FINAL COMPREHENSIVE REPORT
THE MATERNAL AND CHILD HEALTH RESEARCH PROGRAM:
REDUCING ENVIRONMENTAL TOBACCO SMOKE IN NICU INFANTS' HOMES
(PI: A. STOTTS)

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I. Introduction

Nature of the research problem. The hazards of environmental tobacco smoke (**ETS**) are widely recognized. Resulting legislation to reduce public exposure does not protect children from ETS in their home. Recent estimates indicate that between 20-50% of US children under the age of five live in homes with at least one adult smoker. Rates are especially high in low-income, less educated households.

Chronic ETS exposure in children is associated with diminished pulmonary function, respiratory illnesses, asthma, middle ear disease, and sudden infant death syndrome. In healthy infants and children under the age of 18 months, ETS exposure is attributed as the cause of 150,000 to 300,000 cases per year of bronchitis and pneumonia as well as hospitalization for these infections. ETS exposure in medically vulnerable populations is likely to incur even more profound risks.

Low birth weight infants (**LBW**; <2500 g; 5lbs 8 oz), very low birth weight infants (**VLBW**; ≤ 1500 g; 3 lbs 5 oz), and infants requiring mechanical ventilation in a Neonatal Intensive Care Unit (**NICU**) are particularly vulnerable to the effects of ETS. Many develop bronchopulmonary dysplasia (**BPD**) after birth, resulting in even higher risks of pneumonia, asthma, hospitalization and death, especially in the first 6 months after discharge. Effective interventions to reduce household ETS would reduce the significant infant morbidity, mortality, and associated costs for infants at high respiratory risk.

Purpose, Scope, and Methods of investigation. Based on the work of our group and others, we predicted that an ETS intervention based on empirically-grounded, motivational and behavioral technology and delivered in the NICU setting would reduce infant ETS exposure and potentially improve health outcomes. This initial study addressed the Maternal and Child Health Bureau's (MCHB) Strategic Research Issue #IV, Promoting the healthy development of MCH populations. Because VLBW infants are disproportionately born to disadvantaged families, this study also addressed #II involving economic and racial health disparities.

Nature of the findings. A hospital-based motivational and behavioral ETS reduction program for parents of infants at high respiratory risk was developed and implemented. A randomized, controlled, parallel-group design was used to test the primary hypothesis that the hospital-based program would reduce ETS exposure in the homes of infants at high respiratory risk 6 months after discharge according to objective and standardized self-report measures. Overall, the data support intervention in this area and provided critical insights in conducting larger effectiveness trials aimed at reducing secondhand smoke in NICU infant populations. Enhancements to the intervention are needed, however, to strengthen its effect. Based on the data collected for this study, the National Heart, Lung and Blood Institute has recently funded a large 5-year trial of an intensified intervention, Motivational Incentives to Reduce Secondhand Smoke in NICU Infants' Homes (PI = A. Stotts).

II. Review of the Literature

Using a biological marker, Pirkle et al (1996) found that 40% of U.S. children are exposed to ETS. As only one indicator of the adverse pediatric effects of ETS, 150,000-300,000 cases per year of bronchitis and pneumonia are attributed to ETS among generally healthy children ≤18 months age (Emmons, Wong et al., 2001). LBW infants, VLBW infants, and infants who required mechanical ventilation are often born in impoverished and minority populations. Smoking is more common in these populations and is known to decrease birth weight and increase the risk of neonatal respiratory problems, often requiring treatment with oxygen and mechanical ventilation (e.g. DiFranza, Aligne, & Weitzman, 2004). This treatment is often life saving but causes injury to the lungs. In LBW infants, this injury has been associated with decreased lung volumes, lower airway obstruction, hyperinflation, and residual abnormalities of

varying severity that may persist until later childhood or even adulthood (Koumbourlis et al., 1996). More than 50% of VLBW infants require mechanical ventilation and 22% will develop BPD. Infants with BPD are at an especially increased risk for pneumonia, asthma, repeated hospitalizations, neurodevelopmental deficits, and death (Martin, Hamilton, Sutton, & al., 2005).

Studies of household smoking in VLBW populations suggest substantially increased odds of asthma and wheezing if there is a smoker in the home. Household smoking has also been related to longer duration of hospitalization for respiratory symptoms (Kitchen et al., 1992) and reduced airflow and air-trapping in VLBW children (K. N. Chan, Noble-Jamieson, Elliman, Bryan, & Silverman, 1989; Doyle, Ford, Olinsky, Knoches, & Callanan, 1996). The effects of ETS on infants discharged from neonatal intensive care units is a neglected area study (Kitchen et al., 1992). Moreover, there has been little effort to develop programs to reduce NICU infants' exposure to their parents cigarette smoke.

Developing and testing interventions for the reduction of ETS exposure is a relatively new area of study. Interventions—most commonly done for healthy or asthmatic children between ages 2 and 12—have ranged from minimal or brief counseling by a physician or nurse to multiple in-home sessions by trained counselors utilizing cognitive and behavioral strategies. Gehrman and Hovell (2003) demonstrated that some degree of reduction in ETS exposure was found in the majority of studies. Additional outcomes associated with active ETS intervention included fewer respiratory symptoms (Greenberg et al., 1994); fewer asthma symptoms (Murray & Morrison, 1993); increased reported smoking outside (vs. inside) the home (Groner, Ahijevych, Grossman, & Rich, 2000); and fewer asthma medical visits (Wilson et al., 2001).

Very few ETS-reduction interventions utilized hospitalization as a potentially optimal time for parents to consider behavior change. Clear benefit has been demonstrated for intensive smoking interventions (>15 minutes) started in the hospital and continued into the month following discharge (Odds Ratio = 1.65, 95% confidence interval = 1.44 to 1.90; 17 trials) (Rigotti, Munafo, & Stead, 2007). Parents of hospitalized children who were smokers have reported willingness to participate in an in-hospital program (Winickoff and colleagues,(2001).

Motivational Interviewing (**MI**) is a therapeutic approach that has been used to enhance behavior change in a number of diverse populations (Miller & Rollnick, 2002). It is designed to produce rapid, internally motivated change by employing strategies that mobilize the patient's own change resources. MI is thought to be especially beneficial for individuals who are highly ambivalent about changing or less motivated for change. MI strategies include providing the client with specific feedback on her/his own situation and condition, emphasizing personal responsibility for change, and offering a menu of specific, cognitive and behavioral strategies (W. Miller & Rollnick, 1991). MI in the context of brief interventions delivered within health care settings has demonstrated efficacy for the treatment of hospitalized adult smokers, outpatient and inpatient adolescent smokers, opiate users, and other individuals with addictive behaviors (Colby et al., 1998; W. Miller & Rollnick, 1991; Saunders, Wilkinson, & Phillips, 1995). MI has been found acceptable and feasible in a smoking cessation study with parents of sick children (S. S. Chan et al., 2005); and in another study to be effective in reducing passive smoke exposure in low-income families from diverse backgrounds who arguably face the greatest barriers to lifestyle change (Emmons, Hammond et al., 2001). MI was recommended for parents who may experience guilt related to their children's passive smoke exposure, and was suggested as ideal for ill children who are particularly vulnerable to ETS effects (Gehrman & Hovell, 2003). MI is portable, time-efficient, relatively low-cost, and more effective than self-help (Lancaster et al., 2000), and well-suited for a hospital-based intervention targeting NICU families with household smokers.

III. Study Design and Methods

Study design. Using a parallel-group design, we randomized families into one of three groups: MI intervention (**MI**); Usual Care (**UC**); and Usual Care--Reduced Measurement (**UC-RM**). Efficacy variables included air-nicotine monitors, infant end-tidal carbon monoxide (**ETCO)** levels, and standardized self-report measures of home and car smoking bans. The MI group received two hospital-based MI sessions (approx. 40 minutes/each), as well as two personalized letters and two phone feedback sessions all targeting infant-ETS reduction. ETS studies have found that measures conducted at multiple time points alone have influenced caregiver protective behavior (e.g., Hovell et al., 1994). Thus, we included a second control group (UC-RM) to assess this effect. The MI and UC group had ETS and/or ETCO measurements at 1, 3, and 6 months. The UC-RM group completed an abbreviated baseline measure that did not assess any smoking-related variables and had ETS and ETCO assessed only at 6 months. Thus, the UC-RM participants potential for behavior change due to measurement reactivity was significantly reduced, which protected internal validity.
Population studied. Families (N=144) with infants at high respiratory risk (defined below) in a NICU who reported at least one smoker in the home.
Sample selection. Eligible families: (1) had an infant in the NICU (with enough time for the intervention; at least 2 weeks before infant discharge); (2) had an infant at high respiratory risk [VLBW(<1500g) or received mechanical ventilation for >12 hours]; (3) reported that at least one person in the home smokes; (4) spoke English or Spanish; (5) agreed to the assessments and to attend intervention sessions (as applicable); (7) lived <50 miles away; (8) had access to a telephone; and (9) provided informed consent. Parents were ineligible if they had severe cognitive, and/or psychiatric impairment that precluded cooperation with the protocol.
Instruments used. ETS assessment consisted of passive nicotine emission monitoring, ETCO measures, interviews and questionnaires. Passive sampling diffusion filters captured vapor-phase nicotine emissions from tobacco combustions. Infant ETCO levels were measured using the $COCO_2$ puff breath analyzer which measures samples of exhaled air using a 5F catheter inserted 2 to 3 mm into the baby's nostril. Interviews/self-report measured household smoking, indoor smoking bans, medical outcomes (also verified through chart review), and other psychosocial constructs (e.g., depressive symptoms). The primary caregiver completed the ETS-related interviews and self-report questionnaires. In the MI and UC condition, measures were administered at baseline, 1, 3, and 6 month followups, with exceptions noted for household nicotine levels (1 & 6 months only); the UC-RM group received the 6-month assessment only. The 6-month time point was our primary outcome endpoint.
Data Analysis. Statistical analyses utilized SAS v.9.3 (SAS Institute, Inc., Cary, North Carolina). Preliminary examination of group differences on demographic and baseline variables used chi-square testing and t-tests. Analyses examined the following outcomes: 1) Report of home and car smoking ban; 2) household air nicotine levels; 3) infant end-tidal carbon monoxide (ETCO) levels. Evaluation of between-group differences on continuous outcomes used one-way ANOVA's (Proc GLM; SAS 9.3). Examination of count and dichotomous data used Poisson, negative binomial and logistic regression (Proc GENMOD; SAS v. 9.3). Longitudinal analyses will employ generalized linear mixed models (GLMM; Proc GLIMMIX; SAS 9.3).

IV. Detailed Findings

Prior to this study, virtually no information existed regarding the household smoking practices of families who have a very low birth weight or mechanically ventilated infant in a NICU. Data collected for this study has provided valuable information for understanding and intervening with this population of smokers.

Smoking prevalence and Sample Characteristics

Overall, 26% of families with a VLBW or mechanically ventilated infant reported at least one household smoker. The majority of participants were of racial minority status and primarily African American. All primary caregivers consented were mothers. Only about one-fourth of the mothers were married, and most had a high school education, were unemployed, and were enrolled in Medicaid. The majority of families were overwhelmingly poor, with almost half of the sample reporting an annual income of less than $25,000 and difficulties covering basic living expenses (See Table 1 below). Almost 75% of the sample reported this pregnancy to be unplanned.

Home and Car Smoking Bans at Baseline

Overall, 49% of the sample on which we collected baseline smoking data (MI & UC) reported having a total smoking ban in both their homes and cars. 67% reported a home smoking ban and 53% reported a car smoking ban at baseline. Results which were presented at the 2012 Society for Behavioral Medicine conference indicated interesting differences at baseline among those who reporting a smoking ban compared to those who did not report having a smoking ban.

Mothers who reported **not** having a smoking ban were more likely to:
a) Speak English
b) Have greater than 3 children in the house
c) Report severe financial problems
d) Have less knowledge about secondhand smoke exposure (**SHSe**) and
e) Report more depression and NICU-related stress

A logistic regression analysis was conducted in SAS, v9.3, with Proc Logistic. In a multiple predictor model, three of the variables—SHSe knowledge, NICU-related stress, and number of children in the home—significantly predicted having a total smoking ban at baseline. Mothers with more knowledge about SHSe were more likely to have a smoking ban in place (OR = 1.57, 95% CI 1.10-2.24, p=0.01). Mothers who lived in households with fewer than three children were more likely to have a smoking ban in place, compared to mothers who reported living in households with three or more children (O.R. = 2.78, 95% CI 1.15-6.74, p=0.02). Mothers who reported more NICU-related stress were less likely to have a smoking ban in place (O.R. = 0.55, 95% CI 0.33-0.92, p=0.02).

Feasibility: Recruitment and Retention

Intervening with parents of high-risk infants in the NICU on SHSe is a novel area of study and therefore one aim of this study was to establish feasibility of intervention and of studying this population. Feasibility was determined by observing enrollment rate, retention in the study, and intervention attendance. A detailed description of the recruitment and retention is presented in Figure 1 below. Participants were identified and enrolled in the study at a rate of approximately 4 per month, with a 9% refusal rate. Infant health and social factors proved challenging to both recruitment and retention: 10% of our infants died at some point in the study following consent and 3% of our mothers lost custody of their infants following randomization. Excluding participants with deceased infants, custody and relocation issues, 91.7% in the MI condition, 85.7% in UC, and 80.0% in the UCRM completed at least one follow-up visit in the post-discharge period.

With regard to the intervention, of the participants assigned to the MI condition, 86.4% attended Session 1 and 71.2% attended both sessions. Challenges to intervention attendance included transportation to the NICU, parking costs, and childcare for other children. Many parents did not visit their child in the NICU on a regular basis and some only came during the final week of the hospital stay. Despite the inherent challenges to conducting both intervention and follow-up visits with this population of young adults, our data suggest that both are feasible. Future studies, however, need to incorporate methods for improving adherence.

Table 1.

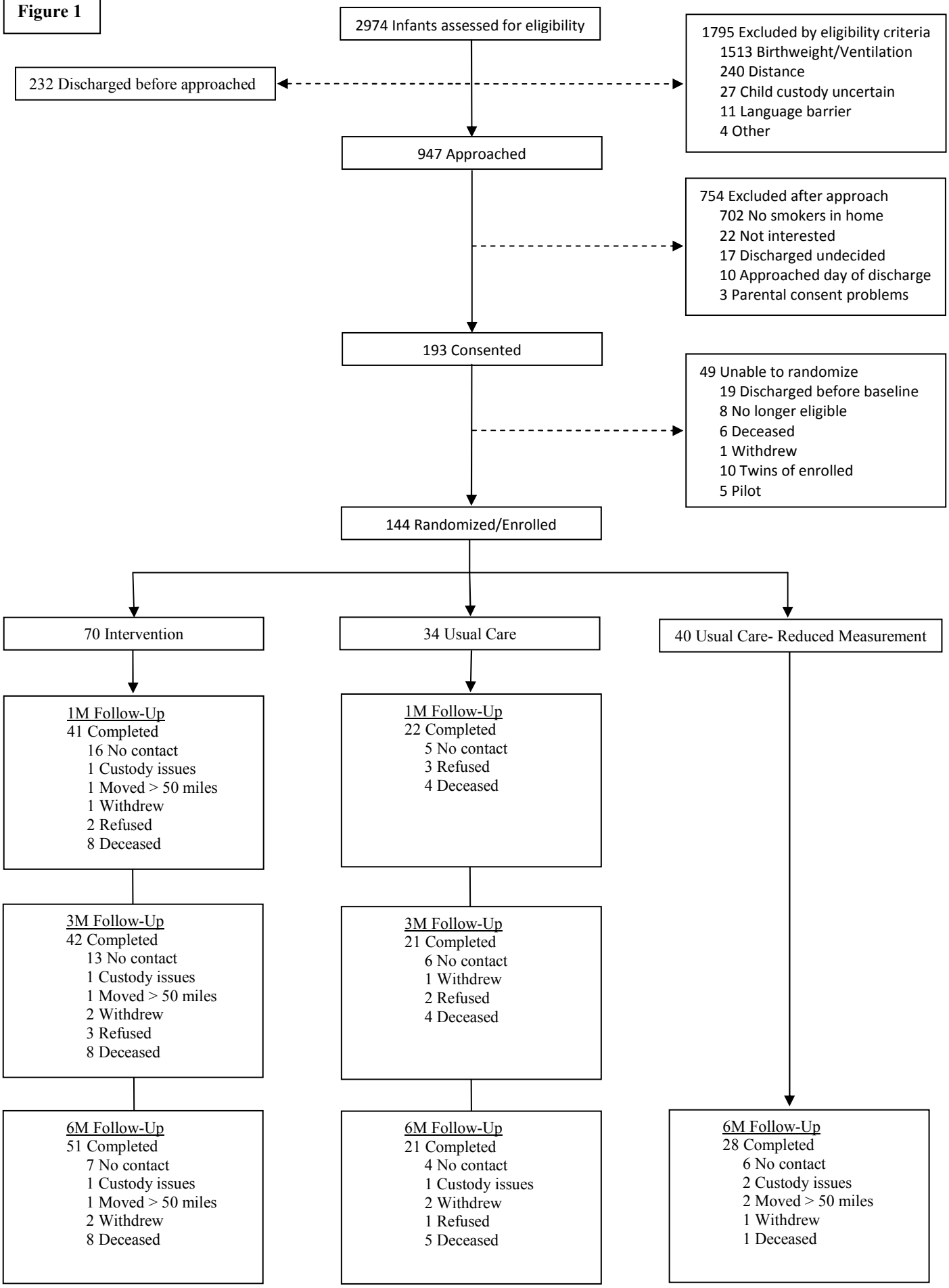
Socio-demographic and Smoking-History Characteristics of the Primary Caregivers and their Families

Characteristic	n (%)
Gender (female)	144(100%)
Race	
Asian	3(2.1%)
Black	72(50.0%)
White, non-Hispanic	30(20.8%)
Hispanic	38(26.4%)
Other	1(0.7%)
Marital status	
Single	46(31.9%)
Married	38(26.4%)
Separated	8(5.6%)
Divorced	2(1.4%)
Living together	49(34.0%)
Employment	
Full-time	23(22.3%)
Part-time	5(4.9%)
Not employed	76(72.8%)
Income ($)	
< 15,000	23(22.1%)
15,000 – 24,999	21(20.2%)
25,000 – 34,999	18(17.3%)
35,000 – 44,999	8(7.7%)
≥ 45,000	12(11.5%)
Not reported	22(21.2%)
In past year, not enough money for:	
Food	30(28.9%)
Housing	30(28.9%)
Utilities	34(32.7%)
Medical Care	24(23.1%)
Medicine	24(23.1%)
Medicaid recipient	87(84.5%)
Living situation	
Living independently	49(47.1%)
Relying on others for a place to live	55(52.9%)
Pregnancy	
Planned	26(25.7%)

Unplanned	75(74.3%)
Delivery method	
Vaginal	44(42.7%)
Caesarean section	59(57.3%)
Premature births	
0	17(16.4%)
1	69(66.4%)
2-4	17(16.3%)
5 or more	1(1.0%)
Breastfeeding or pumping	
Plan to breastfeed	4(3.9%)
Do not plan to breastfeed	25(24.0%)
Currently breastfeeding	55(52.9%)
No longer breastfeeding	20(19.2%)
Smoking status	
Dad only smokes	45(43.3%)
Mom only smokes	15(14.4%)
Both smoke	21(20.2%)
Neither smoke	23(22.1%)
	M (SD)
Maternal age in years	25.8(6.3)
Maternal education in years	12.3(2.1)
Pregnancies	2.6(1.8)
Live births	2.0(1.4)
Cigarettes smoked per day*	12.3(2.1)
Cigarettes smoked in house per day*	2.8(8.1)

Note. Only race, marital status, and maternal age were captured on the full sample (N=144). Usual Care, Reduced Measurement participants were not measured on other characteristics; therefore, data for the remaining characteristics does not include them (N=104). Percentages were calculated with the available data. Less than 1% of data was missing for baseline characteristics.
**Represents all smokers in the household (not just the primary caregiver)*

Figure 1


2974 Infants assessed for eligibility
232 Discharged before approached
1795 Excluded by eligibility criteria
1513 Birthweight/Ventilation
240 Distance
27 Child custody uncertain
11 Language barrier
4 Other
947 Approached
754 Excluded after approach
702 No smokers in home
22 Not interested
17 Discharged undecided
10 Approached day of discharge
3 Parental consent problems
193 Consented
49 Unable to randomize
19 Discharged before baseline
8 No longer eligible
6 Deceased
1 Withdrew
10 Twins of enrolled
5 Pilot
144 Randomized/Enrolled
70 Intervention
34 Usual Care
40 Usual Care- Reduced Measurement
1M Follow-Up
41 Completed
16 No contact
1 Custody issues
1 Moved > 50 miles
1 Withdrew
2 Refused
8 Deceased
1M Follow-Up
22 Completed
5 No contact
3 Refused
4 Deceased
3M Follow-Up
42 Completed
13 No contact
1 Custody issues
1 Moved > 50 miles
2 Withdrew
3 Refused
8 Deceased
3M Follow-Up
21 Completed
6 No contact
1 Withdrew
2 Refused
4 Deceased
6M Follow-Up
51 Completed
7 No contact
1 Custody issues
1 Moved > 50 miles
2 Withdrew
8 Deceased
6M Follow-Up
21 Completed
4 No contact
1 Custody issues
2 Withdrew
1 Refused
5 Deceased
6M Follow-Up
28 Completed
6 No contact
2 Custody issues
2 Moved > 50 miles
1 Withdrew
1 Deceased

Primary Outcome: Household and car smoking bans

Inspection of cross-sectional proportions indicated differences in report of having a total smoking ban (both home and car; Figure 2), $\chi_2(1) = 8.80$, $p<0.012$, and a car smoking ban, $\chi^2(2) = 9.2$, $p\leq0.01$ (Figure 3), as a function of treatment group at the 6-month follow-up. In both cases, the proportions demonstrated lower rates of smoking bans in the UC-RM group. No differences emerged between groups on report of having a home smoking ban alone. Evaluation of change in households reporting no smoking ban in their homes and cars at baseline indicated that 63.6% of those in the MI group instituted a ban by 1 month post-discharge compared to 20% of the usual care group, $\chi_2(1) = 5.24$, $p<0.02$

Figure 2. *Percent of participants who reported having a total smoking ban in home and car.*

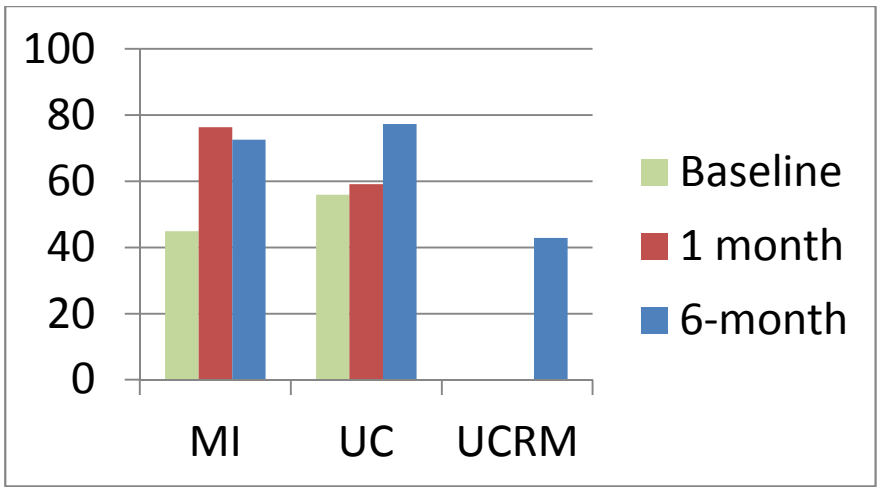
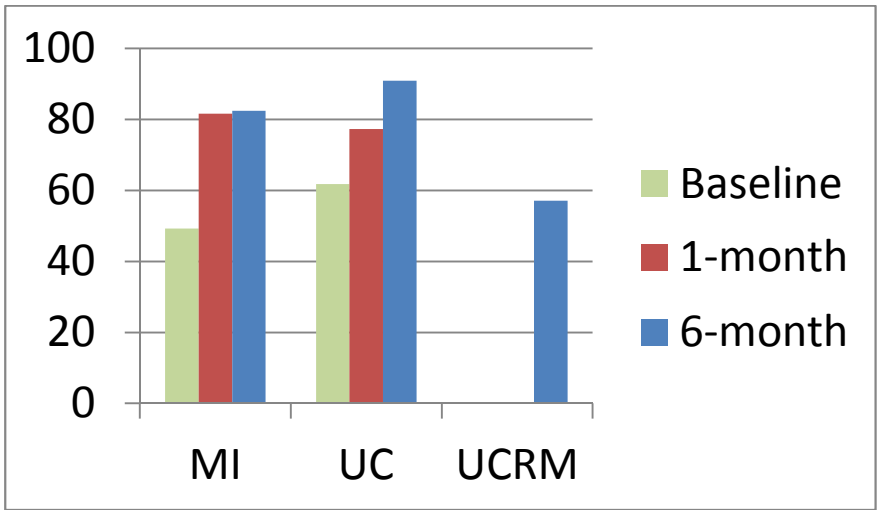


Figure 3. *Percent of participants who reported having a smoking ban in their car.*



Primary Outcome: Nicotine Dosimeters

Household nicotine monitors did not demonstrate differences as a function of treatment when analyzed cross-sectionally at each time point.

Examination of household nicotine levels as a function of time ($F(1,32) = 6.22$, $p<0.018$), treatment ($F(1,32) = 0.62$, $p<0.435$) and the interaction of time and treatment ($F(1,32) = 0.27$, $p<0.606$) indicated a reliable linear trend across time for both MI and UC groups. There was a 10.8% (95% CI 1.4-20.5) decrease in household nicotine level from one month to six months post-discharge.

Secondary Outcome: Infant ETCO

Although the small sample size necessitates inferential caution, evaluation of smoke exposure using end-tidal carbon monoxide failed to reveal differential change as a function of time ($F(1,10) \leq 0.01$, $p \leq 0.989$), treatment ($F(1,10) = 0.60$, $p \leq 0.457$) and the interaction of time and treatment ($F(1,10) = 0.80$, $p \leq 0.393$). Cross-sectional analyses failed to identify differences across groups (Table 2).

Predictors of Intervention and Follow-up Attendance

We have also investigated participant characteristics associated with attendance at the 2 hospital-based counseling sessions and participation in the follow-up assessments. Results indicated that higher intervention attendance was associated with greater numbers of cigarettes smoked by *other* household members and fewer children (<18 years old) in the home. Maternal smoking abstinence (lifetime), more cigarettes smoked by other household members, fewer children (<18 years old) and more adults ($\geq$18 years old) in the home, and higher perceived interpersonal support was associated with higher follow-up attendance. Thus, mothers with fewer childcare responsibilities and whose households have higher smoking levels are more likely to engage in a SHSe intervention. Additional incentives may be needed to engage mothers with lower yet potentially harmful levels of household smoking, as well as mothers who smoke.

V. Discussion and Interpretation of Findings

Conclusions

Secondhand smoke exposure is an environmental condition that threatens fragile infants discharged from a NICU. This is the first study to examine in depth and attempt to intervene on the smoking and protective practices of parents with a high-risk infant who have a smoker in the household. Collectively the data depict a population of families at extreme risk for social, psychological and physical health problems. The majority of the sample was of racial minority status, only about a quarter of mothers were married, most were not employed and were living at or below poverty level, with the majority receiving Medicaid to cover their child's healthcare expenses. With regard to smoking, over a quarter of families approached reported a smoker living in the home, comparable to rates found by Bock et al. (2008). The majority of smokers were the fathers, although for a quarter of the babies both parents smoked. A startlingly large majority (over 72%) reported that their pre-term, LBW infant was the result of an unplanned pregnancy and 85% reported one or more previous premature births.

Our data suggest a significant potential for tobacco-related health disparities. Important differences in preventative smoke exposure practices were found among various sociodemographic categories. Income and race/ethnicity differences were found with regard to the existence of a total smoking ban (**TSB**). Families were much less likely to have a TSB if they reported making less than $25,000 per year, which is just slightly over the U.S. annual poverty level for a family of four ($22,050). Thus, high risk NICU children born into the poorest of families with a household smoker are less likely to be protected from SHSe and thus are more prone to developing associated acute and chronic health problems.

With regard to intervention, our data suggest it is feasible to intervene with parents while their infants are in the NICU. While there were some challenges to intervention attendance at the hospital, notably multiple children in the home, almost 90% of those who consented attended at least one counseling session and around 70% attended the two planned sessions, indicating interest and acceptability. Follow-up visit attendance was also acceptable providing support for the feasibility of further research with this population.

Based on the outcome data, we believe there is evidence of intervention effect, although not all measures suggest such. The primary effect was seen in the initiation of a home smoking ban. More participants in the MI group who had no smoking bans at baseline instituted a total home and car smoking ban at 1 month post-discharge. There was also a clear measurement effect at 6 months in that the usual care group who received only an abbreviated baseline and a 6 month assessment were less likely to report smoking bans at 6-month post-discharge. Unfortunately, our objective measures of household nicotine and infant ETCO levels indicated no differences across groups. Thus, while our brief MI intervention and measurement of household ETS appeared to raise awareness of the problem and assisted families in declaring a smoking ban, it is unclear whether actual household smoking behavior changed. A more powerful intervention may be needed to elicit significant shifts in behavior.

Explanation of study limitations

The primary limitation of the study was sample size. We randomized at a 2:1 ratio to the intervention and control groups which resulted in small sample sizes in the two usual care groups. We chose to do this at the beginning of the trial because recruitment was very slow initially. We planned to collapse the usual care groups if indeed there were no meaningful differences between them. Unfortunately the differences due to measurement and increased contact were rather large, therefore precluding the collapsing of the groups. Additionally, while our follow-up rates were not unreasonably low, we had a higher than expected number of participants who lost their babies to death or CPS custody or who moved out of the 50 mile radius. As this was the first study of its kind, knowledge of these implementation difficulties is critical for designing the next study.

Comparison with findings of other studies

While there are no secondhand smoke exposure reduction trials conducted with NICU families in which to compare our findings, our results do not differ dramatically from other such studies. Two review papers of secondhand smoke interventions (Baxter et al., 2011; Gehrman & Hovell, 2003) targeting children or fetuses both concluded that there was mixed evidence regarding the success of these interventions. Of the 19 studies reported in Gehrman & Hovell, 11 found significant reductions in reported ETS. Only one study each found differences in child cotinine levels and home-air-nicotine levels between treatment and control groups. Counseling provided

in the home was generally more effective. Thus, this is a relatively new field of study with a strong need for innovative and effective intervention strategies.

Possible application of findings to actual MCH health care delivery situations

NICU hospitalization offers a rare opportunity to reach a young segment of the low-income, smoker population which rarely presents in health-care settings, thereby precluding exposure to messages regarding the hazards of smoking for families and their children. Those who are poor, depressed, African American or Caucasian are less likely to have protective health behaviors in place to reduce ETS and are therefore at higher risk for tobacco-related health disparities. More powerful interventions to address smoking behaviors in this vulnerable population are certainly needed. However, our usual care group demonstrated change in home smoking policies post-discharge compared to the usual care-reduced measurement group, suggesting that simply raising awareness of the problem may move some parents to make changes.

At the local hospital level, healthcare professionals in the NICU could be trained and systems could be developed to deliver ETS information and education on a more routine basis. Previous research suggests that 5-minutes of physician-delivered smoking cessation counseling can significantly increase quit rates (Folsom & Grimm, 1987; Janz et al., 1987). Further, raising awareness throughout the NICU of the dangers of SHSe will perpetuate an anti-tobacco culture (e.g., Hovell & Hughes, 2009), to which parents will be exposed throughout their infant's hospital stay. On an individual level, ETS counseling as well as evidence-based smoking treatments, such as cessation counseling and pharmacotherapy (e.g., nicotine replacement therapies, bupropion, varenicline) should be offered. To our knowledge, only one smoking cessation study has been conducted in a NICU setting (Ling, Wooderson, Rees, Neild, & Wright, 2008).

Policy implications

Policy to regulate secondhand smoke exposure in public facilities has been implemented in many cities and states. Unfortunately such legislation does not protect children from ETS in their homes. While continued policy efforts to eliminate public exposure to ETS are critical, additional more direct intervention efforts are needed to protect vulnerable infants from household exposure. Policies to regulate tobacco and public ETS exposure will likely have long-term effects on smoking initiation and cessation, however, and must be continued.

Suggestions for further research

Further research is needed to develop innovative and powerful interventions that will elicit behavior change in parents of vulnerable, high-risk infants. NICU parents face many competing demands, such as earning enough money to feed their family, figuring out how to physically get to the NICU to visit their baby, and, once home, caring for a medically fragile infant, not to mention the all too common stressors of substance abuse, domestic violence and divorce. As such, tangible and emotional resources for affecting behavior change are limited. Offering external reinforcers of sufficient magnitude for desired behavior change in this context is likely one of the few ways to raise the saliency of a problem that lacks immediacy in its consequences (e.g., infant illness). Our new NIH-funded study will test an intervention combining motivational interviewing plus motivational incentives in attempt to increase intervention effects.

VI. List of products (peer reviewed articles, books, chapters in books, master and doctoral dissertations, conference presentations, etc.).

Published Peer-Reviewed Paper:

1. Stotts, A., Evans, P., Green, C., Northrup, T.F., Dodrill, C, Fox, J., Tyson, J. & Hovell, M. (2011). Secondhand smoke risk in infants discharged from a NICU: Potential for significant health disparities? *Nicotine and Tobacco Research, 13*(11), 1015-1022. DOI: 10.1093/ntr/ntr116.

Published Abstracts:

2. Northrup, T.F., Evans, P.W., Stotts, A.L., (2012). A comparison of depressed and non-depressed NICU mothers on infant health, breastfeeding, and household smoking. *Annals of Behavioral Medicine, 43*(Suppl. 1), Society of Behavioral Medicine, p. s104.

3. Stotts, A.L., Northrup, T.F., Hovell, M., (2012). Families of High Respiratory Risk Infants in a Neonatal Intensive Care Unit: Who has a Household Smoking Ban? *Annals of Behavioral Medicine, 43*(Suppl. 1), Society of Behavioral Medicine, p. s128.

Submitted Manuscripts:

4. Northrup, T.F., Green, C., Evans, P., & Stotts, A.L. (under review). Engaging NICU mothers in health behavior intervention and research: Predictors of attrition in a randomized clinical trial of secondhand smoke reduction among smoking household members.

5. Northrup, T.F., Evans, P.W., & Stotts, A.L. (under review). Depression among mothers of high-risk infants in a neonatal intensive care unit.

Manuscripts In Preparation:

6. Stotts, A., Evans, P., Green, C., Northrup, T.F., Dodrill, C, Fox, J., Tyson, J. & Hovell, M. (in preparation). The Baby's Breath Project: A Pilot Trial to Reduce Secondhand Smoke Exposure in High Respiratory Risk Infants in the Neonatal Intensive Care Unit (primary outcome paper).

7. Northrup, T.F., Green, C., Evans, P., Wooten, S., & Stotts, A.L. (in preparation) A comparison of depressed and non-depressed NICU mothers on breastfeeding practices.

8. Stotts, A.L., Northrup, T.F., Green, C., & Hovell, M.F. (in preparation). *Families of High Respiratory Risk Infants in a Neonatal Intensive Care Unit: Who has a Household Smoking Ban?*

Poster Presentations:

9. Stotts, A.L., Northrup, T.F., & Hovell, M.F. (April, 2012). *Families of High Respiratory Risk Infants in a Neonatal Intensive Care Unit: Who has a Household Smoking Ban?* Presented at the 2012 annual convention of the Society for Behavioral Medicine, New Orleans, LA.

10. Northrup, T.F., Evans, P.W., Stotts, A.L. (April, 2012). *A comparison of depressed and non-depressed NICU mothers on infant health, breastfeeding, and household smoking*. Presented at the 2012 annual convention of the Society for Behavioral Medicine, New Orleans, LA.

11. Evans, P.W., Northrup, T.F., Stotts, A.L., (April, 2012). *Incentives and Deterrents to Support Services for Mothers of NICU Infants.* Presented at the 2012 annual meeting of the Pediatric Academic Societies, Boston, MA.

12. Northrup, T.F., Green, C., Evans, P.W., Stotts, A.L., (March, 2012). *Predicting Attrition in a Secondhand Smoke Intervention Study with Families in a Neonatal Intensive Care Unit*. Presented at the 2012 annual convention of the Society for Research on Nicotine and Tobacco, Houston, TX.

13. Stotts, A.L., Northrup, T.F., Green, C., Evans, P.W., Tyson, J., Hovell, M.F. (March, 2012). *The Baby's Breath Project: A Pilot Trial to Reduce Secondhand Smoke Exposure in High Respiratory Risk Infants in the Neonatal Intensive Care Unit*. Presented at the 2012 annual convention of the Society for Research on Nicotine and Tobacco, Houston, TX.

14. Dodrill, C.L., Stotts, A.L., Evans, P.W., Lindsay, J.A., Jimenez, M., Tyson, JE. Depression and Trauma Symptoms in Mothers of High-Risk NICU Infants. Poster presented at the Annual Convention of the Association for Behavioral and Cognitive therapy, New York City. (November 2009).

15. Stotts, A.L., Dodrill, C.L., Evans, P.W., Green, C., Tyson, J.E. Hazardous Homes: Smoking Habits and Motivation for Change Among Parents of Infants in a Neonatal Intensive Care Unit. Poster presented at the Annual Convention of the Association for Behavioral and Cognitive Therapy, New York City. (November 2009).

<u>Social Media:</u>

16. UTHealth - Behavioral Health and Addictions Research Program (BHARP) Facebook page. Initiated in 2011

<u>Related Grants:</u>

17. A. L. Stotts, Principal Investigator, "Motivational Incentives to Reduce Secondhand Smoke in NICU Infants' Homes," NIH/NHLBI. 03/1/12-8/31/17, $3,196,514.

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