relapse or breastfeeding between groups. Babies with lower birth weight would be expected to have longer lengths of stay in the NICU. As the study intervention was completed within the first 2 weeks of hospitalization, mothers whose babies had a longer length of stay did not receive more tobacco cessation interventions. All mothers received weekly encouragement to remain smoke free and to continue breastfeeding whether or not their infant remained in the NICU. We cannot exclude the possibility that more support for breastfeeding was provided for mothers of infants who remained hospitalized.

Only English-speaking mothers were enrolled; therefore, generalization to non-English speakers may also be limited. Although the intervention was designed to support mother–infant bonding, no direct assessment of mother–infant bonding or attachment were measured. Appropriate measures of attachment are available for older infants, but were beyond the scope of this project. Studies providing mothers with information about newborn behaviors that included measures of mother–infant bonding or attachment, as well as follow-up at 1 to 2 years of age would be enlightening.

Conclusion

Interventions to support mother–infant bonding during a newborn's hospitalization in the NICU are associated with reduced rates of smoking relapse and prolonged duration of breastfeeding during the first 8 weeks postpartum in mothers who quit smoking during or just before pregnancy. By decreasing the rate of smoking relapse and increasing the duration of breastfeeding, both of which have well-documented short- and long-term benefits, this intervention makes an important contribution to the health of infants and their mothers.

Conflict of interest

The authors declare no conflict of interest.

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References

1 Castles A, Adams EK, Melvin CL, Kelsch C, Boulton ML. Effects of smoking during pregnancy. Five meta-analyses. *Am J Prev Med* 1999; **16**(3): 208–215.
2 Fang WL, Goldstein AO, Butzen AY, Hartsock SA, Hartmann KE, Helton M *et al.* Smoking cessation in pregnancy: a review of postpartum relapse prevention strategies. *J Am Board Fam Pract* 2004; **17**(4): 264–275.
3 Colman GJ, Joyce T. Trends in smoking before, during, and after pregnancy in ten states. *Am J Prev Med* 2003; **24**(1): 29–35.
4 Suplee PD. The importance of providing smoking relapse counseling during the postpartum hospitalization. *J Obstet Gynecol Neonatal Nurs* 2005; **34**(6): 703–712.
5 Kaaresen PI, Ronning JA, Ulvund SE, Dahl LB. A randomized, controlled trial of the effectiveness of an early-intervention program in reducing parenting stress after preterm birth. *Pediatrics* 2006; **118**(1): e9–19.
6 Browne JV, Talmi A. Family-based intervention to enhance infant-parent relationships in the neonatal intensive care unit. *J Pediatr Psychol* 2005; **30**(8): 667–677.
7 Liu J, Rosenberg KD, Sandoval AP. Breastfeeding duration and perinatal cigarette smoking in a population-based cohort. *Am J Public Health* 2006; **96**(2): 309–314.
8 Horta BL, Kramer MS, Platt RW. Maternal smoking and the risk of early weaning: a meta-analysis. *Am J Public Health* 2001; **91**(2): 304–307.
9 Vohr BR, Poindexter BB, Dusick AM, McKinley LT, Higgins RD, Langer JC *et al.* Persistent beneficial effects of breast milk ingested in the neonatal intensive care unit on outcomes of extremely low birth weight infants at 30 months of age. *Pediatrics* 2007; **120**(4): e953–e959.
10 Vohr BR, Poindexter BB, Dusick AM, McKinley LT, Wright LL, Langer JC *et al.* Beneficial effects of breast milk in the neonatal intensive care unit on the developmental outcome of extremely low birth weight infants at 18 months of age. *Pediatrics* 2006; **118**(1): e115–e123.
11 Miller WRRS. *Motivational Interviewing: Preparing People for Change*, 2nd edn. Guilford Press: New York, 2002.
12 Eisenberg MJ, Filion KB, Yavin D, Belisle P, Mottillo S, Joseph L *et al.* Pharmacotherapies for smoking cessation: a meta-analysis of randomized controlled trials. *CMAJ* 2008; **179**(2): 135–144.
13 Thompson-Linton PAH. *Prematurely Yours (Video)*. Polymorph Films: Boston, MA, 1983.
14 Vida Health Communications, Inc.. *No Matter How Small: A Parent's Guide to Preterm Infant Development (DVD*. Vida Health Communications, Inc.: Cambridge, MA, 2006.
15 Hussey-Gardner B. *Understanding My Signals: Help for Parents of Premature Infants*. VORT Corp: Palo Alto, CA, 1998.
16 Flushman B, Gale G, Lackey S, Sweet N, VandenBerg K. *My Special Start: A Guide for Parents in the Neonatal Intensive Care Unit*. VORT Corp: Palo Alto, CA, 1991.
17 *The First Years Last Forever: First 5 California Children and Families Commission and First 5 California Children and Families Count Commission*. (Video), New Screen Concepts, Stamford, CT, 1997.
18 Klause M, Klaus P. *Amazing Talents of the Newborn (Video)*. Johnson and Johnson Pediatric Institute, L.L.C.: New Brunswick, NJ, 1998.
19 Barnard KE. *Keys to Caregiving*, 2007 edn., Seattle: NCAST Programs. (print), 1990.
20 Jana LA, Shu J. *Heading Home with Your Newborn: From Birth to Reality*. American Academy of Pediatrics: Evanston, IL, 2005.
21 Barker SJ, Curry J, Redford D, Morgan S. Measurement of carboxyhemoglobin and methemoglobin by pulse oximetry: a human volunteer study. *Anesthesiology* 2006; **105**(5): 892–897.
22 *Carbon Monoxide Test Helps Doctors Determine Patients' Smoking Status* Science Daily, Rockville, MD, 2007. Available in: http://www.sciencedaily.com/releases/2007/10/071022124744.htm.
23 Montalto NJ, Wells WO. Validation of self-reported smoking status using saliva cotinine: a rapid semiquantitative dipstick method. *Cancer Epidemiol Biomarkers Prev* 2007; **16**(9): 1858–1862.
24 Etter JF, Vu Duc T, Perneger TV. Saliva cotinine levels in smokers and nonsmokers. *Am J Epidemiol* 2000; **151**(3): 251–258.
25 Cox JL, Holden JM, Sagovsky R. Detection of postnatal depression. Development of the 10-item Edinburgh postnatal depression scale. *Br J Psychiatry* 1987; **150**: 782–786.
26 Abidin RR. *Parenting Stress Index*. Pediatric Psychology Press: Charlottesville, VA, 1986.
27 McBride CM, Curry SJ, Lando HA, Pirie PL, Grothaus LC, Nelson JC. Prevention of relapse in women who quit smoking during pregnancy. *Am J Public Health* 1999; **89**(5): 706–711.
28 *How Tobacco Smoke Causes Disease: The Biology and Behavioral Basis for Smoking-Attributable Disease. A Report of the Surgeon General*. In: Center for Disease Control and Prevention NCfCDPaHP, Office on Smoking and Health editor. U.S. Department of Health and Human Services: Atlanta, 2010.
29 Winickoff JP, Hillis VJ, Palfrey JS, Perrin JM, Rigotti NA. A smoking cessation intervention for parents of children who are hospitalized for respiratory illness: the stop tobacco outreach program. *Pediatrics* 2003; **111**(1): 140–145.
30 Ralston S, Roohi M. A randomized, controlled trial of smoking cessation counseling provided during child hospitalization for respiratory illness. *Pediatr Pulmonol* 2008; **43**(6): 561–566.
31 Bock BC, Becker BM, Borrelli B. Smoking behavior and risk perception among the parents of infants in the neonatal intensive care unit. *Nicotine Tob Res* 2008; **10**(1): 47–54.
32 Winickoff JP, Healey EA, Regan S, Park ER, Cole C, Friebely J *et al.* Using the postpartum hospital stay to address mothers' and fathers' smoking: the NEWS study. *Pediatrics* 2010; **125**(3): 518–525.
33 Tay LF, R P (ed). *Caring for Substance Affected Families*. The Connecticut Center for for Effective Practices of the Child Health and Development Institute, Inc, Farmington, CT, 2005.
34 Field TM, Scafidi F, Pickens J, Prodromidis M, Pelaez-Nogueras M, Torquati J *et al.* Polydrug-using adolescent mothers and their infants receiving early intervention. *Adolescence* 1998; **33**(129): 117–143.

35 Black MM, Nair P, Kight C, Wachtel R, Roby P, Schuler M. Parenting and early development among children of drug-abusing women: effects of home intervention. *Pediatrics* 1994; **94**(4 Pt 1): 440–448.

36 Suchman N, Pajulo M, Decoste C, Mayes L. Parenting interventions for drug-dependent mothers and their young children: the case for an attachment-based approach. *Fam Relat* 2006; **55**(2): 211–226.

37 Sinha R. Chronic stress, drug use, and vulnerability to addiction. *Ann NY Acad Sci* 2008; **1141**: 105–130.

38 Weiser TM, Lin M, Garikapaty V, Feyerharm RW, Bensyl DM, Zhu BP. Association of maternal smoking status with breastfeeding practices: Missouri, 2005. *Pediatrics* 2009; **124**(6): 1603–1610.

39 Gordon I, Zagoory-Sharon O, Leckman JF, Feldman R. Oxytocin and the development of parenting in humans. *Biol Psychiatry* 2010; **68**(4): 377–382.

40 Aisaka K, Mori H, Ogawa T, Kigawa T. [Effects of mother-infant interaction on maternal milk secretion and dynamics of maternal serum prolactin levels in puerperium]. *Nippon Sanka Fujinka Gakkai Zasshi* 1985; **37**(5): 713–720.