DEVELOPING EDUCATIONAL MATERIAL TO PROMOTE AWARENESS OF NICOTINE USE AS A SIGNIFICANT RISK FACTOR FOR SUDDEN INFANT DEATH SYNDROME

by

Nicole Bencs

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As members of the DNP Project Committee, we certify that we have read the DNP Project prepared by Nicole Bencs entitled “Developing Educational Material to Promote Awareness of Nicotine Use as a Significant Risk Factor for Sudden Infant Death Syndrome” and recommend that it be accepted as fulfilling the DNP Project requirement for the Degree of Doctor of Nursing Practice.

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Final approval and acceptance of this DNP Project is contingent upon the candidate’s submission of the final copies of the DNP Project to the Graduate College.

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SIGNED: Nicole Bencs
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DEDICATION

This DNP Project is dedicated to all the families and infants who have fallen victim to SIDS. SIDS remains a health mystery, but education about modifiable risk factors can positively impact families. My hope is that this project will impact women and promote health changes that will decrease the likelihood of SIDS and potentially save infant lives and family turmoil.
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ABSTRACT

Introduction and Rationale: Sudden infant death syndrome (SIDS) continues to be the leading cause of death in infants 28 days to 12 months old and the third leading cause of infant mortality (CDC, 2014; Task Force on SIDS, 2011a). SIDS has no identifiable cause although many hypotheses have existed and there are many known risk factors. Nicotine use is the second most modifiable risk factor for SIDS and to date there is no national public education campaign. Formal education is needed. Written education materials, such as brochures, are an effective way to increase knowledge and awareness of a health topic.

Purpose and Objective: The purpose of this DNP Project was to create an educational brochure about SIDS and nicotine as a significant modifiable risk factor. The brochure is directed towards pregnant women and women with infants less than 12 months of age. The objective was to educate and inform mothers about SIDS, nicotine and its relation to SIDS, and the importance of abstaining from nicotine during and after pregnancy.

Methods: The brochure was created using the Health Belief Model (HBM) as a framework. The HBM was used to explain health behavior modifications and was used as a foundation for education interventions. The model has successfully been applied to explain other preventative health behaviors and provide health education in various contexts.

Results: The brochure was evaluated by two subject matter experts who have published peer reviewed articles using the HBM. Both subject matter experts found the HBM applied to the brochure appropriately. In their opinion, the content of the brochure should have positive impact for health modification in women who use nicotine and are pregnant or have a child less than 12 months of age.
Conclusions: This DNP Project demonstrated SIDS as a current significant health problem and identified maternal nicotine use as the second most modifiable risk factor. Due to lack of current public education, a brochure was created using the HBM as a framework. Subject matter experts stated the brochure was created based on the HBM and will likely have positive health influence on the intended population.
CHAPTER ONE: OVERVIEW

Introduction

The focus of this DNP Project was sudden infant death syndrome (SIDS). The purpose was to develop an evidence-based educational brochure for pregnant women and women with infants. Foundational to this project was an understanding of SIDS and the current recommendations. This chapter will provide an overview and history of SIDS. This chapter will also discuss the significance of SIDS education to advanced practice nursing.

Sudden Infant Death Syndrome

Sudden infant death syndrome is the “sudden death of an infant less than 12 months of age that cannot be explained after a thorough investigation is conducted, including a complete autopsy, examination of the death scene, and review of the clinical history” (Centers for Disease Control and Prevention [CDC], 2014). With about 2,000 infant deaths annually, an incidence of 55 per 100,000 live births in the United States (US), SIDS is the leading cause of death in infants 28 days to 12 months old and the third leading cause of infant mortality (CDC, 2014; Task Force on SIDS, 2011a). The risk of SIDS peaks between 2 and 3 months of age, it is uncommon in the first month of life and decreases after 3 months. Most cases of SIDS, approximately 85% of cases, occur before 6 months of age (Mitchell, 2009).

SIDS has no identifiable cause and has been the debate of many hypotheses for decades (Schnitzer, Covington, & Dykstra, 2012). In the 1970s and 1980s the dominate theory was apnea and cyanosis. This hypothesis has not been supported by the use of cardiorespiratory recordings or apnea monitors. Neither have been able to predict those at higher risk or prevent deaths, and SIDS rates have not declined with their use (Mitchell, 2009). Other hypotheses that have been
reported and explored include cardiac arrhythmias, immunizations, toxic gases, prone sleeping and thermal mechanism, airway obstruction, exposure to traditional cigarette smoke and nicotine (most specifically maternal), infective or inflammatory mechanism, and rebreathing of expired respiratory gases (Mitchell, 2009).

Another hypothesis for the cause of SIDS is the triple risk hypothesis. The triple risk hypothesis is based on the idea that SIDS is not dependent upon a single characteristic of the infant, but rather the result of an interaction with one or more risk factors with variable possibilities. Over the years, spanning back to 1972, there have been a series of triple risk hypotheses developed by researchers. In 1969, before the first triple risk hypothesis, Bergman presented the idea at a conference that SIDS is not dependent upon a single characteristic of the infant, but rather the result of an interaction with one or more risk factors with variable possibilities (Guntheroth & Spiers, 2002). From here came a number of models hypothesizing that SIDS is the combination of three factors that require the effect of each other (Ostfeld, Esposito, Perl, & Hegyi, 2010). The first triple risk model came in 1972 by Wedgwood following Bergman’s idea. Wedgwood’s model included 1) general factors such as poverty, prematurity, gender, and race that would increase the probability of death in an individual by any cause, 2) risks related to age and developmental status, and 3) precipitating factors such as sleep state, position, and infection (Guntheroth & Spiers, 2002). In 1993 Rognum and Saugstad provided their model, the “fatal triangle in SIDS,” which was based on morphological, biochemical, and immunological findings. Their model, shown in Figure 1, included 1) vulnerable developmental stage of the central nervous system (CNS) and mucosal immunity, 2)
predisposing factors, astrogliosis, genetic make-up, and 3) a trigger event such as possible over-stimulation of the immune system (Rognum & Saugstad, 1993).

FIGURE 1. The Hypothesis of a “Fatal Triangle” in SIDS. (*Rognum & Saugstad, 1993*)

Many studies aim to identify risk factors associated with SIDS. SIDS cases are rarely found to be risk-free or with only one risk. One study showed 2 of 244 (0.8%) cases examined, were risk-free, 44 of 244 (18%) had only one risk factor. More commonly, cases present with multiple risk factors (Ostfeld et al., 2010).

In 1994 the Back to Sleep campaign was launched. The focus was the name sake of the campaign, putting infants on their backs to sleep and discouraging prone sleeping. This campaign was very successful and there was a steady decline in SIDS deaths. This decline continued until 2000, but since 2001 the rate of SIDS has remained constant (Moon & Lu, 2012). In 2011 the American Academy of Pediatrics (AAP) Task Force on SIDS published an expansion of recommendations for a safe infant sleeping environment. In this document, the AAP outlines and discusses risk factors beyond sleep position and provides their official recommendations (Task Force on SIDS, 2011b). In response to the plateau and recommendations
by the AAP, the Back to Sleep campaign was modified and in 2012 changed to the Safe to Sleep campaign (National Institute of Child Health and Human Development [NICHD], 2013). The Safe to Sleep campaign focuses more on the sleep environment of the infant, not just the sleep position.

Since the plateau in SIDS cases, it has been apparent that sleep position is not the only factor involved and other SIDS related factors have been identified. The AAP, CDC, and NICHD each comprehensively list other identified risk factors. Other risk factors include: soft sleeping surface, increased temperature during sleep, sleeping with soft or loose bedding, co-sleeping, prematurity/low birth weight, non-breastfeeding, prenatal and postnatal maternal nicotine use, and a number of pathophysiological factors (NICHD, 2013; Task Force on SIDS, 2011). Overall, the major risk factors for SIDS are prone sleeping, maternal nicotine use, and prematurity (Richardson & Horne, 2013). Prone sleeping and maternal nicotine use are modifiable risk factors; prematurity is not directly modifiable though there are modifiable risk factors for prematurity. Not only does the AAP discuss identified risk factors, they also discuss recommendations to reduce the risk of SIDS. These include placing infants supine for every sleep, using a firm sleep surface, room sharing without bed sharing, the use of a pacifier when the infant is falling asleep, avoiding the use of soft bedding, receiving routine prenatal care, avoiding nicotine use pre and postnatally, breastfeeding, avoiding overheating of infant during sleep, immunizing infants, and avoiding the use of commercial sleep positioners (Task Force on SIDS, 2011b). Based on this information two models were developed. The purpose of the models was to provide a visual tool to collaborate the main points identified about SIDS. These models will be explored and discussed in further detail in Chapter Two: Background.
Significance to Advanced Practice Nursing

Nurse practitioners (NPs) are expected to provide education and anticipatory guidance to patients and families with each health care encounter. SIDS is a large public health concern, but there are gaps in knowledge. The Back to Sleep campaign promoted supine sleeping and effectively resulted in a decrease in SIDS rates and an increase in infants who routinely sleep supine (Task Force on SIDS, 2011a). The other risk factors of SIDS have received less attention and promotion despite the change to the Safe to Sleep campaign. Nicotine use is the second most modifiable risk factor for SIDS, but to date there are no SIDS education campaigns targeting nicotine (Duncan et al., 2009). NPs are a valuable resource in the primary care setting and can serve as educators to assist in closing this knowledge gap (Cronenwett et al., 2011). NPs are in women’s health clinics as well as pediatric clinics. This allows for education to occur prenatally and during well-child visits. In addition, doctoral prepared NPs (DNPs) are prepared in leadership, scholarly practice, practice improvement, and innovation which are needed to deliver the highest evidence-based practice (Sperhac & Clinton, 2008). The promotion of SIDS education will provide the DNP opportunity to lead practice change and collaborate with other healthcare providers to improve patient health outcomes as described by the American Association of Colleges of Nursing Essentials of Doctoral Education for Advanced Nursing Practice (AACN, 2006).

Purpose

The purpose of this DNP Project was to develop an educational brochure about SIDS and nicotine as a significant modifiable risk factor. Nicotine was selected as the focus based on literature review of its significance to SIDS and the current lack of public campaign education.
The brochure is intended for pregnant women and women with infants less than 12 months of age. The focus is education about nicotine use and how it relates as a significant modifiable risk factor for SIDS. The educational brochure will inform mothers about SIDS, nicotine and its relation to SIDS, the importance of abstaining from nicotine during and after pregnancy, and suggestions and support to quit nicotine use. It is hoped that this brochure will encourage mothers to change their health habits for the benefit of their child and thus reducing SIDS rates. This brochure was developed based on review of current research and the application of the Health Belief Model (HBM).

**Definitions**

**SIDS**: “Sudden death of an infant less than 12 months of age that cannot be explained after a thorough investigation is conducted, including a complete autopsy, examination of the death scene, and review of the clinical history” (CDC, 2014).

**Triple Risk Hypothesis**: The idea that SIDS is not dependent upon a single characteristic of the infant, but rather the result of an interaction with one or more risk factors with variable possibilities. Multiple models have been created, including the “fatal triangle in SIDS”, which includes morphological, biochemical, and immunological factors.

**Back to Sleep**: Public education campaign launched in 1994 to promote placing infants on their backs to sleep and discourage prone sleeping in effort to decrease the incidence of SIDS.

**Safe to Sleep**: Latest public education campaign, launched in 2012, promoting prevention strategies related to infants’ safe sleep environment.

**Health Belief Model**: A model that served as a framework for SIDS and nicotine education. The Health Belief Model has been used effectively in other efforts to promote health behavior
changes. The model consists of seven dimensions: perceived susceptibility, perceived severity, perceived benefit, perceived barriers, demographic variables, and cues to action. These dimensions are specifically defined in Chapter Three: Methods.
CHAPTER TWO: BACKGROUND

Introduction

SIDS remains a high cause of infant mortality despite the Back to Sleep and subsequently the Safe to Sleep campaigns. SIDS is a popular research topic across the world with active research in many areas, ranging from brain pathophysiology to temporal trends. Researchers are constantly seeking reasons for the cause of SIDS and how to decrease its incidence. Research so far has been unable to identify one distinct cause for SIDS, but has identified many factors, some modifiable and others pathophysiological. Even still, some of the pathophysiological factors identified have been attributed to changes that occurred after a modifiable risk factor was present. For example, studies have shown changes in specific areas of fetal and infant brains that are only present in those who had prenatal nicotine exposure through maternal nicotine use. These brain changes are not present in fetal or infant brains where the mother did not use nicotine during pregnancy. To be clear, maternal smoking does not cause these changes in every case, but they are found significantly more in fetuses and infants whose mother smoked during pregnancy (Lavezzi, Mecchia, & Matturri, 2012; Poetsch, Czerwinski, Wingenfeld, Vennemann, & Bajanowski, 2010; Tang, Machaalani, & Waters, 2012). This example shows a pathophysiological change after the presence of a modifiable risk factor. And so there is overlap in these areas, causing even more uncertainty about the cause of SIDS. It is apparent from years of research that there is not one cause of SIDS and that it is a combination of biological factors and situational variables. Still, the goal is to reduce the risk of SIDS in any reasonable way possible and many factors identified are modifiable, but require parent education. Also, there is
some overlap between factors. In the next sections the individual SIDS risk factors and recommendations for prevention will be discussed.

Search Strategy of Literature Review

PubMed was the search engine used for all literature searching. Specific search criteria and terms were used. Search criteria included, within the last five years, English, and human. Terms related to SIDS were used and combined several ways to optimize search results. “Sudden infant death syndrome” was the main search term and was combined individually with other terms. The other terms that were combined with “sudden infant death syndrome” were: contributing factors, sleep temperature, co-sleeping, low birth weight, second hand tobacco exposure, tobacco, nicotine, soft bedding, prone, breastfeeding, and pathophysiology. Several articles were found in duplication using these search terms if the article was about more than one topic. For the initial literature review, 94 articles were saved for review. Of those 94, 40 useful articles were read, reviewed, and organized by table format. During the writing process additional PubMed searches were performed to find additional supporting evidence.

SIDS Risk Factors

Figure 2 represents the contributing factors to SIDS, both modifiable and pathophysiological. This model was designed based on literature review and factors identified by the AAP, CDC, and NICHD.
FIGURE 2. SIDS Contributing Factors.

**Prone Sleeping Position**

Prone sleeping is the most commonly known risk factor for SIDS and was strongly educated against and publically endorsed by the Back to Sleep campaign. Through the Back to Sleep campaign, SIDS deaths dropped significantly from 1992 to 2001. In 1992 US SIDS rates were 120 deaths per 100,000 live births and by 2001 the rate had decreased to 56 deaths per 100,000 live births; a more than 50% decline in SIDS rates. The last year that data is available is 2006. From 2001 to 2006 SIDS rates have remained constant thus prompting the updated policy statement and technical report by the AAP and the change in sleep campaign (Task Force on SIDS, 2011a). It is unclear the exact cause or mechanism of prone sleeping being a risk factor, but many theories have been studied. Overall, studies have evaluated other variables and linked them with prone positioning. Examples of other variables are sleep arousal and sleep states, household nicotine use, genetics, and postnatal age.
Sleep arousal has been a concern and is further a concern based on sleep position; prone sleepers have depressed arousability compared to supine sleepers (Richardson & Horne, 2013). Research has found that healthy term infants are 3-times more difficult to arouse in the prone position, more so in the 2 to 3 month old range, the time when SIDS risk is the highest (Wong et al., 2011). Also, infants who usually sleep supine and are naïve prone sleepers are at an increased risk of SIDS if they are placed prone (Richardson & Horne, 2013). Blood pressure and autonomic response are lower in the prone position; infants are more difficult to arouse (Ammari et al., 2009). Impaired arousability and lower blood pressure both could be signs of cerebral hypoxia. Tissue oxygenation index (TOI) is a measurement of oxygen saturation in cerebral vascular compartments and has been shown to have significant changes in both active and quiet sleep based on prone sleep position (Wong et al., 2011). Wong et al. (2011) studied 17 healthy term infants in a longitudinal design and found statistically significant results that TOI is lower in the prone position and not associated with significant changes in body temperature or cardiorespiratory parameters. They studied infants at three age periods: 2 to 4 weeks, 2 to 3 months, and 5 to 6 months, finding significant changes during each period. The mechanism for why TOI is lower is unknown and researchers suggest it may be due to position-related compression of vessels with head rotation (Wong et al., 2011). This study suggests that the prone position has an increased risk of cerebral hypoxia which may then contribute to the risk of SIDS.

**Soft Sleep Surface and/or Bedding**

Soft bedding is another modifiable factor related to SIDS and again the mechanism of why soft bedding is a risk is not clear. Soft bedding includes pillows, blankets, quilts, bumper pads, and soft sleep surfaces such as cushions, sofas, and cushioned chairs (Ajao, Oden, Joyner,
& Moon, 2011). The use of soft bedding items increases the risk of SIDS 5-fold independent of sleep position and 21-fold if the infant is prone (Task Force on SIDS, 2011a; Moon & Fu, 2012). Unfortunately, many parents still use soft bedding with misunderstandings and misbeliefs and there has been no decrease in the use of soft bedding (Ajao et al., 2011; Moon, Tanabe, Yang, Young, & Hauck, 2012). Part of the reason for the use of soft bedding is parents misunderstanding the meaning of firm sleep surface and the perception that soft bedding will keep their infant safe and comfortable. In a qualitative study, mothers report various responses to their perception of a firm sleep surface. Some thought that a surface was firm if the covering was taut and thought that soft bedding and blankets were acceptable as long as there was a sheet pulled taut over the bedding and blankets. In the same study there were a variety of responses for reasons they would use blankets, pillows, and bumper pads. Comfort was the main reason for blanket and pillow use, mothers reported that they thought their baby would sleep better if the sleep surface was soft and comfortable. Safety was the main reason for bumper use because mothers were concerned about infant injury from crib slats. Aesthetics was another reason for bumper use (Ajao et al., 2011). This study shows that as providers and family educators, we need to be clear about terms and recommendations regarding sleep surface and environment.

Studies seeking cause for risk have focused on gas dispersal, CO2 rebreathing potential, and head covering. The overarching concern is the general limitations in developmental skills and physical ability of infants to reposition themselves as needed to avoid problematic situations such as head covering, being wedged in bedding and mattress, and being face down in soft bedding (Pike & Moon, 2008). Studies have focused on CO2 gas dispersal potential of bedding used by infants who died unexpectedly during sleep. One such study took the bedding of 26
infants who died and examined the bedding using a mannequin model. They found that some of
the bedding had high rebreathing potential, especially if the bedding had been covering the
infant’s face (Sakai, Takahashi, & Funayama, 2009). Ultimately, there should not be loose
bedding near the infant’s head during sleep and there should be a firm sleep surface without soft
bedding under or around the infant (Task Force on SIDS, 2011a).

**Bed-Sharing**

Similarly related to soft bedding and firm sleep surface is bed-sharing. Infants who share
a bed with an adult are likely on a soft surface with soft bedding. Research regarding bed-sharing
has been mixed between the risks of SIDS and the benefits of convenient feedings and parent-
child bonding (Venneman et al., 2012). Bed-sharing has been associated with an increased rate
and duration of breastfeeding and is common practice in many cultures. Unfortunately, SIDS
occurs in bed-sharing environments and there is an increased risk if either parent uses traditional
cigarettes or if the mother consumed alcohol in the previous 24 hours (Wong et al., 2011). The
risk is increased 10-times in infants less than 12 weeks of age when parents use traditional
cigarettes (Vennemann et al., 2012). SIDS rates are higher in infants of alcohol-consuming
mothers. Similarly, SIDS is higher over weekends where parents are more likely to consume
increased amounts of alcohol (Phillips, Brewer, & Wadensweiler, 2010). The risk of SIDS is also
increased 2-fold in infants who do not routinely bed-share compared to infants who routinely
bed-share. This could have confounding variables such as the infant being ill which was the
reason for bed-sharing and increases the risk (Venneman et al., 2012).

Hypoxic and hypercapnic events are also increased in bed-sharing situations. Bed-sharing
creates a microenvironment where the infant has risk of rebreathing associated with head
covering by bedding or by positioning which causes the face to be into a pillow or soft bedding. This sleeping arrangement also causes a thermal microenvironment where the temperature of the infant is increased, also increasing the risk of SIDS. Desaturation events occur more often in bed-sharing situations than when infants sleep in their own space, such as a crib or bassinet (Baddock, Galland, Bolton, Williams, & Taylor, 2013). The AAP recommends room-sharing rather than bed-sharing to decrease the risk of SIDS by as much as 50%. Room-sharing consists of the infant sleeping in a separate appropriate sleep area on a firm surface in the parent’s room close to their bed. This allows for close proximity of the infant for feedings and monitoring while maintaining a safe sleep environment (Task Force on SIDS, 2011b).

**Increased Sleeping Temperature**

Thermoregulatory changes have been linked to increase the risk of SIDS. Evidence to support this has been found by observation that many SIDS victims are found in atypically warm environments, covered or wrapped with overly warm clothing or bedding, felt warm or were diaphoretic when discovered, and have higher than normal rectal temperatures upon examination or autopsy (Ammari et al., 2009). Prone sleeping infants have higher surface temperatures than supine sleeping infants, even without excessive bedding or clothing. Evidence suggests that infants 2 to 4 months of age may have less tolerance of heat stress which also correlates to the time when infants are at the highest risk for SIDS (Ammari et al., 2009). Bed-sharing infants have also been found to be warmer. They are more likely to be sleeping with warmer/thicker bedding. They are often in contact with the mother with reduces the infants surface area for heat loss leading to increased temperature. Body temperature is also a concern in premature infants.
who can exhibit periodic breathing, desaturations, and have immature cardiorespiratory control compared to term infants (Baddock et al., 2013).

**Prematurity/Low Birth Weight**

Prematurity is the delivery of an infant prior to the completion of 37 weeks, 36 6/7 weeks or sooner (Spong et al., 2011). Low birth weight (LBW) is a birth weight less than 2,499 grams, very LBW is less than 1,500 grams; both are associated with higher mortality (MacDorman & Mathews, 2009). In general, LBW infants have increased health risks compared to average birth weight infants. Prematurity and LBW infants are at an increased risk for SIDS, though the mechanisms are unclear and remain a current topic of research. Preterm infants are approximately four times as likely to die of SIDS as term infants (20% versus 5%). This proportion has been stable even since the implementation of the Back to Sleep campaign and public education for reducing SIDS. Further, there has been a 30% increase in the number of preterm births over the last 30 years due to improvements in obstetrics and neonatal intensive care units (Richardson & Horne, 2013). Studies with LBW and premature infants have evaluated cortical arousal (CA), heart rate variability (HRV), and tissue perfusion. When evaluating sleep states researchers use full CA and sub-cortical to define infant arousal responses. Research has found preterm infants to have fewer CAs from active sleep had significantly lower SpO2 before arousal. SIDS infants compared to controls have had fewer CAs from active and quiet sleep. Full CA is needed to stimulate a behavioral response of repositioning, for instance when blankets or bedding cover the infant’s face (Richardson & Horne, 2013).

Heart rate variability and tissue perfusion are related. Heart rate variability has been studied as a measure to compare autonomic systems of preterm infants to full term infants as a
risk factor for SIDS. Heart rate variability is used as an indirect non-invasive assessment of autonomic control of heart activity (Thiriez et al., 2009). Research has provided findings that preterm infants have altered and reduced HRV compared to full term infants (Yiallourou et al., 2013). This alteration and reduction of HRV is further exacerbated by nicotine exposure in utero (Thiriez et al., 2009). Prematurity could therefore be a risk factor for impaired autonomic cardiac control maturation. Sahni et al. (2009) studied LBW infants in prone and supine sleep positions and evaluated perfusion index as a non-invasive measure of tissue perfusion that is measured by comparing a pulse oximetry pulsatile signal to a non-pulsatile signal. The measurement is primarily affected by blood flow at the monitoring site, not by oxygen saturation. They found that LBW infants have higher perfusion index when sleeping prone (Sahni et al., 2009). This could reflect cardiovascular and thermal changes, which are altered by position. Other studies have also found that LBW infants are warmer in the prone position and increased temperature is also related to increased risk for SIDS (Ammari et al., 2009). Altered HRV has indications that preterm infants may not have mature cardiovascular control which also could be expressed as altered perfusion index when compared to full term infants.

**Non-Breastfeeding**

Breastfeeding has been found to reduce the risk of SIDS by about 50% in all ages (Vennemann et al., 2009). Since breastfeeding reduces the risk of SIDS as a protective factor, not breastfeeding would be a risk factor of SIDS. The AAP recommends exclusive breastfeeding for 6 months followed by the addition of solid foods and the continuation of breastfeeding for 1 year or longer. Breastfeeding rates are part of the *Healthy People 2010* and *2020* targets. Initiation of breastfeeding is reaching targets, but “any” and “exclusive” breastfeeding are not. Over the past
10 years, rates of “any breastfeeding” at 3 and 6 months has increased, but have not reached the Healthy People 2010 and 2020 targets (Eidelman & Schanler, 2012). Mothers should be encouraged to breastfeed for many reasons such as optimal infant nutrition, reduced risk of SIDS, reduced risk of respiratory tract infections and otitis media, reduced gastrointestinal tract infections, reduced incidence of necrotizing enterocolitis, protective effect towards allergic disease, protective effect for celiac disease, lower rates of obesity, reduced risk of childhood inflammatory bowel disease, reduced risk of diabetes, and reduced risk of childhood leukemia and lymphoma. Breastfeeding also has improved maternal outcomes of reduced blood loss, more rapid involution of the uterus, and less postpartum depression (Eidelman & Schanler, 2012). Vennemann et al. (2009) showed in a large case control SIDS study that the positive effect of breastfeeding is independent of sleep position and protection from SIDS is effective as long as breastfeeding continues. Sleep studies have shown breastfeeding infants are more easily aroused compared to formula-fed infants, providing a potential mechanism for the protective effect of breastfeeding (Vennemann et al., 2009). Mothers should be educated that breastfeeding is protective for SIDS and also includes many other health benefits.

**Pathophysiology**

There are many pathophysiological theories to explain the cause of SIDS. Researchers have studied multiple organ systems and cellular levels of infants in search of a causal link. Many studies microscopically evaluate a system of interest in SIDS victims and compare to infants of other causes of death. Common areas of research have been cardiac, placental, various aspects of the brain and nervous system, and interleukin gene polymorphism.
Cardiac muscarinic receptor expression was evaluated in 18 SIDS and 19 controls of other causes of death to determine if there is any biological abnormality in the peripheral vago-cardiac system that could be linked to SIDS (Livolsi et al., 2010). The researchers found a difference in the groups; the SIDS victims had overexpression of muscarinic receptors. The results of this study suggest that cardiac muscarinic expression may be a factor of vulnerability towards SIDS (Livolsi et al., 2012).

Widdows et al. (2012) evaluated placentas retrospectively of normal birth weight (NBW) and small for gestational age (SGA) infants who died of SIDS and compared them to control NBW and SGA placentas. They focused on the morphological development of the placentas, estimating the percentage and total volumes of chorionic villi and villous trophoblast membrane. Researchers found differences in the placentas of the SIDS and control groups. The placentas from the SIDS NBW and SGA groups both showed morphological changes in the chorionic villi and villous trophoblasts. The researchers concluded that their data provides evidence of placental changes which could be a factor of SIDS (Widdows et al., 2012).

Another area of pathophysiological SIDS research is related to brainstem abnormality or maturational delay that would affect neuroregulation of cardiorespiratory control. Previous studies focused on neuropathological expression and found an increased expression of apoptotic markers in SIDS infants. Other alterations in neurotransmitters and neuronal receptor expression have also been reported. Given previous evidence of apoptosis and neurochemical abnormalities additional research is needed to further understand the mechanism and interactions in SIDS (Tang Machaalani, & Waters, 2012). Tang et al. (2012) studied brain-derived neurotrophic factor (BDNF) to see if there are any changes in the brainstem medulla of SIDS infants. BDNF is a
neurotrophin which is important in the development of the nervous system for regulating cell survival and apoptosis. They reported differences in the expression of BDNF between SIDS and non-SIDS infants. Their findings provide pathological evidence of brainstem differences between SIDS and non-SIDS infants (Tang et al., 2012).

Other research has focused on cytokines and interleukin-1 (IL-1) gene cluster and their links to SIDS. A study focusing on the genetic risk of SIDS in the IL-1 gene cluster found an association between SIDS and combinations of the IL-1α gene. In this study, some genotypes also found a correlation between sleeping position and SIDS; most SIDS victims with these genotypes were found sleeping in the prone position (Ferrante, Opdal, Vege, & Rognum, 2010). Another study focused on the relationship between cytokine gene polymorphisms and SIDS. This study also showed findings related to prone sleeping position. They reported a correlation between single nucleotide polymorphisms in the gene encoding IL-8 and prone sleeping positioning in SIDS cases. These studies support the idea that SIDS is multifactorial, going along with the fatal triangle theory, and is likely the combination of environmental risk factors and a predisposing inheritance pattern (Ferrante, Opdah, & Rognum, 2010).

Pre- and Post-Natal Maternal Tobacco and Nicotine Use

Nicotine exposure is the second major modifiable risk factor for SIDS (second only to prone sleeping), though the mechanism is unknown. Pre and postnatal nicotine exposure has been linked to increasing the risk of SIDS 2- to 5-fold (Duncan et al., 2009). Epidemiology indicates that smoking traditional cigarettes is a risk factor, but there is little evidence for a biological explanation; current research has focused on evaluating the potential mechanisms and providing some explanation for this increased risk (Machaalani, Say, & Waters, 2011).
Nicotine is neurotoxic and can have effects on fetal development that impair neuronal pathways in the brain. Nicotine can further have an effect on fetal central nervous system activity and development, as well as cardiovascular autonomic maturation during pregnancy (Thiriez et al., 2009). Exposure as a fetus and/or neonate can have long-term central nervous system consequences (Lavezzi et al., 2012). Maternal nicotine use, both prenatal and postnatal, also has effects on infant arousal, both CA and sub-cortical arousal (Richardson et al., 2009). Nicotine readily crossed the placenta; levels in fetal cord blood have generally been 15% higher than levels in maternal blood. Maternal use of nicotine during pregnancy can cause fetal hypoxia by a reduction in uterine blood flow and thus a reduced supply of oxygen and nutrients for the fetus (Thiriez et al., 2009). Nicotine also readily crosses into breast milk (Lavezzi et al., 2012).

A common focus of nicotine/SIDS research is focused on the brain. Researchers have studied the brains of SIDS and non-SIDS infants with prenatal nicotine exposure and without prenatal nicotine exposure looking for differences to show the effects of nicotine exposure to fetal brain development. Machaalani et al. (2011) focused to evaluate the effects of prenatal cigarette use on the immunohistochemical expression of \( \alpha_7 \) and \( \beta_2 \) nicotinic receptor subunits in the brainstem nuclei of SIDS infants compared to non-SIDS infants. They found changes in the \( \alpha_7 \) and \( \beta_2 \) nicotinic receptor subunits of SIDS infants with a history of cigarette smoke exposure compared to infants without exposure. The areas of focus within the brainstem control respiration and arousal (Machaalani et al., 2011). The area postrema is a small protuberance in the inferior portion of the fourth ventricle that has involvement in autonomic control of cardiovascular and respiratory activities. The area postrema is more commonly known as a chemoreceptor trigger zone that induces the emetic reflex in the presence of noxious chemical
stimulation. Under histological and immunohistochemical evaluation, the area postrema has had alterations in SIDS cases compared to age-matched controls. The changes were found significantly related to maternal nicotine use, specifically smoking during pregnancy (Lavezzi et al., 2012).

Primates have also been studied to further evaluate the effects of nicotine exposure in the serotonergic (5-HT) system in the medulla oblongata. SIDS infants have 5-HT abnormalities, but a baboon model was used to test the hypothesis that prenatal nicotine exposure is responsible for 5-HT abnormalities. Baboons were chosen because of their similarities to humans in pregnancy physiology, placental function, and brain/neurobehavioral development. The baboon model showed alterations in 5-HT when there was chronic exposure to nicotine at levels equivalent to levels a pregnant woman would have in the afternoon smoking an average of 15 cigarettes per day or wearing a 22 mg/day nicotine patch. The researchers also found increased HRV in the prenatal exposure of fetal baboons (Duncan et al., 2009). This correlates with other studies where infants who have increased HRV having a higher risk of SIDS. The baboon study adds to our knowledge about prenatal nicotine exposure by providing a biologically plausible mechanism for the increased risk of SIDS.

Similarly, a large infant dataset was used to evaluate abnormal 5-HT expression in SIDS and non-SIDS infants. This particular study focused on the serotonergic receptor subtype 1A (5HT1AR) because it appears to be one of the main subtypes involved in brain development. SIDS and non-SIDS infants were evaluated for 5HT1AR changes. The findings were consistent with the baboon model where there were alterations significant to prenatal nicotine exposure in SIDS victims (Machaalani, Say, & Waters, 2009).
Recommendations for Prevention

Figure 3 represents recommendations for prevention of SIDS. This model was designed based on literature review and factors identified by the AAP, CDC, and NICHD.

FIGURE 3. SIDS Recommendations for Prevention.

Supine Sleeping Position

Supine sleeping is the most commonly known method of prevention for SIDS. Since the Back to Sleep program in 1992, SIDS rates have declined and correlate with the promotion of infants sleeping supine for every sleep. From 1992 to 2001 the prevalence of supine sleeping increased 59%. The prevalence of supine sleeping has been consistent from 2001 to 2010, staying around 75%. While the exact reason other sleep positions pose a risk is unknown, data has shown that supine sleeping decreases the risk of SIDS (Task Force on SIDS, 2011a). Premature and LBW infants are placed prone in the neonatal intensive care unit (NICU) primarily for developmental reasons. This can cause confusion to the parents because they see
the medical staff using the prone position routinely. It is important to transition NICU infants to supine prior to discharge and explain to families why they should continue to position their infant supine at home (McMullen, 2013). Parents of infants with gastroesophageal reflux are concerned about their infant vomiting and choking or aspirating. There has been no evidence supporting an increased risk of aspiration in a supine sleeping position (Task Force on SIDS, 2011a).

**Firm Sleep Surface, No Soft Bedding**

The ideal sleep surface is a firm mattress only covered with a fitted sheet, no blankets, pillows, soft toys, quilts, or bumper pads (Ajao et al., 2011). Soft bedding and soft items sleeping with the infant pose a risk for gas dispersal, CO₂ rebreathing, head covering, and increase the risk of SIDS 5-fold, 21-fold if the infant is prone (Task Force on SIDS, 2011a; Moon & Fu, 2012). Parental beliefs are a barrier to infants sleeping on a proper surface and environment. Parents mistakenly believe that their infant’s bed is safer and more comfortable with soft bedding, blankets, and bumper pads. They also believe their infant will sleep better in this softer environment than on a firm surface with no soft bedding (Ajao et al., 2011). Current recommendations by the AAP are to sleep in a crib, bassinet, or portable crib/play yard that meets consumer safety standards, using a mattress designed specifically for the item being used, covering the mattress with a fitted sheet, and having no additional items in the sleep area with the infant. Routine sleeping should also not occur in car safety seats, strollers, swings, infant carriers, and infant slings. If an infant falls asleep in one of these sitting devices, they should be moved to their usual sleep area (Task Force on SIDS, 2011b).
Avoid Overheating During Sleep

As stated previously, thermoregulatory changes have been linked to increase the risk of SIDS. Many SIDS infants are found in atypically warm environments, with overly warm clothing and bedding, and have higher than normal temperatures upon clinical exam (Ammari et al., 2009). Prone sleeping is also associated with increased temperature during sleep than supine sleeping. It is recommended that appropriate infant clothing should be used that is sufficient to keep the infant warm for the environment without overheating or causing any potential hazard of head covering or entrapment. There currently is not sufficient data to state a specific room temperature guideline to avoid overheating. There also is insufficient evidence regarding the use of a fan (Task Force on SIDS, 2011b).

Use of Pacifier

Pacifier use has been shown to decrease the incidence of SIDS, though the mechanism is unclear (Moon et al., 2012; Task Force on SIDS, 2011b). Infants who used a pacifier during their last sleep had a decreased risk for SIDS. One study found that pacifier use reduced the risk of SIDS by about 70%. Pacifier use is more protective for infants sleeping in adverse environments such as bed-sharing or side/prone sleeping (Moon et al., 2012). It is recommended that infants be offered a pacifier at nap time and bedtime. If the pacifier falls out after the infant is asleep it is not necessary to reinsert; the protective effect of pacifier use has been shown to sustain the sleep even if the pacifier falls out. However, the pacifier should not be attached to any cord or stuffed toys as this may pose a risk of harm to the infant (Task Force on SIDS, 2011b).
Avoid the Use of Commercial Positioners

Commercial positioner devices will claim to reduce the risk for SIDS, suffocation, or gastroesophageal reflux; however, they are unsafe and unreliable devices. From 1997 to 2011 there were 13 cases reported to the US Consumer Product Safety Commission (CPSC) of infant deaths related to sleep positioners (Lawrence et al., 2012). In 2010 the US CPSC and Food and Drug Administration (FDA) made a news release warning consumers against the use of infant sleep positioners. They reported that sleep positioners are a risk for infant suffocation after rolling from the positioner (CPSC, 2010). The position of the AAP is that sleep positioners should not be used and that they are not needed for infants to maintain a supine sleeping position. They are usually made from soft, compressible materials which increases the risk of suffocation (Task Force on SIDS, 2011a). Infants simply should be placed supine to sleep, if they are developmentally able to roll to their side or prone they need not be repositioned after rolling and a sleep positioner is not needed to keep any infant supine (Task Force on SIDS, 2011a).

Room-Sharing Without Bed-Sharing

Bed-sharing has been found to be an increased risk for SIDS though it is common practice in many cultures and is associated with increased breastfeeding (Weber, Risdon, Ashworth, Malone, & Sebire, 2012; Wong et al., 2011). Variables such as parental alcohol consumption or tobacco use and infant illness increase the risk of SIDS during bed-sharing (Phillips et al., 2010; Venneman et al., 2012). Parents are encouraged to room-share with their infant without bed-sharing. The definition of this concept is the parent and infant sleeping in the same room, but each in their own sleep space with the infant’s sleep space positioned close to the parents’ bed (Task Force on SIDS, 2011a). This sleep arrangement allows for close proximity of
the infant for monitoring and feedings while maintaining a safe sleep environment (Task Force on SIDS, 2011b).

**Routine Immunizations**

Overall vaccinations are an effective disease prevention measure (Kuhnert et al., 2012). Literature has been mixed about vaccines having no relationship to SIDS and being protective against SIDS. A meta-analysis found that the risk of SIDS could be reduced by as much as half with immunizations. Evidence shows no causal relationship between routine immunization and SIDS, but does support that routine immunizations may have a protective effect against SIDS (Vennemann, Hoffgen, Bajanowski, Hense, & Mitchell, 2007). In a more recent article, researchers conduct a reanalysis of previously published case-control studies examining the cases during different time periods after vaccinations. They found the risk of SIDS to be reduced in all evaluated time periods after vaccination and that the risk of SIDS is higher in unvaccinated infants (Kuhnert et al., 2012). The AAP continues to promote and support routine vaccinations as a method to reduce the risk of SIDS (Task Force on SIDS, 2011b).

**Breastfeeding**

As stated previously, breastfeeding is a protective factor and can decrease the risk of SIDS by about 50%. This protective effect lasts as long as breastfeeding continues and is independent of sleep position (Vennemann et al., 2009). Physiologic sleep studies have shown that breastfed infants are more arousable from sleep than formula fed infants. The protective effect of breastfeeding increases with exclusivity, but any breastfeeding provides some protection (Task Force on SIDS, 2011a). Breastfeeding also has many other health benefits as discussed previously, both for the infant and the mother. Mothers should be encouraged to
exclusively breastfeed for at least 6 months per recommendations by the AAP. After 6 months of exclusivity, solid foods should be added to the infant’s diet along with the continuation of breastfeeding for 1 year or longer. An interesting calculation is that if 90% of mothers exclusively breastfed for 6 months, 900 infant lives would be saved per year from SIDS (Eidelman & Schanler, 2012).

Avoid Exposure to Nicotine

Fetal and infant nicotine exposure has been strongly linked to increasing the risk of SIDS and is the second most modifiable risk factor after sleep position (Duncan et al., 2009). Mothers should avoid using nicotine products while pregnant, breastfeeding, and after the infant is born. As discussed in the SIDS Risk Factors section, there are many physiological effects that nicotine can have on the fetus and infant which can lead to an increased risk for SIDS. Nicotine can cross the placenta and breast milk (Thiriez et al., 2009; Lavezzi et al., 2012). Nicotine is also neurotoxic and can effect fetal development of neuronal pathways in the brain, central nervous system activity and development, and cardiovascular autonomic maturation (Thiriez et al., 2009). Maternal nicotine use, specifically smoking traditional cigarettes, has been associated with impaired arousal processes in infancy which may increase the risk of SIDS (Richardson et al., 2009).

Pregnant women should also avoid exposing themselves to second hand smoke from other people smoking traditional cigarettes. Second hand smoke has also been related to adverse effects on fetal and neonatal health; there is no risk-free amount of second hand smoke exposure, any amount can be harmful. Individuals who live with a person smoking traditional cigarettes are found to have cotinine levels ≥0.05 ng/mL (Kaufmann et al., 2010). The most common source of
second hand smoke for a pregnant woman is her partner. This is more likely of pregnant women who smoke traditional cigarettes or are trying to quit versus nonsmoking pregnant women. Overall, pregnant smokers of traditional cigarettes are more likely to be exposed to second hand smoke compared to nonsmokers. Women who are attempting cessation will be more successful if they do not have a partner who smokes traditional cigarettes. Women with partners who smoke traditional cigarettes are much less likely to be successful in cessation or reducing their use of traditional cigarettes (Eiden et al., 2011). Interesting too is that if women have a partner who uses traditional cigarettes, it does not matter if he smokes in the home or outside because hair samples from the woman shows higher nicotine levels than women with nonsmoking partners. Having a partner who uses traditional cigarettes outside is better than inside, but it does not eliminate second hand exposure (Yoo et al., 2010).

**Nicotine Sources**

Nicotine is a highly addictive substance found in tobacco products, electronic cigarettes, and nicotine replacement therapies. Tobacco products have been used in the US for over 100 years while electronic cigarettes are a relatively new method for nicotine use (Appleton, 2011). Additional nicotine products are marketed for nicotine cessation. This section will discuss common sources of nicotine.

**Traditional Sources**

Nicotine is most commonly found in traditional tobacco cigarettes, but cigars, pipes, smokeless tobacco, and roll-your-own tobacco are other sources (O’Connor, 2012). Tobacco intended for human consumption is regulated by the FDA under the Family Smoking Prevention and Tobacco Control Act, or more commonly the Tobacco Control Act which became law on
June 22, 2009. Under the Tobacco Control Act, the FDA has the authority to regulate the manufacture, distribution, and marketing of tobacco products, this includes cigarettes, smokeless tobacco products, and roll-your-own tobacco. Under the Tobacco Control Act companies are required to provide the FDA with a list of ingredients and notify the FDA of any changes in ingredients. Before the Tobacco Control Act, companies were not required to notify of ingredient changes and could do so without consumers or the public knowing (Husten & Deyton, 2013). An average traditional cigarette contains 1 to 3 mg of nicotine, a person smoking a pack-per-day will absorb between 20 to 40 mg of nicotine each day (Stead et al., 2012). Cigars are typically 10 to 20 times more potent than traditional cigarettes. Average nicotine for snuff and chewing tobacco, both smokeless tobacco products, are 3.6mg and 4.5mg respectively (Solarino, Rosenbaum, Riebelman, Buschmann, & Tsokos, 2010).

**Electronic Cigarettes**

Electronic cigarettes, also known as e-cigarettes, are essentially nicotine inhalers which contain nicotine in disposable or refillable cartridges. Traditional cigarettes use combustion to inhale nicotine; e-cigarettes are battery operated and use heat in the cartridge to produce a nicotine vapor (Goniewicz et al., 2014). E-cigarette liquid typically contains nicotine, an aerosolizing agent such as propylene glycol or glycerol, and flavorings (Corey et al., 2013). E-cigarettes have been on the US market since 2007 and there has been concern and controversy ever since. E-cigarettes are marketed as a safe, more cost effective and, more socially acceptable alternative to traditional cigarettes; some even market as a method for cessation (Regan, Promoff, Dube, & Arrazola, 2013). According to data from Campaign for Tobacco-Free Kids.org, the average retail price per pack of traditional cigarettes including all taxes ranges from
$4.20 to $10.11 nationwide (Boonn, 2013). It is difficult to compare traditional cigarette cost to e-cigarette cost because of the variety in e-cigarette manufactures, cartridges, and liquid. Liquids vary based on nicotine content, flavors, volume, and concentration. Many e-cigarette distributors claim they are free of toxic chemicals that are found in traditional cigarettes. This claim has limited scientific evidence. One study analyzed 12 brands of e-cigarettes and tested for selected toxic compounds that are commonly found in traditional cigarettes. The results showed that toxins in e-cigarettes were 9 to 450 times lower than traditional cigarettes though they were present (Goniewicz et al., 2014). Another study evaluated several brands for their level of nicotine delivery which varies greatly depending on manufacturer and product content. Research is limited on e-cigarette safety, health effects, or cessation properties (Pepper & Brewer, 2013).

Unfortunately, there currently is no FDA control on e-cigarette products and the future of regulation is yet to be known. There are many manufactures and models of the devices, and the liquids vary greatly. There is no standardization or quality control on the devices or the liquids. There is a growing body of research on this topic, but more is needed. A challenge of e-cigarette research stems from the lack of control and consistency of the devices and contents. The devices and contents can change without warning and are varied between manufactures and models such that research may be difficult to generalize or may already be outdated by the time it gets to publication (Etter et al., 2011). Further, when using the search terms “electronic cigarette” and “pregnancy” in PubMed, one study in Alaska Native women was found for the use of traditional cigarettes and e-cigarettes versus no nicotine use during pregnancy. The study evaluated the three groups to measure potential differences in birth weight, crown-heel length, and head circumference. They found a modest, but non-significant difference in birth weight of infants
born to mothers who used e-cigarettes compared to those born to mothers who did not use nicotine (England et al., 2012). This supports the idea that e-cigarette research is lacking tremendously in the prenatal population and little is known about the risks and consequences of fetal exposure.

Data is limited on e-cigarette use rates and patterns; most information to date is based on surveys. One survey reported an increased awareness of e-cigarette products from 16.4% in 2009 to 32.2% in 2010, with the largest increase of awareness in current traditional cigarette smokers. Rates of adults using e-cigarettes in the past month prior to the survey more than quadrupled in the same time span, increasing from 0.6% to 2.7%. In this survey, current traditional cigarette smokers were 2.5 more likely than never-traditional cigarette smokers to have heard of e-cigarettes and were nearly 6 times as likely to have tried the product (Regan et al., 2013).

Alarming is the increase of e-cigarette use among middle and high school students from 2011 to 2012. E-cigarette ever use among students in grades 6 to 12 increased from 3.3% to 6.8% and current use increased from 1.1% to 2.1%. Ever use rates among middle school student increased from 1.4% to 2.7% while current use increased from 0.6% to 1.1%. Ever use rates among high school students increased from 4.7% to 10.0% while current use increased from 1.5% to 2.8%.

Many of the students who reported ever use of e-cigarettes in the survey had never used traditional cigarettes (Corey et al., 2013). Unfortunately, along with lack of regulation on the products is lack of regulation on their sales. Many states have no regulation of selling e-cigarettes to minors (Chatham-Stevens et al., 2014).

Research on secondhand exposure to e-cigarette vapors is limited, but studies have found the vapors are not benign. Czogala et al. (2013) reported that e-cigarette secondhand exposure
contains nicotine. One challenge is the level of nicotine from e-cigarette vapor exposure varies on the e-cigarette brand and nicotine level of the e-cigarette liquid. Overall, the levels are significantly less than the secondhand smoke emitted from traditional cigarettes (Czogala et al., 2013). Another study evaluated particulate matter, particle number concentration, volatile organic compounds, polycyclic aromatic hydrocarbons, carbonyls, and metals of e-cigarette vapors. All components were increased compared to controls. This study also confirmed that e-cigarette vapors are not emission-free (Schober et al., 2013). Further research is needed to evaluate the cotinine and nicotine levels of persons exposed to e-cigarette vapors.

**Nicotine Replacement Therapy**

Nicotine replacement therapy (NRT) is a pharmacotherapy used in cessation programs. NRT is available as gum, transdermal patch, nasal spray, inhaler, and sublingual tablets/lozenges. NRT temporarily replaces nicotine from cigarette smoking to transition people from cigarette smoking to cessation. The use of NRT increases the rate of cessation by 50 to 70%. Nicotine replacement products are all formulated to be absorbed through the skin or through the oral or nasal mucosa. Nicotine pills would be ineffective because of first pass metabolism in the liver. Transdermal patches are available in doses between 5 mg and 52.5 mg of nicotine per 24 hour period. Transdermal patches deliver nicotine doses slowly and passively, typically over 24 hours and are changed daily. Nicotine gum is available in 2 mg and 4 mg strengths, nicotine lozenges are available in 1 mg, 1.5 mg, 2 mg, and 4 mg strengths. With gum and lozenges the amount of nicotine absorbed is less than the original dose (Stead et al., 2012). A 4 mg piece of nicotine gum will be absorbed to approximately 2.2 mg of nicotine with proper use. A 4 mg lozenge will be absorbed to approximately 3.2 mg of nicotine with proper use. Nasal
spray delivers in 0.5 mg nicotine actuations. After a 1 mg dose, approximately 0.7 mg of nicotine is absorbed (Hudmon, Corelli, & Prokhorov, 2010).

**Nicotine Concerns**

Nicotine is not a safe substance. Nicotine is the cause of many preventable health problems and concerns in adults as well as children in the US. Nicotine acts on the parasympathetic and sympathetic nervous system; the central nervous system is stimulated by small doses and depressed by large doses (Solarino et al., 2010). This section will discuss nicotine as a harmful and toxic substance.

**Nicotine and Pregnancy**

It is well documented that maternal nicotine use during and after pregnancy is a risk factor for SIDS. Women should be educated that nicotine is harmful to their fetus/infant for the risk of SIDS as well as other maternal and fetal complications during pregnancy. Not only is it a modifiable risk factor for SIDS, it is the most modifiable cause of poor pregnancy outcomes (American College of Obstetricians and Gynecologist [ACOG], 2010). Nicotine is transferred to the fetus via the placenta where levels peak 15 to 30 minutes after a mother consumes nicotine. Much of the nicotine is returned to the mother’s circulation for elimination, but a certain amount is excreted by the fetus into the amniotic fluid. Consequently, the fetus is exposed to nicotine after maternal blood levels have decreased (Maritz, 2009). The use of nicotine during pregnancy has an adverse effect on placental development. This is significant because the placenta is responsible for the transfer of nutrients and oxygen to the fetus. With nicotine use there is a decrease in nutrient and oxygen transfer to the fetus which can result in premature delivery, intrauterine growth restriction, and microcephaly (Blood-Siegfried & Rende, 2010). Prenatal
nicotine use also increases the risk for abruption of the placenta, ectopic pregnancy, and preterm premature rupture of the membrane. Women who use nicotine during pregnancy are 2 to 3 times more likely to deliver a LBW infant than women who do not use nicotine during pregnancy. Additionally, the risk of stillbirth and intrapartum fetal death is increased with nicotine use (Murin, Rafii, & Bilello, 2011). The use of nicotine during pregnancy results in developmental changes in the fetus and long-term sequelae in childhood.

Prenatal nicotine exposure results in multiple health problems for infants and children. It has developmental effects on the central nervous system. Offspring of women who use nicotine during pregnancy may have long-term developmental effects on learning, memory, and attention, as well as increased rates of mood and conduct disorders. Attention-deficit disorder/hyperactivity is increased in children whose mother used nicotine during pregnancy. Prenatal nicotine use is also associated with children being overweight (Murin et al., 2011).

The challenge is getting women to quit smoking, preferably before they become pregnant. Reports vary about the percentage of women who attempt to quit smoking either before or during pregnancy, ranging from 45% to 75% depending on the report (ACOG, 2010; Ashwin & Watts, 2010). The Pregnancy Risk Assessment Monitoring System (PRAMS) is “a state- and population-based surveillance system designed to monitor selected maternal behaviors and experiences that occur before, during, and after pregnancy among females who deliver live-born infants in the US” (Tong et al., 2013, p. 1). Based on PRAMS data, between 2000 and 2010 none of the 40 participating sites met the Healthy People 2020 goal to reduce prenatal smoking prevalence to 1.4%, though some sites did report decreases. In 10 PRAMS sites, there were
significant decreases in the prevalence of smoking during pregnancy (from 13.3% to 12.3%) (Tong et al., 2013).

The literature is undecided about the safety of NRT during pregnancy. ACOG committee opinion concludes that there is not enough evidence to support the efficacy or safety of NRT use in pregnancy. Trials studying NRT in pregnancy are difficult to accomplish and many of the ones that have been conducted have been stopped by data and safety monitoring committees. A recent study examined cotinine levels generated in pregnant women using NRT transdermal patches versus cotinine levels while smoking cigarettes. The study concluded that cotinine levels from NRT transdermal patches are less than those generated by smoking cigarettes. The results indicate that a standard dose NRT may not be enough to effectively help women quit smoking cigarettes during pregnancy (Bowker, Lewis, Colemen, Vaz, & Cooper, 2014). ACOG recommends that NRT be used after careful consideration by the patient and physician weighing the benefits and risks and under close monitoring. Other cessation techniques include counseling, cognitive and behavioral therapy, hypnosis, and acupuncture. Nicotine addiction and dependence is physiologic and psychologic and may require multiple techniques (ACOG, 2010).

**Nicotine and Children**

There have been incidences of children ingesting nicotine through conventional and novel tobacco products. In terms of overall childhood ingestions, nicotine is low on the list in annual reports by the American Associate of Poison Control Centers. Still, ingestions occur annually, most by infants less than 1 year of age and can be potentially fatal (Connolly et al., 2010). Historically children have ingested various forms of nicotine including traditional cigarettes, chew tobacco, cigars, snuff, and e-cigarette liquid. A lethal dose of nicotine in adults
ranges from 0.5 to 1 mg/kg of body weight though toxic symptoms can be seen at lower doses (Solarino et al., 2010). A lethal dose of nicotine in children is estimated at 1 mg/kg of body weight (Connolly et al., 2010). Nicotine toxicity can cause nausea, vomiting, increased, salivation, dizziness, headache, vision or hearing changes, seizure, cardiovascular complications, respiratory failure, and central nervous system changes (Solarino et al., 2010). Children can have toxicity symptoms from ingesting as little as 1 mg of nicotine (Connolly et al., 2010). The CDC recently conducted a study analyzing data from US poison centers of human exposures to e-cigarettes from September 2010 to February 2014. E-cigarette exposure calls to poison centers have increased drastically during this time, from 0.3% in September 2010 to 41.7% in February 2014. This equates to one call in September 2010 and 215 calls in February 2014. E-cigarette exposures were more likely to have adverse health effects compared to traditional cigarette exposure calls. E-cigarette exposures most commonly caused contact dermatitis, vomiting, nausea, and eye irritation (Schober et al., 2013; Chatham-Stevens et al., 2014). Spilling e-cigarette liquid onto the skin can also cause toxicity symptoms (Schober et al., 2013). With all this data in mind, all nicotine containing products should be kept out of the reach of children. Products should be sold in child-safe containers. Continued research is needed for additional evidence of the health risks associated with e-cigarette use and secondhand exposure.

**Conclusion**

This chapter discussed SIDS risk factors and recommendations for prevention. A particular focus was the relation of nicotine and SIDS, discussing the strong link between nicotine exposure in fetuses and infants and the increased risk of SIDS. Also discussed in this chapter were nicotine sources, both traditional and non-traditional, including the recent market of
e-cigarettes. Also discussed was nicotine as a health concern and focused this concern to pregnant women and children.
CHAPTER THREE: METHODS

Introduction

This chapter will focus on the need for an intervention to educate pregnant women and mothers with infants less than 12 months of age about nicotine use as a significant risk factor for SIDS. The HBM was used as a framework for education. In this chapter, the HBM will be defined and outlined in terms of SIDS. Through the application of the HBM, an educational brochure was created to inform the stated population nicotine use and SIDS.

A Need for Education

Over the years much has been learned about SIDS and risk factors for prevention. Unfortunately not all risk factors are modifiable, but many are and parents need to know ways to potentially protect their infants from SIDS. Ultimately education is key. We found through the Back to Sleep campaign that with education parents could and would change their practice of how they put their infant to sleep. SIDS deaths dropped from 120 deaths per 100,000 live births to 55 deaths per 100,000 live births from 1992 to 2001. Additionally, the prevalence of supine sleeping from 2001 to 2010 has consistently been 75% (Task Force on SIDS, 2011a). Healthcare providers are instrumental in providing education to families about the effects of tobacco and nicotine use on the health of their infant and the risk of SIDS. In a study surveying families about the sleep position of their infant, one third of mothers reported positive advice from their provider regarding supine sleep position, one third reported negative advice, and one third reported receiving no advice. The mothers who received positive advice were three times more likely to report the supine position as the usual sleep position of their infant compared to the mothers who received negative advice and no advice (Colson et al., 2012). This supports the idea
that education is instrumental in behavioral changes of parents. Some may not know the risk that nicotine exposure has on their fetus and infant, but if they did they may be motivated to change their habit for the benefit of their child.

**Framework**

The HBM was developed in the 1950s by social psychologists to conceptualize why screening programs within the US Public Health Service were being under-utilized (Janz & Becker, 1984; Galvin, 1992). The original model, Figure 4, consisted of four dimensions: *perceived susceptibility, perceived severity, perceived benefits, and perceived barriers*. Since then *demographic variables, cues to action, and self-efficacy* have been included into the model (Janz & Becker, 1984).

![FIGURE 4. Health Belief Model. (Recreated from Becker & Maiman, 1975.)](image-url)
Dimensions Defined

Perceived susceptibility. *Perceived susceptibility* is an individual’s perception of the likelihood in experiencing illness, injury, or disease. The more an individual perceives they are at risk, the more likely they are to engage in behaviors to decrease their risk. An example would be vaccinations. The more a person feels they are susceptible to a vaccine preventable disease, the more likely they are to become vaccinated. Just as conversely, if they feel unlikely to contract a disease they are less likely to become vaccinated (Cao et al., 2014).

*Perceived susceptibility* in the context of SIDS is the mother’s own perception of the likelihood that their child is at risk for or could succumb to SIDS. *Perceived susceptibility* is a strong determinant for the likelihood of the mother engaging in SIDS modifiable actions such as placing her infant supine to sleep and not using nicotine products. Does she even believe that SIDS could happen to her infant? If not, she has little motivation for change believing that SIDS will not happen anyways.

Perceived severity. *Perceived severity* is an individual’s perception of the seriousness or severity of a potential illness, injury, or disease. This includes dimensions of medical/clinical consequences and emotional/social consequences (Janz & Becker, 1984). Consequences could include pain, discomfort, disability, and death, loss of employment, financial burden, emotional distress, and stress to family unit (Janz & Becker, 1984; Cao et al., 2014).

*Perceived severity* in the context of SIDS is the belief the mother holds regarding the effects she would sustain if SIDS occurred. Obviously from a medical dimension SIDS would cause death of the infant. Emotional/social consequences would be a burden to the mother and
her family. *Perceived severity* also encompasses mother’s belief of SIDS. Does she believe that SIDS is a real health concern in our modern first-world society?

**Perceived benefit.** *Perceived benefit* is an individual’s perception that taking action will be useful in preventing illness, injury, or disease. It is the value or worth an individual holds to a particular action or intervention to be beneficial, feasible, and efficacious (Janz & Becker, 1984). Health screening exams such as for cervical cancer and colon cancer are examples. A woman is more likely to have cervical cancer screening performed if she believes the test is reliable to detect cancer, believes cancer can be detected prior to clinical symptoms, and believes that if caught early it is treatable with favorable prognosis (Becker & Maiman, 1975).

*Perceived benefit* is how useful the mother believes that modifiable actions will decrease her infant’s risk of SIDS. How well does she believe that nicotine cessation will improve the health of her fetus and/or infant? How well does she believe this will aid in preventing SIDS occurrence? Mothers will be more likely to engage in preventative behaviors if they truly believe the actions will promote the health of their fetus and/or infant and prevent SIDS.

**Perceived barriers.** *Perceived barriers* are the individual’s perception of the potential negative aspects and obstacles of a health intervention or behavior. Change is not usually easy and individuals will analyze if an action will be inconvenient, expensive, unpleasant, distressing, or painful. Based on this analysis an individual may decide an action is not worth the benefit over the barriers (Cao et al., 2014; Roden, 2004).

*Perceived barriers* in the context of SIDS are the mother’s view of the obstacles in the way of adopting a new behavior. In the scope of nicotine cessation to decrease the risk of SIDS and other health effects, how difficult would it be to stop using nicotine products? What would
be the personal barrier to cessation of nicotine? The mother will consider a personal cost-benefit analysis where she may ask herself what it would take to begin cessation, the side effects and unpleasant feelings they may have during the cessation process, and how inconvenient is the process of cessation? If she has friends or family who use nicotine products she will consider how would this be a barrier to her own cessation.

Demographic variables. Demographic variables include personal variables such as parental age, sex, education level, culture, socioeconomic status, past experience, social influence, and motivation (Becker & Maiman, 1975; Roden, 2004). Based on these variables mother’s will have differing viewpoints about SIDS and nicotine cessation. A mother who has lost a previous child to SIDS has a very different past experience modifying variable than a mother who barely knows the term SIDS.

Cues to action. Cues to action also influence behavior. Cues to action are the stimulus to move people to change a behavior, i.e. events, people, things that influence the parent’s behavioral change. Examples of cues include prior education or experience, symptoms, media sources such as television, social networking, and newspapers, advice from a health care provider or others, and mass media campaigns promoting a health topic (Janz & Becker, 1984).

Self-efficacy. Self-efficacy is an individual’s own belief in their ability to implement a health behavior change. Does an individual believe they can successfully lose weight? Do they believe they can eat nutritious food and maintain a healthy lifestyle? People who do not believe they can do something are unlikely to make behavior changes (Rosenstock, Strecher, & Becker, 1988).
Self-efficacy in the context of SIDS is how well the mother believes she can successfully participate in a nicotine cessation program. She is not likely to attempt cessation if she does not have the belief in herself that she actually could succeed.

The HBM is an appropriate model to serve as a framework for SIDS and nicotine education. It has previously been used effectively to promote behavior changes for health promotion and is appropriate for the application of SIDS (Cao et al., 2014). The current project used the HBM to develop an educational brochure in order to promote maternal awareness that the use of nicotine is a significant modifiable risk factor for SIDS.

Implementation of Brochure

Written education materials, such as brochures, are an effective way to increase knowledge and awareness of a health topic, but are best when they have a theoretical and empirical research basis (Perry et al., 2012; Whittingham et al., 2008). During brochure design it is important to be aware of content, readability, and overall appearance (Rodriguez, 2014). An educational brochure was created as an interventional tool to provide education regarding nicotine and SIDS. According to adult education theories, adults are interested in information that helps them improve their well-being. Print material such as a brochure can be an effective method for educating and creating awareness to the public about health behaviors. Nurse practitioners often educate patients and families with verbal communication. Written material can be used to supplement verbal communication and improve the effectiveness of education by maximizing knowledge and adherence of positive health behaviors (Hoffman & Worrall, 2004). A brochure will be a useful tool to supplement the verbal education a nurse practitioner will provide regarding nicotine and SIDS. A brochure is advantageous because it provides a
consistent message that the learner can look back upon and re-read, it is portable and easy to deliver, and it is economical to produce and update (Hoffmann & Worrall, 2004). The HBM was used as a framework for brochure design. The HBM and its application to brochure design will be discussed in Chapter 4.

**Conclusion**

This chapter discussed the need for public education of nicotine use and SIDS. The HBM was presented as a framework for developing a brochure for SIDS education. Each of the HBM dimensions were defined and applied to SIDS. The use of a brochure or written material for health education was presented.
CHAPTER FOUR: DESIGN OF BROCHURE

Introduction

This chapter will discuss the design of the brochure through the use of the HBM. It will outline how each dimension of the HBM was applied in the brochure. It will also discuss considerations that should be made when making a brochure and detail how the brochure was designed.

Brochure Design

The HBM is a widely used health framework. It is used to explain health behavior modifications and is used as a foundation for education interventions (Kloeblen & Batish, 1999). The model has successfully been applied to explain preventative health behaviors and provide health education. The HBM has previously been evaluated and applied as a model for traditional cigarette smoking cessation. The HBM has also been applied to nutritional education for pregnant women (Sharifirad et al., 2013; Kloeblen & Batish, 1999). In addition, the model has been applied to educate pregnant women about the harmful effects of environmental tobacco smoke exposure and with pregnant women to examine the effects of health education regarding having a smoke free home (Kazemi, Ehsanpour, & Nekoei-Zahraei, 2012; Kazemi et al., 2011). No known study to date has applied the HBM to educate pregnant women and mothers of infants on the impact and risks of using nicotine as they relate to SIDS.

Health education can change health belief. Health education with pregnant mothers and mothers of infants is unique because the woman is not only concerned for her own health, she is also concerned for the health of her child. Based on the HBM, a pregnant woman or mother is more likely to be cautious of her behavior if she thinks or feels her fetus or infant is susceptible
to harm or inadequate health based on her actions (Kazemi et al., 2011). Health education can change her belief of how her actions affect her child. The goal of applying the HBM to pregnant women and mothers of infants is to educate about the effects of nicotine use and exposure on SIDS risk with the intent that women will decrease or discontinue use and second-hand exposure to nicotine following education.

An educational brochure was designed and created using the HBM framework. Education followed the HBM framework by providing information to support the framework’s dimensions. Information directed towards perceived susceptibility includes statistics about the number of SIDS deaths annually. Information directed towards perceived severity includes statements about how SIDS is a preventable occurrence but causes significant emotional and social consequences to families who fall victim. Information directed towards perceived benefit includes how valuable it could be to a fetus or infant’s health for their mother to abstain from nicotine. Information about perceived barriers acknowledges that nicotine addiction is difficult, but possible and worth the health benefits to the mother, fetus, and infant. Information directed towards self-efficacy provides encouraging statements with the intent of making the mother believe she is capable of nicotine cessation success. The educational brochure in its entirety is intended to serve as a cue to action. Demographic variables are not addressed through the brochure as they are individual to each person and circumstance.

When creating a brochure, attention needs to be given to creating material in a manner that will be best comprehended by readers. There are many guides and articles available as resources for creating effective health education material. Generally speaking, a brochure needs to be easy to read and understand (Perry et al., 2012). More specifically, text coherence,
integration of text with pictures, and highlighting important areas of the text are ways to increase text comprehension (Whittingham et al., 2008). Text comprehension is related to how much the reader assimilates the text to their personal knowledge base. Readers use prior knowledge and experience to link text into memory. Text coherence is the logic and structure of the text at macro and micro levels. Macro-level is when topics and heading follow a logical order (Whittingham et al., 2008). The most important and useful information should be provided first (Hoffmann & Worrall, 2004). Micro-level is sentences within paragraphs having structure, connection, and flow from each sentence to the next. Illustrations combined with text have been shown to increase information comprehension and recall (Whittingham et al., 2008). However, if illustrations are not used appropriately they can distract the reader’s attention from the text. Each illustration should correspond with the text and communicate a single idea (Hoffmann & Worrall, 2004). Pop-out effects are a way to bring attention to specific areas in a text. When a reader scans a document these items would draw their attention. This can be achieved by changing the color, style, size, or shape of a text (Whittingham et al., 2008).

Further, the text needs to be written to be read by people with a range of literacy skills. It should be written at the lowest reading level possible to convey accurate information. It is suggested that health education material be written between a 5th and 6th grade reading level. Common words should be used, avoiding jargon. Text should be written in an active voice with a conversational style, adding the pronoun ‘you’ can assist in engaging the reader (Hoffman & Worrall, 2004). There are many ways that reading level can be determined and programs and tools available. Some tools include the Flesch-Kincaid Readability Test, the Fry Readability
Graph, the Gunning ‘FOG’ Readability Test, and the Simple Measure of Gobbledygook Readability Formula (CDC, 2009).

The above has all been considered when creating the brochure. The brochure was created using Microsoft Word, using a tri-fold brochure template for formatting convenience. Microsoft Word was chosen because of the wide availability of access for users to download and view the document, as well as the popularity of .doc files for printing services in the future. Microsoft Word is also beneficial because it has a functionality to calculate reading level and readability using the Flesch-Kincaid Readability Test. The text is Times New Roman, a Serif type font, recommended because Serif fonts are usually easier to read than Sans Serif fonts (CDC, 2009). Text font sizes range from 12 to 36 point, with headings being in larger font size than content text. Headings are bolded; text is bulleted and aligned with left justification. There are five pictures incorporated, a sleeping infant in a crib, an infant awake on his tummy up on his arms, a pregnant woman’s belly with pink and blue ribbons, a pregnant woman’s belly and the woman breaking a cigarette in half, and a burning cigarette. The Flesch-Kincaid Grade Level is 5.6, the Flesch Reading Ease is 73.5 and passive sentences are 0%.

Conclusion

This chapter discussed the appropriateness of using the HBM for SIDS and nicotine use education and how it has been used similarly for other health related education. It also discussed how health education can have positive impact on health belief and change health related actions and that an educational brochure was designed based on the dimensions of the HBM. Additionally, consideration for technical and formatting structure were outlined. The chapter was
concluded by detailing the program used for creating the brochure, formatting details, and overall readability scoring.
CHAPTER FIVE: EVALUATION

Evaluation of the brochure was conducted through the use of professional subject matter experts; people with recent use and knowledge of the HBM. A brief literature search was conducted searching for the use of the HBM in the context of nicotine or tobacco. The purpose of this search was to identify potential authors to contact to serve as subject matter experts in the use of the HBM. The subject matter experts evaluated the brochure based on the application of the HBM in the context of nicotine and tobacco.

Through this search Dr. Leslie Moore, PhD, Associate Professor of Nursing at Georgia College & State University, was identified as a candidate to serve as a subject matter expert. Dr. Moore was identified based on her publication “Smoking cessation in women at the time of an invasive cardiovascular procedure and 3 months later.” This article was published in 2013 with five additional authors in the Journal of Cardiovascular Nursing. Dr. Moore has co-published one additional article in 2010 also related to cardiac disease in women. Dr. Moore was contacted via email about serving as a subject matter expert for this DNP Project and graciously agreed. Her feedback was provided in written format via email. Dr. Moore was the first to provide feedback and she created the feedback format and table. Table 1 is Dr. Moore’s comments of the brochure.
<table>
<thead>
<tr>
<th>HBM Variable</th>
<th>How It is Applied</th>
<th>How Well It is Applied</th>
<th>Suggestions for Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived Susceptibility</td>
<td>Statements “Did you know SIDS happens more in infants whose mothers smoke or use nicotine,” “SIDS is real and it can happen to you! Nobody is exempt from SIDS; it can happen to any infant”, “Nicotine is the second highest risk factor for SIDS,” and “Infants of mothers who use nicotine products are 2 to 5 times more at risk of SIDS” provide clear information regarding how pregnant women’s smoking contributes to increased risk of SIDS.</td>
<td>Very well</td>
<td>None</td>
</tr>
<tr>
<td>Perceived Severity</td>
<td>Statements “Infants who smoke can die of SIDS” and “Your infant’s life depends on you quitting!” help pregnant women smokers understand that their smoking can cause their infant’s death.</td>
<td>Very Well</td>
<td>None</td>
</tr>
<tr>
<td>Perceived Benefit</td>
<td>Statements “You can help prevent SIDS” and “your infant’s life depends on you quitting!” are meant to increase pregnant women’s beliefs about the effectiveness of smoking cessation.</td>
<td>Very well</td>
<td>None</td>
</tr>
<tr>
<td>Perceived Barriers</td>
<td>Statements “Quitting can be hard, but it will be worth your infant’s health and possibly his/her life” and “It is okay if you need help. Most people cannot always quit on their own, so you may be more successful with help” indicate that difficulty in quitting and without help could be a cost of taking the recommended action of smoking cessation.</td>
<td>Very well</td>
<td>None</td>
</tr>
<tr>
<td>Perceived Self-Efficacy</td>
<td>Statements “You can help prevent SIDS,” “What can you do?” and “Believe in yourself to quit for your health and your infant’s health” are meant to increase women’s confidence in their ability to prevent SIDS and stop smoking.</td>
<td>Very well</td>
<td>None</td>
</tr>
<tr>
<td>Cue to Action</td>
<td>Brochure serves as a trigger to initiate smoking cessation in pregnant women.</td>
<td>Very well</td>
<td>Overall, the brochure appears very effective in making the case for smoking cessation in pregnant women. It is evident that the brochure is based on variables within the Health Belief Model.</td>
</tr>
</tbody>
</table>
Through the same search Dr. Mable Kinzie, PhD, Professor, Curry School of Education at University of Virginia, was identified as a candidate to serve as a subject matter expert. Dr. Kinzie was identified based on her publication “Instructional design strategies for health behavior change.” This article was published in 2005 in Patient Education and Counseling. Dr. Kinzie has published over 30 articles focused on education dating back to 1988. Dr. Kinzie was also contacted via email and graciously agreed to serve as a subject matter expert. Her feedback was provided in written format via email. The table created by Dr. Moore was used, but slightly modified per the request of Dr. Kinzie. Dr. Kinzie requested that the definitions of each HBM variable also be included in the table. She also added two additional rows: User interface design/Accessible design principles and Reading Level. Table 2 is Dr. Kinzie’s comments of the brochure.
<table>
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</table>
| **Perceived Susceptibility:** An individual’s perception of the likelihood in experiencing illness, injury, or disease. The more an individual perceives they are at risk, the more likely they are to engage in behaviors to decrease their risk. | • DID YOU KNOW?? Sudden Infant Death Syndrome happens more in infants whose mothers smoke or use nicotine  
• SIDS is real and it can happen to you! Nobody is exempt from SIDS; it can happen to any infant.  
• Infants of mothers who use nicotine products are 2 to 5 times more at risk of SIDS  
• Photographs depict pregnant individual chain smoking as well as vulnerable infants, reinforcing the perception of susceptibility. | Good  
Excellent  
Excellent  
Excellent | • The statement itself is effective, but the layout interferes with the ease with which it can be interpreted. |
| **Perceived Severity:** An individual’s perception of the seriousness or severity of a potential illness, injury, or disease. This includes dimensions of medical/clinical consequences and emotional/social consequences. Consequences could include pain, discomfort, disability, and death, loss of employment, financial burden, emotional distress, and stress to family unit. | • Infants who SMOKE… can DIE of SIDS  
• Sudden death of an infant less than 1-year of age that cannot be explained after a thorough investigation is conducted, including a complete autopsy, examination of death scene, and review of clinical history.  
• About 2,000 SIDS deaths occur every year. SIDS is the leading cause of death in infants 28 days to 12 months.  
• Nicotine is the second highest risk factor for SIDS. Sleep position is the highest risk factor.  
• Infants of mothers who use nicotine products are 2 to 5 times more at risk of SIDS | Fair  
Fair  
Excellent  
Excellent  
Excellent | • It is possible, especially in a low-literate population, that this analogy will not be understood. Be more explicit: If the mother smokes, the baby “smokes”  
• The definition is a little abstract and hard to interpret. Can you rephrase and be more direct (and lower the required reading level for this sentence)?  
• Excellent use of statistics. No improvement needed. |
| **Perceived Benefit:** An individual’s perception that taking action will be useful in preventing illness, injury, or disease. It is the value or worth an individual holds to a particular action or intervention to be beneficial, feasible, and efficacious. | • Not smoking or using nicotine products can lower your infant’s risk of SIDS. It can also improve your overall health.  
• Your infant's life depends on you quitting!! | Fair | • Be more specific about reductions in risk levels. Also state (if it is known) how quickly the risk levels can drop. In other words, counter the young woman who says, “My baby is already X months old, he/she is already exposed.” |
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<th>Suggestions for Improvement</th>
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<tbody>
<tr>
<td>Perceived Barriers:</td>
<td>The individual’s perception of the potential negative aspects and obstacles of a health intervention or behavior. Change is not usually easy and individuals will analyze if an action will be inconvenient, expensive, unpleasant, distressing, or painful. Based on this analysis an individual may decide an action is not worth the benefit over the barriers.</td>
<td>Good</td>
<td>• It is a strength of the brochure that the barriers associated with quitting are acknowledged.</td>
</tr>
<tr>
<td></td>
<td>• Quitting can be hard, but it will be worth your infant's health and possibly his/her life.</td>
<td></td>
<td>• Could alternatives to smoking be recommended? (e.g., healthy snacks?)</td>
</tr>
<tr>
<td></td>
<td>• It is okay if you need help. Most people cannot always quit on their own, so you may be more successful if you have help.</td>
<td>Good</td>
<td>• Space is limited but it’s not clear how any of these can really help. Might it be better to include fewer services and describe more specifically how they can help?</td>
</tr>
<tr>
<td></td>
<td>• There are medications, programs and support groups to help you quit. o Arizona Smokers Hotline (ASH) <a href="http://www.ashline.org">www.ashline.org</a> o American Lung Association's Freedom From Smoking ® <a href="http://www.ffsonline.org">www.ffsonline.org</a> o Tobacco Free Arizona <a href="http://www.azdhs.gov/tobacco/freeaz/health/quitting.htm">www.azdhs.gov/tobacco/freeaz/health/quitting.htm</a></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>o AHCCCS and private insurance plans have coverage to quit.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived Self-Efficacy:</td>
<td>An individual’s own belief in their ability to implement a health behavior change.</td>
<td>Fair</td>
<td>• “Believe in yourself” needs some bolstering…it’s a bit empty. How about acknowledging their efficacy in seeking health care to ensure their baby’s health, and that quitting is a logical and important extension of that? (or similar)</td>
</tr>
<tr>
<td></td>
<td>• Believe in yourself to quit for your health and your infant's health</td>
<td>Very Good</td>
<td>• Can you report on the effects of quitting smoking on SIDS prevalence?</td>
</tr>
<tr>
<td></td>
<td>• YOU CAN HELP PREVENT SIDS…. do not smoke or use nicotine containing products during pregnancy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cue to Action:</td>
<td>The stimulus to move people to change a behavior, i.e. events, people, things that influence the parent’s behavioral change.</td>
<td>Good</td>
<td>• Sometimes there isn’t much of a relationship between a patient and a care provider, and there is limited time available during office visits. Given this, how can this request seem to be safer? How about: “Your health care provider can help you quit…and they want to help you. Ask!”</td>
</tr>
<tr>
<td></td>
<td>• YOU CAN HELP PREVENT SIDS…. do not smoke or use nicotine containing products during pregnancy</td>
<td>Fair</td>
<td>• This statement may make women</td>
</tr>
<tr>
<td></td>
<td>• Ask your health care provider how they can help you quit.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• If you are planning a pregnancy, you should stop smoking or using nicotine products before you become pregnant.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HBM Variable</td>
<td>How It is Applied</td>
<td>How Well It is Applied</td>
<td>Suggestions for Improvement</td>
</tr>
<tr>
<td>------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Overall opinion of the brochure and HBM application. | • Nicely designed!  
• The constructs associated with health behavior change are effectively realized.                                                                                                                       | Very Good!             | • In order to accommodate the additional content I’ve suggested, I’d recommend going in and ruthlessly editing the existing text down. How can you say more with fewer words, shorter sentences?  
This will increase readability and visual appeal as well.                                                                                       |
| User interface design / Accessible design principles | • The brochure is colorful and this use of color is generally appealing. (However the assignment of colors to text vs. background creates some problems. See comments to the right.)  
• The photo choices generally contribute to the effectiveness of the brochure.                                                                           |                        | Suggestions regarding graphical design:  
• For on-screen display, it is acceptable to use light gray lettering on a dark blue background, provided the font size is large and the character weight is bold. However, on page two of the brochure, the light color together with the smaller font size and density of content makes the text harder to read than is desirable.  
• Red text on a blue background (p. 1) will pose issues for individuals with visual impairment; due to lack of contrast between these two colors.  
• When I printed the brochure to a color printer, the blue background was replaced with a white background, and the text was pale gray, almost impossible to read.  
• Take care when super-imposing text over photographs, as on your...                                                                                       |
<table>
<thead>
<tr>
<th>HBM Variable</th>
<th>How It is Applied</th>
<th>How Well It is Applied</th>
<th>Suggestions for Improvement</th>
</tr>
</thead>
</table>
| Reading Level | • Entire Brochure: Flesch-Kincaid Grade Level 5.  
• Page 2: Flesch-Kincaid Grade Level 6 | | • The reading level appears to be appropriate for the target audience. |

title pane (right side of p. 1). The detail in the photograph interferes with the readability of the title. This coupled with the different font color, varied font sizes, and varied use of all capitals and capitals/lower case, prevent the question on the title pane from really being registered.
Conclusion

This chapter discussed how individuals were identified and contacted to serve as subject matter experts. It introduced the two subject matter experts, Drs. Moore and Kinzie. It presented the feedback from these individuals in table format.
CHAPTER SIX: DISCUSSION AND FUTURE IMPLICATIONS

This project completed a recent literature review of SIDS risk factors and recommendation strategies. Through this literature review it was discovered that maternal nicotine use is the second most modifiable risk factor for SIDS prevention. The Back to Sleep campaign, now the Safe to Sleep campaign, educated and emphasized placing infants on their back to sleep. The Safe to Sleep campaign now also includes other prevention strategies related to infants’ safe sleep environment. No national campaign has targeted educating about the use of nicotine as a risk factor. The goal of this project was to design and create an educational brochure regarding the use of nicotine as a risk factor for SIDS. This was accomplished using the HBM as a framework. The brochure was then professionally evaluated by Dr. Leslie Moore and Dr. Mable Kinzie who have published using the HBM. Dr. Moore’s opinion was that the brochure was created using the HBM appropriately and that the brochure would be effective in making the case for maternal smoking cessation. Dr. Moore felt all HBM variables were applied very well to the brochure and provided no additional feedback per HBM variable. Dr. Kinzie’s opinion was that overall the brochure nicely designed and found the constructs associated with health behavior change effectively realized. Dr. Kinzie rated the application of the HBM variables fair, good, very good, and excellent, providing suggestions for every rating except excellent. Additionally, Dr. Kinzie commented on the User Interface Design/Accessible Design Principles and the Reading Level based on Flesch-Kincaid.

Modifications to the original brochure were made based on the comments provided by Dr. Kinzie. The most significant change made was the brochure and text color. A neutral color was selected for both for improved readability and consideration of individuals who may have
visual impairment towards certain colors. The image on page one was moved away from the text, the font on the words “Did you know” was increased, and each capital letter of SIDS was bolded. Wording was changed throughout the brochure based on suggestions made by Dr. Kinzie. This includes the deletion of one statement as suggested. Brief statements about each of the suggested support services available were listed. After modifications, the brochure now has 3% passive sentences, the Flesch-Kincaid Grade Level is 5.3, and the Flesch Reading Ease is 74.4. The Flesch-Kincaid Grade Level decreased from 5.6 to 5.3 and the Flesch Reading Ease increased from 73.5 to 74.4, both improvements.

In the future, this project could be further evaluated. One way to evaluate would be to create a focus group to provide user feedback regarding the brochure. A focus group could provide rich information of the participant’s views, knowledge, beliefs, perceptions and attitude about SIDS, and nicotine as a risk factor (Perry et al., 2012). The focus group would also be useful to provide opinioned feedback for the brochure regarding content, readability, visual aesthetics, and pre and post evaluation of knowledge. Additional brochure edits would then be made based on focus group results.

Planning of future brochure implementation should be considered and discussed. This step would occur after the focus group is completed. Several questions regarding brochure implementation include: how to approach clinics about providing brochure, how will the brochures be distributed within the clinic, will staff require training and if so what will be taught, how will effectiveness of the brochure be measured? Another implementation factor is how will the cost and sustainability of the brochure be supported?
The brochure was designed to be appropriate in prenatal obstetrician and pediatric primary care clinics. Distribution to clinics would be as simple as approaching clinics, providing information about the brochure, and asking permission to provide and distribute the brochure. During selection of clinic sites specific populations with higher rates of nicotine use could be targeted. For instance, American Indian/Alaska Natives have the highest smoking prevalence among ethnic groups (Agaku, King, & Dube. 2014). Further, nicotine use before, during, and after pregnancy is also highest for this ethnic group (Tong et al., 2013). Additionally, SIDS occurs more in American Indian/Native Alaskan and non-Hispanic black populations (CDC, 2014). Arizona is heavily populated by American Indians with 22 tribes across the state. In southern Arizona we share our community with the Pascua Yaqui Tribe and the Tohono O’odham Nation Tribe (Arizona Commission of Indian Affairs, 2014). With these statistics in mind, it would be a good idea to start brochure distribution among the American Indian population. Indian Health Services (IHS) has multiple healthcare facilities in southern Arizona: San Simon Health Center, San Xavier Health Center, Santa Rosa Health Center, and Sells Hospital. These healthcare facilities would be starting locations for brochure distribution.

Now that clinics have been identified, what will be the method for distribution and what training will staff need? Brochures would be provided to the clinics and resupplied as needed. Staff will need simple education. Medical staff (nurses and medical assistants) should be instructed on the target population for distribution. In prenatal clinics screening should be done for nicotine use and any mother who indicates current or pre-pregnancy nicotine use should receive a brochure. In primary care clinics screening should be done in mothers of infant up to 12 months of age for current nicotine use. Any mother who indicates nicotine use should receive a
brochure. The medical staff should refer to the providers of the clinic for any questions regarding the brochure content. Providers can also perform nicotine screening, but most likely the screenings will be done by the medical staff.

Effectiveness of the brochure can be evaluated at this point. A study could be conducted where brochure recipients are consented and agree to participate in a pre-post survey. Screening for brochure distribution would be conducted as stated previously. Eligible brochure recipients would also be offered to participate in the effectiveness study to evaluate their knowledge gained from the brochure. Participants would then be provided a pre-brochure survey asking questions regarding their current knowledge of SIDS and maternal nicotine use as a risk factor. They would then be provided the brochure. After reading the brochure participants would be provided a post-brochure survey to evaluate their knowledge gained from reading the brochure. Statistical analysis of the surveys would be conducted. Ideally the study would show that after reading the brochure mothers have increased knowledge regarding the use of nicotine as a risk factor for SIDS.

The future of the brochure will rely on financial sustainability. How will the cost of maintaining the brochure be supported so that clinic distribution can continue? Grant funding would be one source of sustainability. Based on the initial effectiveness study results a grant proposal could be written. There would be better odds for grant funding if the brochure shows effectiveness. Another source of sustainability could be corporate sponsorship. Corporations might be willing to provide financial support in exchange for their logo on the back of the brochure. This would be a marketing benefit for corporations.
The brochure will be a tool for education in prenatal and primary care. The brochure has been created based on an identified educational need supported by current literature. It is grounded by the HBM, a framework that has previously been successfully used for health education interventions. DNPs can utilize the brochure to educate and provide meaningful information to mothers in prenatal and primary care settings. DNPs are leaders and educators in these settings and this brochure will allow DNPs to distribute reliable and evidence based information in their practice. DNPs collaborate with other providers and can also utilize the brochure to share this educational opportunity with other providers who might have patients who could benefit from the brochure’s content. The SIDS education in this brochure is new and DNPs can be leaders to disseminate the information to families and collaborative providers thereby leading the way to improve patient health outcomes.

Conclusion

This DNP Project has identified SIDS as a significant health problem with lack of public education. Through literature review, this DNP Project discussed and supported maternal nicotine use as a significant risk factor for SIDS; the second most modifiable risk factor. An educational brochure directed towards mothers regarding nicotine use as a risk factor for SIDS was created using the HBM as a framework. Professional evaluation and feedback of the brochure was provided by individuals who have published articles using the HBM. Evaluation feedback concluded that the brochure was created applying the HBM appropriately, and in the opinion of the reviewers, will positively influence women to change their health behavior regarding nicotine use. The original brochure was modified based on feedback from Dr. Kinzie and a second brochure was created. Future implications including distribution to at risk
populations, further brochure evaluation, and financial sustainability were discussed. A DNP is a valuable leader and resource in primary care. DNPs are positioned to provide SIDS education to patients and families in women’s health and pediatric clinics. Promoting this valuable SIDS education will likely require collaboration with other healthcare providers; a DNP has the opportunity to lead this movement and improve patient health outcomes.
APPENDIX A:

SIDS AND NICOTINE EDUCATIONAL BROCHURE
YOU CAN HELP PREVENT SIDS....
do not smoke or use nicotine containing products during pregnancy

Infants who SMOKE... can DIE of SIDS

Ask your health care provider how they can help you quit.
Believe in yourself to quit for your health and your infant's health.

DID YOU KNOW??
Sudden Infant Death Syndrome happens more in infants whose mothers smoke or use nicotine

Designed and Created by: Nicola Bates, MSN, ACNP-BC, CFNP
DNP Candidate
University of Arizona
College of Nursing
**SIDS Facts**

**Centers for Disease Control and Prevention Definition:**

“Sudden death of an infant less than 1 year of age that cannot be explained after a thorough investigation is conducted, including a complete autopsy, examination of death scene, and review of clinical history.”

- SIDS is real and it can happen to you. Nobody is exempt from SIDS; it can happen to any infant.
- About 2,000 SIDS deaths occur every year. SIDS is the leading cause of death in infants 2 to 12 months.
- Nicotine is the second highest risk factor for SIDS. Sleep position is the highest risk factor.
- Infants of mothers who use nicotine products are 2 to 3 times more at risk of SIDS.

**What Can You Do?**

- If you are planning a pregnancy, you should stop using nicotine products before you become pregnant.
- Do not smoke or use nicotine products during pregnancy or around your infant. Not smoking or using nicotine products can lower your infant’s risk of SIDS. It can also improve your overall health.
- Quitting can be hard, but it will be worth your infant’s health and possibly his/her life.
- It’s okay if you need help. Most people cannot always quit on their own, so you may be more successful if you have help.

**Your infant’s life depends on you quitting!!**

There are medications, programs and support groups to help you quit.

- Arizona Smokers Hotline (ASH)
  www.ashline.org
- American Lung Association’s Freedom From Smoking®
  www.f4s.tobaccofreehealth.org
- TobaccoFree Arizona
  www.azdia.gov/tobacco-free/health/quitting.html
- AHCCCS and private insurance plans have coverage to quit.
APPENDIX B:

SIDS AND NICOTINE EDUCATIONAL BROCHURE WITH HEALTH BELIEF MODEL INDICATORS
**Cue to action:** the entire brochure

**YOU CAN HELP PREVENT SIDS.... do not smoke or use nicotine containing products during pregnancy.**

**Infants who SMOKE... can DIE of SIDS.**

Ask your health care provider how they can help you quit.
Believe in yourself to quit for your health and your infant’s health.

Perceived Benefit

**Perceived Severity**

DID YOU KNOW??

Sudden Infant Death Syndrome happens more in infants whose mothers smoke or use nicotine.

Perceived Susceptibility

Perceived Self-Efficacy

Redesigned and Created by Nicole Hines, MSN, RN BC-CN, PhD Candidate
University of Arizona College of Nursing
Perceived Susceptibility

Perceived Self-Efficacy

Perceived Barriers

Perceived Severity

**SIDS Facts**

Centers for Disease Control and Prevention Definition:

"Sudden death of an infant less than 1 year of age that cannot be explained after a thorough investigation is conducted, including a complete autopsy, examination of death scene, and review of clinical history."

- SIDS is not prone to happen at any age. Nobody is exempt from SIDS; it can happen at any age.
- About 1,000 SIDS deaths occur every year. SIDS is the leading cause of death in infants 1 to 12 months.
- Nicotine is the second leading cause of death in infants and children.
- Infants of mothers who use nicotine products are 2 to 5 times more at risk of SIDS.

**What Can You Do?**

- If you are pregnant or planning a pregnancy, you should stop using nicotine products before you become pregnant.
- Do not use or encourage tobacco products around your infants. Not using tobacco means you can lower your risk of SIDS.
- It can improve your overall health.
- Quitting can be hard, but it will be worth your infant's health and possibly his life.
- It's okay if you need help. Most people cannot stop on their own, so you may have to ask for help.

There are medications, programs, and support groups to help you quit.

- American Lung Association (ALA) www.americanlung.org
- American Cancer Society (ACS) www.cancer.org
- Tobaccofree: America www.tobaccofree.net/tobaccofree/healthcare providers
- AHCCCS: Arizona's Medicaid program www.ahcccs.gov
APPENDIX C:

MODIFIED SIDS AND NICOTINE EDUCATIONAL BROCHURE
YOU CAN HELP PREVENT SIDS....
do not smoke or use nicotine containing products during pregnancy

If the mother SMOKES, the baby SMOKES

Your health care provider can help you quit...and they WANT to help you. ASK today!

You know you are a strong woman, start quitting today.

DID YOU KNOW??

Sudden Infant Death Syndrome

happens more in infants whose mothers smoke or use nicotine

Designated and Created by:
Nicole Bence, MSN, RN-BC, CPNP
DNP Candidate
University of Arizona
College of Nursing
SIDS Facts

Centers for Disease Control and Prevention Definition:

SIDS is the sudden and unexpected death of an infant less than 12 months of age that cannot be explained by any other cause.

- SIDS is real and it can happen to you! Nobody is exempt from SIDS; it can happen to any infant.
- About 2,000 SIDS deaths occur every year. SIDS is the leading cause of death in infants 28 days to 12 months.
- Nicotine is the second highest risk factor for SIDS. Sleep position is the highest risk factor.
- Infants of mothers who use nicotine products are 2 to 5 times more at risk of SIDS.

What Can You Do?

- Do not smoke or use nicotine products during pregnancy or around your infant. Not smoking or using nicotine products can lower your infant's risk of SIDS. It can also improve your overall health.
- Quitting can be hard, but it will be worth your infant's health and possibly his/her life.
- Any decrease in nicotine use is helpful to you and your infant's health.
- It's okay if you need help. Most people cannot always quit on their own, so you may be more successful if you have help.

Your infant’s life depends on you quitting!!

There are medications, programs, and support groups available to help you quit.

- Arizona Smokers' Hotline (ASH) www.ashline.org or call 1-800-55-66-222
  Offers free telephone and web-based services to help you quit.
- Tobacco Free Arizona www.azed.gov/tobacco/freeazh
  Education and resources to help you quit.
- AHCCCS plans have coverage for free medications and nicotine replacement therapies.
- Private insurance also provide coverage.
REFERENCES


