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TOBACCO-FREE PRISON POLICIES AND HEALTH OUTCOMES AMONG INMATES

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ABSTRACT OF DISSERTATION

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University of Kentucky

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TOBACCO-FREE PRISON POLICIES AND HEALTH OUTCOMES AMONG INMATES

ABSTRACT OF DISSERTATION

A dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Philosophy
in the College of Nursing
at the University of Kentucky

By

Alison R. Connell

Lexington, Kentucky

Chair: Dr. Ellen Hahn, Professor, College of Nursing and Public Health

Lexington, Kentucky
2010

ABSTRACT OF DISSERTATION

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This study was the first to examine the effect of tobacco policies in prisons on the health of inmates. Kentucky has two types of tobacco policies in its 16 state prisons: indoor smoke-free policies, where smoking is allowed outdoors and tobacco-free policies, in which no tobacco of any kind is allowed on the grounds of the prison. The smoking rate of inmates is three times higher than that of current smokers in the non-incarcerated population which results in high rates of tobacco-related health conditions such as heart disease and lung cancer.

A literature review discussed the evolution of tobacco policies in prisons, the motivations for strengthening policies in prisons and the unintended consequences. Health outcomes in the non-incarcerated population on the benefits to cardiovascular and respiratory health following passage of smoke-free laws in public places were reviewed. No studies have been found on the health outcomes of inmates with varying degrees of smoke-free or tobacco-free policies.

The first study was a time series analysis comparing the frequency of medication refills for asthma and/or COPD before and after a tobacco-free policy was implemented. Short-acting inhaler refills decreased in the first few months following the tobacco-free policy date but returned to baseline within 12 to 15 months. Rapid turnover of inmates, minimum security status of the prisons, and possible loosening of enforcement may have been related to the gradual increase in use.

The second study was a survival analysis on the time to an inmate's first acute myocardial infarction (AMI) with tobacco policy status (tobacco-free or smoke-free) of the prison as the primary predictor variable. Controlling for the multiple movements over time, facilities, co-morbidities, past smoking history, age and race, there was a 2.87 hazard for AMI for time spent in a smoke-free (indoors) prison compared to a tobacco-free prison. This finding may be due to the fact that tobacco is considered contraband after prisons become tobacco-free and inmates risk disciplinary action by smuggling or using tobacco in the prison, thereby reducing secondhand smoke for non-smokers and probably reducing the consumption of current smokers.

KEYWORDS: prison, tobacco-free policy, acute myocardial infarction, smoke-free policy, respiratory

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August 2, 2010

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To my boys, you can do anything you set your mind to.

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Special acknowledgments go to my colleagues at KCHSN: Dr. Phillip Roeder, who has my respect for his quiet, thoughtful wisdom; Madison Gates, who has laughed with me through the whole process; and Sandi Winter, who is my dear friend, colleague, and supporter.

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CHAPTER 1: INTRODUCTION

Tobacco use is the leading cause of preventable death in the world according to the World Health Organization (WHO, 2006). Tobacco is responsible for 21% of all deaths in the United States including 89% of all lung cancer deaths. Rates of current adult smoking prevalence have decreased in the United States over the past 12 years from 24.7% in 1997 to 20.6% in 2009 (CDC, 2010). Inmates, however, smoke tobacco at higher rates than the general population. Estimates of the current smoking rate among male and female inmates range from 42% to 91% with an average of 70% to 74% (Cropsey, Eldridge, & Ladner, 2004; Connell, Winter, & Curd, unpublished, 2007). Compared to the non-incarcerated population, inmates tend to be of lower socioeconomic status, have fewer years of education, and are more likely to exhibit high-risk behaviors such as drug abuse including intravenous drug use. Higher levels of secondhand smoke (SHS) exposure have been reported in homes of people with lower incomes and among non-Hispanic blacks (MMWR, 2008). Further, few inmates have health insurance when not incarcerated. On average, only 15% of inmates report having health insurance in the year before or after incarceration (Wang, et al., 2009). These factors increase the likelihood for chronic disease among the inmate population.

In state prisons the leading causes of death are heart disease and cancer, consistent with the top two causes of mortality in the United States (Mumola, 2007; Xu, Kochanek, Murphy, & Tejada-Vera, 2010). Over half of the deaths among inmates are caused by heart diseases (27.3%) and cancer (23.3%) (Mumola, 2007). Lung cancer is the most common cancer in inmates and was responsible for one in three cancer deaths in state prisons in 2004 (Mumola, 2007). These diseases are caused by both firsthand tobacco use and exposure to SHS. In the non-incarcerated population, SHS is estimated to cause between 57,800 to 97,700 AMIs annually and between 33,500 and 56,900 deaths from coronary heart disease per year (Lightwood, Coxson, Bibbins-Domingo, Williams, & Goldman, 2009).

Due to the research on the physically harmful effects of cigarette smoking and SHS, there has been a gradual increase in the strength and number of smoke-free laws in communities, states, and countries. The majority of these laws prohibit smoking in indoor public places and/or workplaces. Local, state, and federal prisons and jails have also

adopted smoke-free policies, sometimes secondary to indoor smoke-free laws covering all state buildings. Within prison systems there is a continuum of restrictions, from smoke-free indoors only to tobacco-free throughout the entire prison. These policies have been adopted primarily because of the effects on health and health care costs from tobacco-related disease.

Health of inmates and secondhand smoke exposure in prisons

The provision of health care for inmates has been federally mandated since 1976 when a Supreme Court ruling determined that the government has an "obligation to provide medical care for those whom it is punishing by incarceration"("Estelle v. Gamble," 1976) p. 2). Failure to do so violates the Eighth Amendment proscription against cruel and unusual punishment since inmates do not have the liberty of obtaining health care elsewhere. The key summary statement from Estelle v. Gamble that has since been upheld in cases brought by inmates who were exposed to SHS is that "deliberate indifference to serious medical needs of prisoners constitutes the unnecessary and wanton infliction of pain" (p. 103). In Helling v. McKinney, the Court determined that McKinney's exposure to SHS by his cellmate and other inmates' smoking posed an unreasonable risk to his health, both present and future that constituted "deliberate indifference" by prison officials to standards that society considers as decent ("Helling v Mckinney," 1993).

Litigation related to SHS exposure (Sweda, 2004) plus an increasingly convincing body of evidence of the known harms from smoking and SHS (USDHHS, 2006) have provided impetus to correctional departments to adopt smoke-free or tobacco-free policies. The Surgeon General of the United States determined that there is no safe level of SHS and that separating smokers from non-smokers in indoor spaces cannot eliminate non-smokers' exposure to SHS (USDHHS, 2006). The cost of health care for tobacco-related diseases among inmates and employees, representing approximately 12% of prison expenditures and has been cited by correctional administrators as one of the primary reasons for adopting smoke-free policies (Kauffman, Ferketich, & Wewers, 2008; Stephan, 2004).

Implementation of tobacco-free policies in prisons

Smoke-free policies in prisons vary on a continuum from designated smoking areas indoors; to no indoor smoking with outdoor smoking allowed; to comprehensive smoke-free or tobacco-free policies in which smoking or all tobacco products are prohibited in all indoor and outdoor places. The majority of State Departments of Corrections and the Federal Bureau of Prisons have indoor smoke-free policies (FBOP, 2004). Tobacco-free policies, in which no tobacco products are allowed on the grounds of the prison, indoors and out, are increasing in prevalence (ANRF, 2010). These tobacco-free policies often include smokeless and spitless tobacco (e.g., snus) and sometimes also prohibit nicotine replacement products.

The inherent challenge in reducing tobacco use in prisons by implementing tobacco-free policies is that tobacco is not only an addictive product to be smoked, chewed, sniffed, or placed between the lip and gum but it also is the inmates' informal currency (Lankenau, 2001). Inmates are not permitted to have cash and earned income from working in the prison is monitored in an account managed by the prison staff and inmates can access it to buy goods from the prison commissary. Tobacco becomes a durable form of currency which is often used to barter or buy services, bribes, or other favors As restrictions on tobacco use or access to the product increase with more restrictive prison policies, the real price of tobacco increases (Garland, 2006; Johnson, 2010).

The security status of the prison (minimum, medium, or maximum) may be related to the proportionate value of tobacco. Minimum security prisons have fewer physical restrictions such as barbed wire fences or guard towers, allowing greater access to the outside. Also, inmates in minimum security prisons frequently work away from the prison on work-release programs which allow greater access to tobacco even if the prison is ostensibly tobacco-free. Even in medium security prisons with tobacco-free policies, many smokers find ways to continue smoking after tobacco is officially prohibited (Proescholdbell, Foley, Johnson, & Malek, 2008).

Another challenge in implementing tobacco-free prison policies and studying their effects is that prisons do not house a stable population of inmates compared to the non-incarcerated population who typically reside in the same community over time.

Ninety-five percent of inmates are eventually released from prison. In 2008, there were 739,132 inmates admitted and 735,454 inmates released from state and federal prisons (Sabol, West, & Cooper, 2009).

Health outcomes and smoke-free policies

Studies with non-incarcerated populations have reported improvements in cardiovascular and respiratory health following passage of legislation prohibiting smoking in indoor public places and workplaces. The primary outcome measure in the literature is acute myocardial infarction (AMI), which has valid and reliable diagnostic criteria. Respiratory symptoms have also been measured as health outcomes but these are typically self-report data. Some studies have used emergency department visits for asthma as a proxy marker of respiratory health (Rayens, et al., 2008). To date, there have been no published health outcome studies of tobacco-free prison policies, although there have been a few air quality monitoring studies in prisons before and/or after implementation of these policies (McGuire & Connell, 2010; Proescholdbell, et al., 2008).

Study population: Kentucky Corrections Health Services Network

The Kentucky Department of Corrections (KY DOC) is one of a few state systems to have partnered with a university to assist in managing the health care of its inmates. In 2003, the KY DOC joined with the University of Kentucky to create a public-private partnership called the Kentucky Corrections Health Services Network (KCHSN). The three KCHSN partners are the KY DOC, the University of Kentucky, and CorrectCare Integrated Health, Inc, a for-profit health management company. The KCHSN partnership established a health services network to provide medical care to inmates incarcerated across the state and to contain costs while at the same time improving quality of care. In addition, health care-related data (costs and related data on hospitalizations and specialty consults) are tracked electronically by CorrectCare and can be linked to patients, providers, and facilities. The KCHSN implemented an electronic health record (EHR) that allows access to the medical status, history, and medication record of each inmate. There is one pharmacy vendor, Diamond Pharmaceutical, for the

state that receives medication orders directly from providers via the EHR. Diamond data is tracked electronically and can be reported by inmate identification number, by drug, or disease state. This research was facilitated by having centralized databases that track the health care of all Kentucky inmates in state prisons.

Purpose of the dissertation

This dissertation research was designed to evaluate the effects of two different tobacco policies on respiratory and cardiovascular health indicators in Kentucky State prisons The overarching policy for the KY DOC prisons is an indoor smoke-free policy (smoking allowed outdoors) but there are five KY DOC prisons that have adopted a tobacco-free policy in which no tobacco products are allowed on the grounds of the prisons including nicotine replacement products. It was hypothesized that greater improvements in respiratory and cardiovascular health outcomes would occur over time in inmates housed in a tobacco-free prison environment than those in a prison with an indoor smoke-free policy.

Overview of Chapters Two through Five

Chapter Two is an integrative review of the evolution of smoke-free and tobacco-free policies in correctional systems and the benefits and unintended consequences of these policies. Research on health outcomes following passage of smoke-free legislation in the non-incarcerated population is discussed. There are no studies on the effects of smoke-free or tobacco-free prison policies on the health of inmates.

Chapter Three describes a time series analysis of secondary data examining the effects of the implementation of a tobacco-free policy on respiratory health using medication refills for asthma and/or COPD as a proxy marker. The purpose was to evaluate the effect of a tobacco-free prison policy compared to an indoor smoke-free policy (smoking is allowed outdoors) on the respiratory health of inmates with asthma and/or COPD. It was hypothesized that due to expected reductions in the rate of current smoking and subsequent SHS exposure in tobacco-free prisons, inmates would use fewer medications for asthma and/or COPD following the implementation of the tobacco-free policy compared to those residing in smoke-free prisons.

Chapter Four describes a survival analysis of secondary data that evaluates the hazard ratio for having an AMI in a smoke-free prison compared to a tobacco-free prison. It was hypothesized that there would be an increased hazard for AMI in smoke-free prisons versus tobacco-free prisons due to the high proportion of current smoking and subsequent SHS exposure.

Chapter Five summarizes the dissertation results and discusses implications for practice, policy change and future research. Findings from this study will be presented to the KY DOC Commissioner and Medical Director and other correctional administrators.

CHAPTER 2: SMOKE-FREE AND TOBACCO-FREE POLICIES IN AMERICAN PRISONS

Introduction

Over the past 20 years there has been a worldwide trend by municipalities, states and countries to enact smoke-free legislation. By April 2010, there were 19 states with 100% smoke-free laws in all workplaces, restaurants and bars and nearly 400 universities with smoke-free policies according to the Americans for Nonsmokers' Rights (ANR, 2010). Correctional systems, including prisons and jails, increasingly are adopting smoke-free policies and like many universities and hospitals are also going one step further to becoming tobacco-free on the entire campus both inside and outdoors. With a tobacco-free policy, no tobacco products are allowed on the campus, including smokeless tobacco products such as chew or dip and spitless products such as snus.

The primary stimulus for smoke-free and tobacco-free policies is the harmful health effects of tobacco use. Tobacco use and secondhand smoke (SHS) are the leading causes of preventable death in the United States and the world. The World Health Organization (WHO) states that tobacco causes five million deaths a year and that "one in ten deaths worldwide" is attributable to tobacco (WHO, 2006). Smoking was calculated to be the cause of 512 of every 2404 deaths, or 21% of deaths in the United States in 2000 (Peto, Lopez, Boreham, & Thun, 2006). For people who die between ages 35 and 69 years, 28% of the deaths are caused by smoking, with an average of 23 years of life lost per death from smoking (Peto, et al., 2006).

Smoking and SHS cause heart disease (USDHHS, 2006). SHS causes 80% to 90% as much health damage as smoking (Barnoya & Glantz, 2005) and has been estimated to be the cause of 46,000 deaths per year in the United States (CDC, 2006) and 58,400 acute myocardial infarctions (AMI) annually (Lightwood, et al., 2009). SHS is defined as a combination of sidestream smoke (from the end of a lit cigarette, cigar or pipe) and mainstream smoke (exhaled by the smoker) (ACS, 2010). Even brief exposure to SHS from 15 minutes to 6 hours can increase the risk for cardiovascular disease by increasing platelet activation (Burghuber, Punzengruber, Sinzinger, Haber, &

Silberbauer, 1986), impairing endothelial-dependent vasodilation (Otsuka, et al., 2001), and lowering high density lipoprotein cholesterol levels (Moffatt, Chelland, Pecott, & Stamford, 2004). SHS increases the risk of AMI by 25% to 31% (He, et al., 1999). The overall relative risk for coronary heart disease for people who smoke is 1.78 and is 1.31 for people exposed to SHS (Barnoya & Glantz, 2005). However, there is a dose-dependent effect from increasing cigarette exposure as seen in a large international study, the INTERHEART study in 52 countries which was designed to examine cardiovascular risk factors for AMI including the effects of smoking and secondhand smoke on the risk for AMI (Teo, et al., 2006). The study enrolled 15,152 cases of first AMI matched by age and sex with 14,820 controls in 52 countries. The odds ratio (OR) for AMI increased by 1.056 for every additional cigarette smoked per day so that a person who smoked 40 cigarettes per day had an OR of 9.16. There was an increased risk of AMI with increasing hours of SHS exposure. The OR for having an AMI was 1.24 with 1 to 7 hours per week of SHS which increased to 1.62 for people living with a spouse who smoked or with those exposed to over 21 hours per week of SHS.

There are multiple respiratory effects from smoking and SHS. Cigarette smoking is responsible for 89% of all lung cancer deaths and SHS is responsible for approximately 3000 lung cancer deaths yearly (Peto, et al., 2006). Cigarette smoking and SHS cause airway obstruction through bronchoconstriction, inflammation and airway remodeling (Flouris, Vardavas, Metsios, Tsatsakis, & Koutedakis, 2010). SHS of one hour duration decreases lung function as evidenced by a reduction in forced expiratory volume in one second (FEV_1) (Flouris, et al., 2009).

Inmates have higher rates of current smoking than the non-incarcerated population with rates ranging from 42 to 91 % with an average of 70-74% prevalence which results in high secondhand smoke exposure for nonsmoking inmates and staff (Cropsey, Eldridge, Weaver, Villalobos, & Stitzer, 2006; Durrah, 2005). A survey of 388 male inmates in a Kentucky state prison found that 71.4% were current smokers (defined as smoking every day or some days) and 85.8% reported having smoked at least 100 cigarettes in their life (Connell, Winter, & Curd, 2007). This is similar to the 73.9% rate of current smokers in a female Mississippi prison (Cropsey, Eldridge, & Ladner, 2004). Kentucky and Mississippi may have higher proportions of inmates who smoke since there

is a greater prevalence of current smokers in those states (25.6% and 23.3% respectively) (BRFSS, 2009; MMWR, 2009). This compares to a smoking prevalence of 20.6 % among adults in the United States in 2008 and 2009 who are current smokers according to the Centers for Disease Control and Prevention (CDC, 2010; MMWR, 2009). Even in California which has a 14% prevalence of current smoking in the general population, approximately 50% of inmates smoke (Gardiner, 2005).

This paper reviews the current literature on smoke-free and tobacco-free policies in correctional systems, primarily at the state and federal levels. The first section explains the difference between smoke-free and tobacco-free policies and the evolution of smoke-free to tobacco free policies in correctional systems. The second section discusses the health outcomes of smoke-free policies and potential health benefits in the incarcerated population. The third section describes litigation surrounding the use of tobacco in prisons and the unintended consequences of smoke-free and tobacco-free policies in incarcerated populations. Finally, implications for research on outcomes of the tobacco-free policies in the prisons will be presented. A search of the current literature was performed using the key words: smoke-free policy, tobacco-free policy, secondhand smoke, prison, and inmates, in the Web of Science, PubMed, the Bureau of Justice Statistics, and on state Departments of Corrections websites for specific laws and policies.

The evolution of smoke-free and tobacco-free policies in correctional systems

Smoke-free laws or policies enacted by municipalities, states, and adopted by correctional facilities typically require that there is no tobacco smoking indoors and also within a certain distance of entrances, windows, and vents. There are increasing numbers of municipalities that are also limiting outdoor smoking in public places such as cafes, bus stops, sports arenas, parks and sidewalks (ANR, 2010). Institutions such as universities, hospitals and prison systems are also adopting tobacco-free policies in which no tobacco products are allowed on the facility's campus such as the University of Kentucky in November, 2009 (*University of Kentucky Tobacco Policy*, 2009).

Smoke-free policies vary among correctional systems in comprehensiveness of the scope of the policy. Smoke-free policies in prisons usually mean that smoking is not

allowed indoors. Depending on the state, this may apply to inmates and staff or just inmates. In some correctional systems, smoke-free means that there is no smoking indoors but there are designated outdoor or covered outdoor smoking areas for staff and/or inmates such as in the Federal Bureau of Prisons (FBOP) (FBOP, 2004). Indiana implemented a smoke-free policy in 1997 in which no lit tobacco was allowed on the grounds of the prison and cigarettes were no longer sold in the commissary (Cropsey & Kristeller, 2003). The three primary reasons for adopting smoke-free policies cited by State Departments of Corrections administrators are to reduce health care costs while improving the health of employees and inmates, avoid litigation, and comply with pending or current laws limiting smoking in state-owned facilities (Kauffman, et al., 2008; Patrick & Marsh, 2001). However, indoor smoke-free policies in prisons where the majority of inmates still smoke outdoors expose non-smokers to SHS. The 2006 U.S. Surgeon General Report states that there is no risk-free level of SHS and that simply separating smokers from nonsmokers does not protect them from the effects of SHS (USDHHS, 2006).

Tobacco-free policies in prisons are stricter and disallow any form of tobacco on the prison grounds. Under these policies tobacco is considered contraband similar to illicit drugs such as heroin for staff and inmates. The exposure to SHS by non-smokers and the health costs secondary to smoking by inmates and staff have been the primary motivators for prisons to become tobacco-free. A warden in Kentucky expressed concern that it was morally and fiscally irresponsible to sell cigarettes to pregnant women, asthmatics or people with heart problems (Lamb, 2007). Providing health care to inmates is federally mandated and is costly, which adds an extra stimulus to eliminate tobacco in prisons to reduce morbidity and associated costs. Inmates are the only sub-population group in the United States who are mandated to receive health care by the Supreme Court which determined that refusing health care to inmates could be considered cruel and unusual punishment ("Estelle v. Gamble," 1976). The cost of health care for all state prisons in 2001 was $3.29 billion or 12% of prison operating costs (Stephan, 2004).

There has been a gradual transition in correctional systems from allowing smoke in the entire prison, to indoor smoke-free policies followed by more comprehensive smoke-free and tobacco-free policies which have become increasingly more prevalent in

recent years. Since the early 1990s, there has been an increase in the number of indoor smoke-free policies in state and federal correctional systems. The American Correctional Association (ACA) and the American Jail Association adopted resolutions in 1990 supporting non-smoking policies (Vaughn & del Carmen, 1993). The ACA reinforced their support in 1999, 2004 and 2009 by ratifying the "Public Correctional Policy on Nonsmoking Policies" which recommended non-smoking policies to improve the health of staff and inmates, decrease medical expenses, and improve fire safety (ACA, 2009). The National Commission on Correctional Health Care (NCCHC) Standard for Health Services on the use of tobacco in prisons and jails recommends no smoking inside, designated outside smoking areas, and availability of nicotine replacement products (NCCHC, 2003).

In 1992, there were no prisons or prison systems that prohibited smoking entirely, but six (12%) state correctional systems designated some cellblocks as non-smoking (Vaughn & del Carmen, 1993). Twenty states' administrators reported that the only inmates who were provided with smoke-free cells were those with pre-existing medical conditions that could be worsened by SHS exposure. Since there were only six states with some smoke-free cellblocks, these inmates would still have been exposed to SHS from neighboring cells. Five states reported that all inmates were provided a smoke-free environment when it was requested. There were 16 states at that time in which no inmates had smoke-free environments (Vaughn & del Carmen, 1993).

The number and strength of smoke-free policies in prisons has increased gradually. A 1996 survey of all 50 states' departments of corrections, the District of Columbia and the Federal Bureau of Prisons reported that seven prison systems had implemented smoke-free policies and 44 had limited indoor smoking in certain areas (Patrick & Marsh, 2001). By 2002, 38 of 50 states had indoor smoking prohibitions or limited indoor smoking (Zoroya, 2004). In 2004, the Federal Bureau of Prisons (FBOP) prohibited lit tobacco products in all of its 105 prisons which house 180,000 inmates (FBOP, 2004).

Smoke-free prison policies when limited to indoor areas do not reduce the rate of current smoking, exposing non-smokers to SHS. With most indoor smoke-free policies tobacco is still sold in the prison commissary and is used as currency between inmates

and sometimes creates a barter system between staff and inmates (Lankenau, 2001). There are drawbacks to indoor-only smoke-free policies in prisons. One, the majority of inmates can continue to smoke unless the entire prison is smoke-free. When the entire prison is smoke-free and inmates are disciplined for visible smoking, there is more incentive to smoke in the cells exposing others to SHS. There is also a risk of fire from smoking paraphernalia which has led some state systems to also prohibit the use or sale of matches in canteens.

Tobacco-free policies in prisons restrict any form of tobacco being brought into the prison, sold in the canteen, or in vehicles on the grounds of the prison. Tobacco on the premises is considered contraband for staff and inmates which in some states is a misdemeanor and in others carries a felony penalty. This includes smokeless and spitless tobacco, including snuff and snus. Some prison systems continue to allow nicotine replacement therapy (NRT) products to be sold in the commissary and some do not. California and South Carolina did not allow NRT because nicotine gum can be made into a mold to make keys and disable locks (Gardiner, 2005; Polito, 2009) and nicotine patches can be dried and smoked (Polito, 2009).

Correctional facilities in the District of Columbia became tobacco-free on August 1, 2004 (Corrections, 2004). California's correctional systems became tobacco-free with the passage of Assembly Bill 384 on July 1, 2005 which prohibits the use, sale and possession of tobacco products by inmates and prison employees (Gardiner, 2005). By 2005, seven states had tobacco-free policies in their prisons (Colorado, Delaware, Idaho, Indiana, Maine, Minnesota, and Nebraska) (Gardiner, 2005). A 2007 survey of the 50 states, the District of Columbia and the Federal Bureau of Prisons reported that 31 (60%) had tobacco-free policies but most of these refer to indoor smoke-free policies as opposed to completely tobacco-free prison policies (Kauffman, et al., 2008). By April 2010, nine State Departments of Corrections' prisons had tobacco-free prison policies and four more are poised to become tobacco-free in 2010 including Nevada, Virginia, North Carolina, and Georgia (Gardner, 2009; Mower, 2009; Sheinin, 2009). In some states, there is not one policy that covers all prisons as in Kentucky where the overarching policy for all prisons is smoke-free indoors with smoking allowed outside but five of the 16 state

prisons also have tobacco-free campuses in which no tobacco is allowed on the prison grounds (Adams, B. personal correspondence, March 12, 2009).

Health outcomes of smoke-free policies in the non-incarcerated population

The health benefits of smoke-free legislation affecting the non-incarcerated population have been documented primarily in the reduction of cardiovascular and respiratory diseases. The Institute of Medicine (IOM) concluded in 2009 that there was sufficient evidence to infer a causal relationship between low levels of SHS and coronary heart disease and that smoke-free policies reduce the risk for AMI (IOM, 2009). The CDC recommends that people with heart disease avoid SHS (USDHHS, 2006). The incidence of acute myocardial infarction (AMI) is the most commonly used policy outcome measure. AMI as an outcome variable has the benefit of having distinct, measurable diagnostic criteria as opposed to a respiratory outcome which is usually measured by subjective reports of symptoms such as rhinorrhea, shortness of breath or cough.

The impact of city, state and national smoke-free legislation on the reduction of AMIs has been widely studied. The first report on AMI incidence was from Helena, Montana after enactment of a smoke-free ordinance in 2002 which was followed by a 40% reduction in AMIs over the next six months compared to the same six months the year before (Sargent, Shepard, & Glantz, 2004). A time-series analysis using the 18 month period before and after an ordinance was implemented in Pueblo, Colorado found a 27% reduction in AMI hospitalizations in the City of Pueblo and no decrease in the adjacent county where public smoking was allowed (Bartecchi, et al., 2006). New York State passed a comprehensive smoke-free law in 2003. In the following year there were 3,813 fewer hospital admissions (8% reduction) for AMI than expected after adjusting for seasonal and secular trends (Juster, et al., 2007).

Reductions in AMI have also been reported after entire countries enacted indoor smoke-free laws. The hospitalization rate for AMIs in a region of Italy decreased by 11% among people younger than age 60 after a prohibition on indoor smoking in public places in 2005 (Barone-Adesi, Vizzini, Merletti, & Richiardi, 2006). There was a 17% reduction in the risk for AMI in a meta-analysis of 11 studies from 10 locations worldwide where

smoke-free laws were enacted (Meyers, Neuberger, & He, 2009). A meta-analysis of studies on AMI hospitalizations found a pooled risk estimate of 0.83 following smoke-free policy enactment with the relative risk reduced to 0.64 after three years of follow-up (Lightwood & Glantz, 2009).

In addition to improvements in cardiac health, the implementation of a smoke-free ordinance was associated with reductions in emergency department visits for asthma and respiratory symptoms. In Lexington, Kentucky in the 32 months after passage of a smoke-free law prohibiting smoking in most indoor public places there was an overall 22% reduction of emergency department visits (p <.001; confidence interval (CI) 14% to 29%) compared to the 40 months prior to the law (Rayens, et al., 2008). Bar workers in Perthshire, Scotland reported a decrease in respiratory symptoms within one month of a smoke-free law (p < .001) (Menzies, et al., 2006). Fifteen of the 105 bar workers had asthma. The FEV_1 in the entire cohort increased by 8.2% after one month (CI 3.9-12.4, p < .001) and by 15.7% in those with asthma (CI 5.7-25.7, p = .008).

In the non-incarcerated population where smoke-free policies do not restrict individuals from smoking in private locations such as homes and cars, there have been reductions in health care costs and in the proportion of current smokers. In New York State after a comprehensive smoke-free law was passed in 2004, fewer hospital admissions for AMI resulted in direct health care cost savings of $56 million (Juster, et al., 2007). In the 20 months after the passage of a smoke-free ordinance in Lexington, Kentucky there was a 32% decrease in current adult smokers, with no change in the percent of smokers in comparable counties, resulting in an estimated $21 million in healthcare cost savings per year (Hahn, et al., 2008).

After passage of smoke-free legislation there are lower levels of ambient SHS. Particulate matter ($PM_{2.5}$) which measures fine particle pollution such as SHS has a National Ambient Air Quality Standard (NAAQS) for outdoor air for 24 hours of 35 micrograms per cubic meter ($\mu g/m^3$) (EPA, 2009). $PM_{2.5}$ was measured in eight restaurants and a bowling alley before and after smoke-free legislation was passed with levels decreasing by 79% one week after implementation of the law (Lee, Hahn, Riker, Head, & Seithers, 2007). Comprehensive smoke-free laws result in greater decreases in $PM_{2.5}$ than partial smoke-free laws which encompass some but not all public venues.

$PM_{2.5}$ levels dropped by 88% from a mean of 161 $\mu g/m^3$ to 20 $\mu g/m^3$ in communities with comprehensive smoke-free laws. However, levels varied dramatically based on the type of venue in communities with a partial law: bars which were exempt had an average of 235 $\mu g/m^3$ in bars, while restaurants which were covered under the law had an average of 10 $\mu g/m^3$ (Lee, et al., 2009).

Potential health benefits of comprehensive smoke-free and tobacco-free policies in prisons

Consistent with the high rates of smoking among inmates, the prevalence of tobacco-associated disease burden is high. The leading cause of death in state prison inmates is heart disease, accounting for 27% of the deaths in state prisons between 2001 and 2004 (Mumola, 2007). A study of the deaths in the Cook County Jail in Chicago, IL, from 1994 to 2004 showed that heart disease was the number one cause of death with an age-adjusted mortality rate of 312.1 per 100,000 per year compared to the national average in the non-incarcerated population of 240.8 per 100,000 per year (Kim, et al., 2007). Using data from a self-report survey of jail inmates in 2002 and of state and federal inmates in 2004, the prevalence of hypertension was between 27.9% in jail inmates and 29.5% in federal inmates, compared to the U.S prevalence of 25.6% (Wilper, et al., 2009). The proportion of those with asthma was 7.7% for federal inmates and 9.8% for state inmates compared to 7.5% for the U.S non-incarcerated population (Wilper, et al., 2009). Cancer is the second leading cause of death in state prison inmates, with lung cancer accounting for a third of the cancer deaths (Mumola, 2007).

The cost of treating chronic and acute diseases in inmates continues to climb each year. In 2001 the cost for health care in the 50 state prison systems was $3.3 billion, accounting for 12% of the total operating cost (Stephan, 2004). Kentucky Department of Corrections reported that the highest medical cost by category was for the treatment of diseases of the circulatory system which cost $3.4 million in the 10 months from July 1, 2008 to April 30, 2009 (Upton & Spaulding, 2009). Georgia spends $226 million per year or 17% of its budget on health care (Sheinin, 2009). As the population ages it is anticipated that health care costs will continue to climb. The cost of tobacco use in prison inmates has not been estimated for all states or the federal prison system. In 1999, the

California Department of Health Services estimated the cost of tobacco use among inmates as $3,331 per smoker per year (TEROC, 2003).

Most States' Departments of Corrections cite improvements in health and reductions in health care costs as the primary motivators for implementing tobacco-free policies; however there are no published data on the health outcomes or health care cost savings of smoke-free or tobacco-free policies in prisons. Based on studies in the non-incarcerated population, reductions in the proportion of current smokers and cigarettes consumed would be anticipated to provide health benefits with improvements in cardiovascular and respiratory health. The Lightwood and Glantz (2009) study which estimated a relative risk of 0.83 for having an AMI one year after smoke-free legislation in public places was passed, assumed that only 23% of the population were current smokers and that there was a relative reduction of cigarettes smoked by 29% using data from a previous study showing that 3.8% of current smokers quit after a smoke-free workplace law was enacted and the ones who continued to smoke smoked an average of 3.1 fewer cigarettes per day (Fichtenberg & Glantz, 2002). Given that inmates as a sub-population group have excessively high rates of tobacco use with an average of 70% current smokers, subsequent reductions in current smoking, tobacco use, and SHS exposure following a tobacco-free policy would be expected to have greater improvements in health than prisons with indoor smoke-free policies.

Reductions in current smoking and cigarette consumption have been reported in prisons that have adopted comprehensive (indoors and outdoors) smoke-free policies and tobacco-free policies (Cropsey & Kristeller, 2005b; Proescholdbell, et al., 2008). The reductions vary by the comprehensiveness of the policy and by the security status of the prison. After adoption of a comprehensive indoor and outdoor smoke-free policy in the Indiana DOC where no cigarettes were sold in the canteen, 76% of current smokers reported that they continued to smoke one month after the date of the policy implementation (Cropsey & Kristeller, 2005a). Inmates were surveyed in two prisons, one of which had a tobacco-free policy and one with a tobacco-free indoor policy, and reported a higher prevalence of current smoking in the prison with the partial policy (64%) than inmates in the prison with a complete tobacco-free policy (42%). In a qualitative survey of 140 inmates and 50 staff from 10 jails and six prisons in eight states,

inmates reported that in prisons with a lower security status (i.e. minimum security or work release), there was greater ease of violating a tobacco-free policy than in higher security prisons. Maximum security prisons had the least tobacco smuggled into the prison (Lankenau, 2001).

Litigation related to tobacco use in prisons

Litigation has been a driving force in prompting smoke-free policies in the corrections environment. The most prominent court case that went to the U.S. Supreme Court was in 1993 when a non-smoking inmate charged that his cell-mate smoked five packs a day, causing the plaintiff's current and future health problems ("Helling v Mckinney," 1993). The Court upheld the plaintiff's claim of health damage from SHS, citing the Eighth Amendment which bars criminals from infliction of cruel and unusual punishment. The court ruling referred to the case of Estelle v. Gamble ("Estelle v. Gamble," 1976) which stated "that deliberate indifference to serious medical needs of prisoners" constitutes an Eighth Amendment violation (p.103). This judicial ruling set the precedent for inmates to receive a standard of medical care, the denial of which would "result in pain and suffering which no one suggests would serve any penological purpose" (p. 103). A lawsuit in Wisconsin by an inmate with severe chronic asthma claimed that the warden and other prison staff acted with deliberate indifference in allowing prisoners to smoke in violation of prison policy (Sweda, 2004). The Court of Appeals upheld his case stating that his health was being endangered by SHS exposure. An asthmatic inmate was awarded $54,750 in compensatory and punitive damages because he had been denied a smoke-free cell for five years ("Reilly v. Grayson," 2001).

However, in lower courts, the standard of Helling v. McKinney has not always been maintained (Wilcox, 2007a). In Michigan in 2003, the court ruled that the potential health hazards from SHS did not represent a sufficiently serious medical risk and there was not deliberate indifference because the prison had adopted an indoor non-smoking policy ("Henderson v. Martin," 2003). The Eleventh Circuit ruled against an inmate's claim that SHS exposure was harmful citing lack of evidence of unreasonable high SHS levels ("Kelley v. Hicks," 2005).

Litigation opposing smoke-free policies has also been brought against state departments of corrections. In 1997, eight lawsuits were dismissed by the Massachusetts Superior Court which alleged that smoke-free policies violated inmates' Eighth Amendment rights and "amounted to intentional infliction of emotional distress" (Young, 2002). The smoke-free policy that was being contested was originally implemented as a result of a class-action lawsuit from non-smoking inmates who were concerned about SHS exposure.

In some Western states, American Indians have been allowed to use tobacco in religious ceremonies. However, in South Dakota this policy was reversed by the Director of Prison Operations because tobacco was too addictive to be used for ceremonies and was being abused and traded (Hult, 2009). This is currently being challenged by the Native American Council of Tribes.

Unintended consequences of tobacco-free policies in correctional systems

While there are potential benefits of tobacco-free policies in prisons there may also be unintended consequences which impede the transition to tobacco-free prison systems including: decreased revenue from tobacco sales, enforcement issues, tobacco as contraband, and concerns about inmate tension and behavior disruption. The State of California reported that in 2003 tobacco sales by inmates generated $1 million in tobacco taxes and $370,000 in sales tax which was lost after the state prisons became tobacco-free (Gardiner, 2005). This report suggested that there would be an estimated $280 million in savings in health care costs but this was derived by calculating the approximate health care costs from tobacco use per inmate times the estimated number of current smokers and subtracting that amount from the state healthcare budget. This is not an accurate estimation since inmates may have permanent health damage from tobacco use and the effects of quitting are not immediate.

Enforcement of smoke-free and tobacco-free policies in prisons varies by prison staff and among and within prisons. The biggest problem with enforcement is that tobacco is the primary black market currency in prisons and becomes more valuable with increased restrictions on its use (Lankenau, 2001). Inmates earn an average of 0.50¢ to $1 a day which is deposited in the prison accounts and used to buy food, snacks, hygiene

products and cigarettes if available at the prison canteen. Since money is not available for currency and the majority of inmates are current smokers, loose tobacco and rolled cigarettes are the currency for buying services, goods, and favors. Lankenau (2001) surveyed 140 inmates and 50 staff and officers in 2000 about tobacco use in prisons with smoke-free and tobacco-free policies and reported that inmates have elaborate mechanisms for getting tobacco into the prisons, selling it and smoking it. A "mule" who smuggles the tobacco into the facility may be an officer, another inmate on community work-duty or a community service worker. The officers who participate in the tobacco black market can charge between $20 and $50 per pack of cigarettes and could earn an entire week's pay from one tobacco or cigarette transaction. The inmate then sells the cigarettes for $200 to $500 per carton..

Once prisons become tobacco-free as opposed to being smoke-free or having an indoor smoke-free policy, tobacco becomes an even higher prized commodity which has been reported to overtake heroin as the number one smuggled contraband item (NCCHC, 2004). The Maryland DOC reported that tobacco has become the leading smuggled item and that a can of loose tobacco can sell for $1,000 (Garland, 2005). In Ohio, a year after the prisons became tobacco-free, a can of loose tobacco sold for $300 and a cigarette for $10 (Johnson, 2010). In response to this trend, some states (i.e., New York and Texas) consider smuggling tobacco into prisons a felony (Byrne, 2006). Once prisons become tobacco-free, chips, candy or other items from the commissary may become currency as a substitute for tobacco (Sheinin, 2009).

Enforcement may be hampered by the security status of the prison or by the comprehensiveness of the policy. Minimum security prisons are relatively loosely guarded allowing inmates to have more opportunities for contact with the non-incarcerated population. Many medium security prisons have a minimum security dormitory outside the fenced area for low-risk inmates who do maintenance or work in the community on road crews. The more access the inmate has to the outside, the easier it is to smuggle tobacco in to the prison (Lankenau, 2001). Indoor smoke-free policies are hard to enforce because inmates may smoke in their cells at night and unless the smoking is seen, it cannot be cited. Prisons that have indoor and outdoor smoke-free policies are

also hard to enforce because there are many ways of hiding the tobacco, the smoke, and the lighting paraphernalia.

Variations in the enforcement of smoke-free and tobacco-free policies were found in a study of air quality at four prisons in Kentucky (Unpublished, McGuire, & Connell, 2010). Four prisons were chosen as study sites: two of which had indoor smoke-free policies (outdoor smoke allowed) and two of which had tobacco-free policies (no tobacco on campus). Fine particulate matter ($PM_{2.5}$) was measured for two hours in two dormitories at each prison (see Table 2.1). At the two prisons with smoke-free policies in two medium security dormitories, the maximum $PM_{2.5}$ over the two hour period was 37.1 and 37.5$\mu g/m^3$, while the minimum security dormitories in those prisons had $PM_{2.5}$ of 17.4 and 16.5 $\mu g/m^3$. At the two prisons with tobacco-free policies there were variations in $PM_{2.5}$between dormitories. At one tobacco-free prison the maximum $PM_{2.5}$ was 15.0 $\mu g/m^3$ in a medium security dormitory compared to 4.1 $\mu g/m^3$ in the minimum security dormitory. At the other tobacco-free prison, which was entirely minimum security, one dormitory had a maximum $PM_{2.5}$ of 30.4 $\mu g/m^3$ while another dormitory in the same prison had a maximum $PM_{2.5}$ of 11.2 $\mu g/m^3$ showing a possible difference in enforcement of the policy even within one prison with the same security status (see Table 2.1). Enforcement may not be the only reason for the difference in $PM_{2.5}$ levels. Inmates in a minimum security dormitory may not want to risk a disciplinary violation which might result in loss of privileges, time for good behavior or having to go back into the medium security area "behind the fence" rather than the relative freedom of minimum security. A study in North Carolina reported that there was a 98% decrease in $PM_{2.5}$ from 305 $\mu g/m^3$ before to 6.5$\mu g/m^3$ in a dormitory after a comprehensive tobacco-free policy was implemented (Proescholdbell, et al., 2008).

Another unintended consequence of tobacco-free policies in prisons is the incidence of behavior disturbances among inmates. In Georgia at the Lee Correctional Institution in Leesburg there were about 150 inmates who refused to work after an indoor smoke-free policy was implemented (Sheinin, 2009). However, the NCCHC and the National Network on Tobacco Prevention and Poverty surveyed 100 prison and jail administrators and juvenile detention facilities in 2000 (NCCHC, 2004) and reported few incidents of behavior problems in prisons that adopt smoke-free or tobacco-free policies.

Policy analysis implications

The results of policy analysis studies following passage of smoke-free laws in the non-incarcerated world may not be generalized to prison settings. Prisons have some similarities with the non-incarcerated population but have much dissimilarity. In the non-incarcerated population when there is an indoor smoke-free law, an individual has the ability and the right to smoke in his or her car, house, or land but may not in indoor public places or workplaces. In a prison with a comprehensive smoke-free policy or in a tobacco-free prison, the inmate loses the right to smoke and the only option is to partake in illicit activity to smoke. This may result in a greater decrease in current smoking rates than the non-incarcerated population. There are also varying strengths of smoke-free policies and variations in enforcement of either smoke-free or tobacco-free policies among and within prisons, which create challenges in determining the effect of these policies on health outcomes.

The health benefits of smoke-free policies have been studied in communities, states, and countries and significant benefits in cardiovascular and respiratory health have been documented. However, there are unique challenges that are specific to the corrections community that impact the health outcomes of tobacco policies. One of the primary challenges in studying the health outcomes of policy initiatives in prisons is the transient nature of the inmate population, with as many inmates discharged each year as are committed. For example, in 2008 the Kentucky Department of Corrections admitted 14,426 offenders and released 15,642 offenders but had an average population of 21,700 at any given point in time (Adams, B., personal communication, March 23, 2009). Inmates move fairly frequently between prisons or jails and some of the prisons may be tobacco-free while others have indoor smoke-free policies where outdoor smoking is allowed. Thus, the exposure to the policy by individual inmates becomes hard to quantify.

The long-term effect of a tobacco-free policy is difficult to measure. The majority of inmates who are housed in a tobacco-free environment return to smoking once moved to an environment that allows smoking or when discharged, and the health benefits from tobacco-free policies may not be sustained (Cropsey & Kristeller, 2005a). When inmates are discharged they are usually lost to follow-up precluding long-term follow-up.

Research that examines the effect of a tobacco-free policy on immediate or short-term health outcomes such as respiratory symptoms or physiologic measures like FEV1 may be able to minimize the attrition of a long-term study. In prisons that are becoming tobacco-free, a pre-post-design could be conducted which measures salivary cotinine levels before and after implementation. Surveying inmates on their personal use of tobacco in a tobacco-free prison is hindered by the disciplinary consequences associated with violating prison policy.

Cost as an outcome measure of the effect of tobacco-free policies in prisons is difficult to track in prisons. Health care costs continue to rise and the inmate population is aging which increases health care costs. However, costs may stabilize or decrease as the prison population shrinks due to changes in sentencing laws and parole rules designed to reduce the prison population. The prison population increased by 0.8% in 2008 which is the slowest rate since 2000 so the costs may stabilize based on these changes and not on the tobacco policy (Sabol, et al., 2009).

Conclusions

The general movement toward smoke-free legislation is a relatively recent trend in local communities, states and countries. Correctional systems are also adopting policies that vary in scope from restricting smoking indoors, to complete smoking prohibition indoors and out, to tobacco-free prisons in which all tobacco products are considered contraband for staff and inmates. This trend has been prompted by the need to reduce health care costs, morbidity, and mortality among inmates and staff. It also may be secondary to litigation by inmates who are increasingly concerned about exposure to SHS. National and international research continues to show the benefits of reducing SHS exposure, and the widely accepted knowledge that there is no safe level of SHS (USDHHS, 2006). Improving the health of inmates is an important public health issue since there are currently 7.3 million people in the United States who are under some form of correctional supervision including probation, parole, jails, state and federal prisons (Glaze & Bonzcar, 2009).

Studies in prisons mirror the results from community-based studies in that the strength and enforcement of the tobacco-related policy determine the reduction in SHS

and current smoking. Indoor smoke-free policies do not reduce current smoking prevalence which in inmates is, on average, more than three times the proportion of current smokers in the United States (Connell, et al., 2007). Variations in enforcement of indoor smoke-free policies may result in high indoor SHS. Comprehensive smoke-free prison policies and tobacco-free policies have been associated with reductions in cigarette consumption. However, even in prisons that have adopted complete smoke-free and tobacco-free policies, tobacco is smuggled in to the prison and many inmates continue to smoke especially in prisons with low security status.

Comprehensive smoke-free (indoors and out) and tobacco-free policies in prisons may result in improvements in the health of inmates and correctional staff including lower rates of coronary heart disease, AMIs, and asthma exacerbations. Subsequent reductions in health care costs have been reported in the non-incarcerated population following enactment of smoke-free legislation. Research on health outcomes after prisons adopt smoke-free or tobacco-free policies has not been reported in the literature.

There are unintended consequences of tobacco-free policies in the correctional system such as reduced canteen sales and varied enforcement levels within and among correctional officers and prisons. Tobacco may become a primary contraband item to be smuggled into the prison which in some cases is a misdemeanor but in Texas has been reclassified as a felony due to the number of employees smuggling tobacco (Wilcox, 2007b). Concerns about inmate tension following a tobacco-free policy have occurred but are minimal.

In spite of continued illicit smoking by some inmates and variations in enforcement, it is anticipated that tobacco-free policies will produce declines in AMI incidence and improvements in lung function and decrease health care costs primarily due to the health benefits from reductions in cigarette consumption and SHS exposure. Reducing health risks by implementing and enforcing a tobacco-free prison policy during incarceration for the revolving population of approximately 1.64 million people in state and federal prisons may improve the health of a portion of the population that has high risk factors for cardiovascular and respiratory diseases. If improvements in health and reductions in health care costs are goals for correctional policy makers and

administrators, comprehensive tobacco-free policies with strict enforcement are more likely to achieve that goal.

Table 2.1 Measurements of particulate matter ($PM_{2.5}$) in prisons with indoor smoke-free and tobacco-free policies ($N = 4$)

	Security status of dormitory	Highest level of $PM_{2.5}$ µg/m^3	Security status of dormitory	Highest level of $PM_{2.5}$ µg/m^3
EKCC (Indoor smoke-free)	Medium	37.1	Minimum	17.4
LSCC (Indoor smoke-free)	Medium	37.5	Minimum	16.5
BCC (Tobacco-free)	Medium	15.0	Minimum	4.1
KCIW (Tobacco-free)	Minimum	30.4	Minimum	11.2

(McGuire and Connell, unpublished, 2010)

CHAPTER 3: TOBACCO-FREE PRISON POLICIES AND RESPIRATORY HEALTH AMONG INMATES

Synopsis

Purpose: The purpose of this study was to evaluate the effect of a tobacco-free prison policy compared to an indoor smoke-free policy on the respiratory health of inmates who have asthma and/or COPD.

Hypothesis: It was hypothesized that due to reductions in the rate of current smoking and subsequent SHS in tobacco-free prisons, inmates in these prisons would use fewer medications for asthma and/or COPD compared to inmates with asthma and/or COPD in prisons that were not completely tobacco-free.

Method: This study was a multivariate time series analysis to evaluate the effect of tobacco-free policies in two state prisons on the respiratory health of inmates with asthma and/or COPD compared to inmates with asthma/COPD who were incarcerated at two state prisons designated as smoke-free (smoke-free indoors, with smoking allowed outdoors). Medications for asthma and/or COPD including oral medications and inhalers were used as proxy markers for respiratory health.

Results: There was an immediate effect of the tobacco-free policy on the use of short-term inhalers such as albuterol and ipratropium within a month after the policy was implemented. However, the rate of use gradually increased to the level prior to the policy implementation within 12 to 15 months at the tobacco-free prisons. The rate of refills of long-acting inhalers had opposite trends before and after implementation of the tobacco-free policy. There was no effect of the policy intervention on the use of oral medications but there may have been a prescribing effect by the primary care providers with differences in the use of certain medications in the four prisons.

Conclusion: Although there was an immediate reduction in short-acting inhaler use the effect was not sustained which may be reflective of the rapid turnover in the two tobacco-free prisons or the minimum security status which may facilitate tobacco use by inmates due to fewer physical restrictions in the prison setting.

TOBACCO-FREE PRISON POLICIES AND RESPIRATORY HEALTH AMONG INMATES

Introduction

Cigarette smoking is the leading cause of preventable death in the world, killing 50% of smokers, according to the World Health Organization (WHO) (WHO, 2006). Almost all lung cancer deaths (89%) and 34% of all cancer deaths are attributed to smoking (Peto, et al., 2006). Smoking related damage to the respiratory system results in increased risks for chronic obstructive pulmonary disease (COPD), chronic bronchitis, asthma and upper airway infections (Trupin, et al., 2003). Secondhand smoke (SHS) causes 80% to 90% as much health damage as smoking (Barnoya & Glantz, 2005) and has been estimated to be the cause of approximately 3400 lung cancer deaths per year (Peto, et al., 2006). The 2006 U.S. Surgeon General's report reviewed the scientific evidence to date and concluded that there is no risk-free level of exposure to SHS and that separate smoking areas within a building cannot eliminate SHS. Secondhand smoke is defined by the American Cancer Society (ACS) as a combination of sidestream smoke which is the smoke from the end of a lighted cigarette, cigar or pipe, and mainstream smoke which is the smoke exhaled by the smoker (ACS, 2010).

Prison inmates have a higher prevalence of current smoking than the non-incarcerated population with rates from 42 to 91 percent (average of 70-74%) (Connell, et al., 2007; Cropsey, et al., 2006; Durrah, 2005) compared to 20.6 percent in the U.S. (CDC, 2010; MMWR, 2009). The Centers for Disease Control and Prevention (CDC) defines a current smoker as having smoked at least 100 cigarettes in one's life and smoking every day or some days in the past 30 days.

Consistent with the high rates of smoking among inmates, the prevalence of tobacco-associated respiratory disease burden is high. Cancer is the second leading cause of death in state prison inmates with lung cancer accounting for a third of the cancer deaths, similar to the U.S. non-incarcerated population (Mumola, 2007). The proportion of people with asthma was 7.7% for federal inmates and 9.8% for state inmates compared to 7.5% for the U.S non-incarcerated population (Wilper, et al., 2009). It is important to note that these estimates are based on self-report which are not always reliable.

Cigarette smoking and SHS cause airway obstruction through broncho-constriction, inflammation and airway remodeling (Flouris, et al., 2010). SHS of one hour duration decreased lung function as evidenced by a 20 to 25% reduction in forced expiratory volume in one second (FEV_1) ($p = < .05$) (Flouris, et al., 2009). Non-smoking hospitality workers (n =88) in Vancouver who were employed in bars and restaurants where smoking was allowed had increased odds ratios (OR) for cough (OR 3.5), phlegm production (OR 8.5) and wheeze (OR 3.8) (Dimich-Ward, Lawson, Hingston, & Chan-Yeung, 2005). Workplace SHS increased the odds for cough and phlegm by 65% in workers in Hong Kong who had never smoked and had no SHS at home (Ho, Lam, Chung, & Lam, 2007). The risk of a new-onset of asthma in a random sample of never-smoking adults aged 18 to 60 increased by 39% with SHS exposure (Leuenberger, et al., 1994). In a survey of 377 people with COPD only 19% had never smoked with a population-attributable risk of 51% for current or former smoking, after controlling for demographics and self-reported occupational exposure to other irritants (Trupin, et al., 2003).

Cigarettes contain over 600 ingredients which when burned create more than 4000 chemicals including acetone, ammonia, benzene, butane, carbon monoxide, hydrogen cyanide, lead, nicotine, sulfur dioxide tar, and toluene (USDHHS, 2006). Tobacco smoke also contains at least 50 known carcinogens. SHS contains levels of endotoxins that increase inflammation that are 120 times higher in SHS than in non-exposed air (Larsson, Szponar, & Pehrson, 2004).

Two other less conspicuous but potentially damaging forms of tobacco smoke exposure are thirdhand smoke and outdoor tobacco smoke. Thirdhand smoke is the gas and particle residue from tobacco smoke that lingers in the air and on surfaces after the cigarette is extinguished (Winickoff, et al., 2009). The nicotine residual on indoor surfaces such as floors, walls, furniture and clothing reacts with nitric oxide to form tobacco-specific nitrosamines (TSNA) which are carcinogenic. These TSNAs can enter the body through inhalation of contaminated dust (Sleiman, et al., 2010).

As indoor smoke-free legislation is enacted, outdoor tobacco exposure still occurs and can result in high levels of nicotine among non-smokers. In a study of 10 non-smokers who spent an average of 25 days at outdoor bars and restaurants that allowed

smoking in Athens, Georgia, salivary cotinine increased by up to 162% from baseline after outdoor SHS exposure (Hall, et al., 2009). Outside nightclubs, the average level of particulate matter ($PM_{2.5}$) was 32.2μg/m^3 , close to the National Ambient Air Quality Standard (NAAQS) for 24 hours (35 μg/m^3) (EPA, 2009).

Smoke-free policies in cities and countries have been shown to decrease ambient levels of cigarette-related chemicals. In Dublin before a smoke-free ordinance was passed the levels of benzene and 1,3-butadiene in two pubs averaged 4.83 μg/m^3 and 4.15 μg/m^3 respectively. These levels dropped to 0.54 μg /m^3 and 0.22 μg /m^3 after successful implementation of the policy which had a 97% compliance nationwide (McNabola, Broderick, Johnston, & Gill, 2006). Nine hospitality venues in Georgetown, Kentucky had $PM_{2.5}$ levels averaging 84μg/m^3 before an indoor smoke-free workplace law was enacted which decreased to 18μg/m^3 one week after the law went into effect (Lee, et al., 2007). In nonsmokers, cotinine levels, a metabolite of nicotine, decreased by 89% from baseline one year after Scotland enacted smoke-free legislation in March, 2006 (Semple, et al., 2007).

The decreases in environmental irritants, nicotine and fine particle air pollution after smoke-free laws have been enacted are associated with improvements in respiratory symptoms. In Lexington, Kentucky there was an overall 22% reduction of emergency department visits for asthma in the 32 months after passage of a smoke-free law prohibiting smoking in most indoor public places compared to the 40 months prior to the law (p <.001; confidence interval (CI) 14% to 29%) (Rayens, et al., 2008). Hair nicotine levels declined significantly in bar workers (t = 2.3, p = .03) in Lexington, KY and they also reported significant reductions in wheezing, irritated eyes and mucus production after passage of the smoke-free ordinance in public places (p values from .02 to .05) (Hahn, et al., 2006). Bar workers in Perthshire, Scotland reported a decrease in respiratory symptoms within one month of a smoke-free law (p < .001) (Menzies, et al., 2006). Fifteen of the 105 bar workers had asthma. The FEV_1 in the entire cohort increased by 8.2% after one month (CI 3.9-12.4, p < .001) and by 15.7% in those with asthma (CI 5.7-25.7, p = .008).

Tobacco policies in prisons

There are three basic types of tobacco policies in prisons: indoor smoke-free with smoking allowed outdoors or in designated areas; comprehensive smoke-free policies which prohibit all smoking on the grounds; and tobacco-free policies in which all tobacco products are prohibited on the prison grounds. Tobacco-free policies include smokeless and spitless tobacco and may also apply to nicotine replacement products. Typically these policies apply to all staff, inmates, and visitors.

Within one state system the policies may vary. The Kentucky Department of Corrections (KYDOC) has had a smoke-free policy for over ten years in its 13 state prisons. The KY General Assembly reinforced this policy with the passage of KY House Bill 55 in 2006 which required most state offices and common areas to be smoke-free including all correctional facilities except the Kentucky State Penitentiary at Eddyville which is the maximum security prison for male state inmates (2006). Five of the KY DOC prisons have also adopted a tobacco-free campus policy in which no tobacco of any form is allowed beyond the security gate at the front entrance. This policy applies to inmates, visitors, and staff and in prison vehicles. Any tobacco found on the premises is considered contraband similar to illicit drugs such as heroin, and the person (staff or inmate) in possession of tobacco products is subject to disciplinary procedures.

Air quality studies in prisons have shown that there can be significant reductions in SHS following tobacco-free policies but enforcement is the critical factor in reducing tobacco use. In North Carolina there was a 98% decrease in SHS as measured by $PM_{2.5}$ in a dormitory where the level was 305 $\mu g/m^3$ before a tobacco-free policy and 6.5$\mu g/m^3$ after the policy was implemented (Proescholdbell, et al., 2008). However, levels of SHS may vary even within prisons. In three Kentucky prisons, two of which had an indoor smoke-free policy and one that had a tobacco-free policy, the maximum level of $PM_{2.5}$ in three medium security dormitories was more than double that of the maximum level of $PM_{2.5}$ in minimum security dormitories in the same prisons (McGuire & Connell, 2010).

Research on the effects of tobacco-free policies on the health of inmates has not been published. Given that there have been improvements in lung function and respiratory symptoms after passage of smoke-free laws in communities and countries it is anticipated that a tobacco-free policy in prisons which prohibits all tobacco products on

the grounds would result in improvements in the respiratory health of inmates. The purpose of this study was to evaluate the effect of a tobacco-free prison policy compared to an indoor smoke-free policy on the respiratory health of inmates who have asthma and/or COPD. It was hypothesized that due to expected reductions in the rate of current smoking and subsequent SHS in tobacco-free prisons, inmates in these prisons would use fewer medications for asthma and/or COPD compared to inmates with asthma and/or COPD in prisons that were not completely tobacco-free.

Methods

This study was a multivariate time series analysis to evaluate the effect of tobacco-free policies in two state prisons on the respiratory health of inmates with asthma and/or COPD compared to inmates with asthma/COPD who were incarcerated at two state prisons designated as smoke-free (smoke-free indoors, with smoking allowed outdoors). Medications for asthma and/or COPD including oral medications and inhalers were used as proxy markers for respiratory health. The study period was at least 12 months prior to and 18 months after the implementation dates of the respective policy. Institutional Review Board approval was obtained through the University of Kentucky and in addition, was approved by the Commissioner for the Kentucky Department of Corrections.

Study Setting

Four Kentucky state prisons were chosen for this study, two of which adopted tobacco-free campus policies and two that had indoor smoke-free policies. Blackburn Correctional Complex (BCC) and Kentucky Correctional Institution for Women (KCIW) implemented tobacco-free policies between July and September, 2007. The tobacco-free policy applies to all tobacco products and to all staff, inmates and visitors. The two prisons with smoke-free policies (smoke-free indoors, with smoking allowed outdoors) were Eastern Kentucky Correctional Complex (EKCC) and Little Sandy Correctional Complex (LSCC). Table 3.1 describes the population and the security level of inmates at each prison.

The study prisons could not be matched by security status or gender because security status varied between the two policy study groups and there is only one female prison managed by the KYDOC. BCC is the largest minimum security prison in the KY DOC with the other minimum security prisons having a population of 300 inmates or fewer; matching a minimum security prison of the same size was not possible. Matching prisons based on gender was also not possible since the only other female prison in Kentucky is managed by a private company and comparable data were not available. The majority of the inmates in the two smoke-free prisons (EKCC and LSCC) were in medium security and they live and work "behind the fence" with no access to the free world (see Table 3.1). Inmates living in a minimum security prison such as in BCC usually have fewer restrictions and often work on community needs projects such as road-cleaning crews, and consequently, have more access to the outside world and more opportunity to use tobacco when off the prison campus.

Diamond Pharmaceutical is the vendor for the 13 KY DOC prisons. Prescriptions are electronically ordered by the primary care providers (PCP) at the prisons via the electronic health record (EHR). Once the order is approved by a Diamond pharmacist, maintenance medications are distributed in 30-day blister packs. Some inmates receive medication while being directly observed by medical staff personnel and a corrections officer (Direct Observation Therapy or DOT) while other inmates are permitted to receive a thirty-day supply of medications for self-administration (Self-administered Medications or SAMs). The SAMs inmate population functions similarly to most non-incarcerated patients: they fill or refill medication every month and are responsible for taking their medication without supervision. To refill medications, inmates on SAMs must come to "pill call" which is at a designated time in each prison to request a refill of their medication and then return 2-3 days later to pick up the next month's supply of medication (similar to the non-incarcerated population). Inmates who get their medication by the DOT method must present to "pill call" daily to take their medication directly from medical staff who document acceptance or refusal to take the medication. Refills for DOT medications are requested by prison staff when there is one week's supply of pills left in the blister pack. Very few respiratory medications are administered using the DOT method since most are inhalers and many are used as needed.

Study Sample

The unit of analysis in the study was the number and types of medications for asthma and/or COPD (N = 6,374) that were sent by Diamond Pharmaceutical to the prison each month. These medications were dispensed to 1,109 inmates over the course of the study (see Table 3.4). However, since these data were obtained from the pharmacy vendor only demographic data including inmate number, date of birth, gender and prison were available. Tracking individual inmates' movement between and among prisons was not feasible which precluded a count of medications per treated patient per month since it was unknown on a monthly basis if the inmate continued to be housed in each prison. Inmates typically move multiple times each year between prisons and also shorter trips to court appearances, medical consultations or hospitalizations. Typically inmates move from one prison to another an average of 1.1 times per year and have been reported to move up to seven times in one year (Unpublished, Connell, 2010). With over 1,100 inmates over three years, tracking these data longitudinally was not feasible.

Measures

Medications were in the form of either inhalers or pills. There are two basic types of inhalers for asthma/COPC: rescue inhalers which are used as needed for immediate, short-term bronchodilation and long-term inhalers which are taken daily to reduce airway inflammation and chronic bronchoconstriction. Albuterol, ipratropium bromide and Combivent (albuterol and ipratropium) metered dose inhalers (MDI) were coded as short-acting. Q-var, Advair, Azmacort, and Spiriva were coded as long-acting inhalers. All oral medications were coded as oral (see Table 3.2).

Data from Diamond included the inmate number, birth date, medication, quantity and date the medication was sent to the prison. This date was not necessarily when the inmate picked it up from "pill call" but it is an indicator that the inmate or the DOC staff requested a refill on the medication. The numbers of prescriptions ordered by the PCP for the medication for these drugs were not analyzed because that would not reflect actual use of the medication by the inmate.

The tobacco-free policy was termed "intervention" and was entered as a binary variable of '0' for smoke-free (indoors) at EKCC and LSCC for each month in the entire

study period and 15 months at BCC and 12 months at KCIW prior to the tobacco-free policy. The policy variable was coded as '1' for tobacco-free for the 18 months after implementation of the tobacco-free policy at BCC and KCIW.

In order to calculate the medication rates as metered dose inhalers (MDI) per 1000 inmates, monthly counts of all the inmates in each prison were obtained from the Kentucky Offender Management System (KOMS), the database that tracks all inmate locations and movement. This allowed for equal comparisons among facilities of different sizes. Age was entered as the age when the refill was sent. Smoking history of the sample was not available since the data were derived from the pharmaceutical vendor.

Study Period

The full 36-month period was not available for all four study prisons because Diamond began the contract with the KYDOC on July 1, 2006 (see Table 3.3). For the two tobacco-free prisons (BCC and KCIW), data were available for 18 months after policy implementation, but the pre-policy periods varied. Data were available for 15 months pre-policy at BCC and 12 months pre-policy at KCIW so that the total study period was 33 months at BCC and 30 months at KCIW. For the two prisons with a smoke-free policy (smoke-free indoors, outdoor smoking allowed), data were available for 30 months at EKCC and 18 months at LSCC. The data from Diamond were not available for LSCC prior to July 2007 because the facility had been privately managed by a different pharmacy vendor.

Statistical Analysis

Descriptive statistics were used to summarize the sample of inmates who were taking the asthma/COPD medications including demographic data of gender and age (range and means) in each prison. Race/ethnicity data were not available in the Diamond database.

Poisson regression with a fixed effect for the facility was used in a generalized linear mixed model. The Poisson regression was the most appropriate technique given the small number of inhalers each month since it assumes a non-parametric distribution and determines the rate of medication use from the logarithm of the offset variable. The monthly inmate count in each prison from KOMS data was entered as the offset variable.

Facility was included in the model as a fixed effect and an intervention indicator variable was entered as a binary categorical variable for the smoke-free or tobacco-free policy. ”Month time” was entered as the number of the month in which a particular data point was collected during the course of the study, starting with July 2006 as ‘1’ until the end of data collection which was from 1 to 30 for KCIW and EKCC, 1 to 33 for BCC, and from 13 to 30 for LSCC since the data collection started in July 2007. Seasonality was found not to be significant when a 12-month lag autoregressive term was entered in an autoregressive integrated moving-average (ARIMA) model. Two-way interaction terms were included: month time*facility, intervention*month time, intervention*facility, and a three-way interaction of intervention*month time*facility.

Results

From July 2006 through December 2009, there were a total of 6,374 inhalers and oral medications for asthma and/or COPD dispensed to a total of 1,109 inmates (see Table 3.4). There were differences in the number of inmates among the prisons over the three-year study period ($F = 25.22$, $df = 3$, $p < .001$). KCIW (all female) had almost twice the number of inmates than the male facilities which is likely due to shorter sentencing times and higher turnover of inmates. BCC also had a higher proportion of treated patients for its size suggesting high turnover rates. Among the four different prisons, the mean age at the time the inmate refilled the medication was significantly different with KCIW having the lowest mean age (39.2 years), and BCC having the highest (45.2 years) ($F = .15.56$, $df = 3$, $p = <.001$). However, since BCC and KCIW are the tobacco-free prisons these were grouped together to determine if there was a difference between the two groups of tobacco-free and smoke-free prisons. When the groups were combined, the mean age of the inmates was not significantly different ($F = .78$, $df = 1$, $p = .375$).

Short-acting inhalers were the most commonly used (72.0%); long-acting inhalers second most common (20.2%); and oral medications third (7.8%). There were distinct differences in the proportion of each type of medication by facility with significantly higher rates of use of inhalers at the tobacco-free prisons (BCC and KCIW) than the smoke-free (indoors) prisons (EKCC and LSCC). There were significant differences between the two smoke-free and two tobacco-free prisons for short-acting inhalers ($F =$

401.94, $df = 1$, $p < .0001$), long-acting inhalers ($F = 58.84$, $df = 1$, $p < .0001$), but not for oral medications used for asthma and/or COPD ($F = 1.03$, $df = 1$, $p = .31$). Prescribing differences by the provider were noted particularly with the use of non-formulary drugs (Advair and Spiriva) at the tobacco-free prisons (BCC and KCIW) with none of those two at the smoke-free prisons (EKCC and LSCC). Of the oral medications, theophylline was prescribed more at EKCC than at the other three prisons. Of 259 oral medication refills, 217 (83.8%) were for theophylline compared to an average of 61.3 dispensed at the other three prisons over the study period.

Short-acting Inhaler Use after Tobacco-Free Policy Implementation

The final Poisson regression model for short-acting inhalers showed a significant intervention effect ($F = 7.95$, $df = 101$, $p = .006$). The three-way interaction term of intervention by month time by facility was not significant ($p = .18$) and was removed. Significant two-way interaction effects were observed between intervention*month time ($F = 9.90$, $df = 99$, $p = .002$) and between month time*facility name ($F = 7.95$, $df = 99$, $p < .0001$). Since the log of the monthly inmate count from KOMS was used as an offset variable, the model for short-acting inhalers is:

$$y = e^{\beta 0} + e^{\beta 1 \text{intervention}} + e^{\beta 2 \text{facility}} + e^{\beta 3 \text{month time}} e^{\beta 4 \text{ month time*facility} +} e^{\beta 5 \text{intervention*month time}}$$

A graph of the output from the regression model for short-acting inhalers is shown in Figure 3.1. At the tobacco-free prisons (BCC and KCIW), the rate of short-acting inhalers was decreasing prior to implementation of the tobacco-free policy (marked by the dotted vertical lines). The inhaler use dropped in the month after the policy was implemented but increased gradually back to the level of use prior to policy implementation within 12 months at BCC and 14 months at KCIW. Inhaler use gradually increased at EKCC and decreased at LSCC (smoke-free indoors).

Long-acting Inhaler use after Tobacco-Free Policy Implementation

The model for long-acting inhalers was significant with a three-way interaction effect of intervention by month time by facility ($F = 20.59$, $df = 99$, $p < .0001$). Figure 3.2 displays the results of the regression model for long-acting inhalers with the intervention effect. At the prisons that became tobacco-free (BCC and KCIW) there were opposite

effects before and after the tobacco-free policy was implemented. Prior to the implementation date at BCC, the use of long-acting inhalers was gradually decreasing but was increasing at KCIW. However, after the policy was implemented, the rate increased monthly at BCC and decreased at KCIW. Rates of use returned to the rate prior to the policy date within 7 months at BCC. The rate at KCIW did not return to baseline by the end of the study period. The two prisons with indoor smoke-free policies (EKCC and LSCC) also had opposite trends in long-acting inhaler use with gradual increases at EKCC and decreased use at LSCC.

Oral Medication Use after Tobacco-Free Policy Implementation

Oral medications use was not significantly affected by the tobacco-free policy implementation (F=0.00, df = 102, $p < .99$). There was a two-way interaction between month time and facility (F=6.86, df = 102, p = .0003) in which the rate of use of the medications changed over time with the rate of use of oral medications decreasing over the study period at EKCC and LSCC (smoke-free indoors) and increasing at BCC and KCIW (tobacco-free prisons) (see Figure 3.3).

Discussion

This study was designed to determine the effect of tobacco-free prison policy on the respiratory health of inmates with asthma and/or COPD. Respiratory health was measured by the proxy use of short- and long-acting inhalers and oral medications. The hypothesis that tobacco-free policies would result in improvements in respiratory health as indicated by decreased use of medications for asthma and/or COPD was partially supported. There was an immediate effect of the tobacco-free policy on the use of short-term inhalers such as albuterol and ipratropium within a month after the policy was implemented. However, the rate of use gradually increased to the level prior to the policy implementation within 12 to 15 months at the tobacco-free prisons. The rate of refills of long-acting inhalers had opposite trends before and after implementation of the tobacco-free policy. There was no effect of the policy intervention on the use of oral medications but there seemed to be a prescribing effect by the primary care providers with differences in the use of certain medications in the four prisons.

The results pose more questions than answers about the inconsistent effect of the tobacco-free policy given that improvements in respiratory health have been seen in the non-incarcerated population following smoke-free laws in public places and workplaces. The reasons for this are that inmates may continue to smoke after tobacco-free policies have been implemented or that the security status of the prison allowed for easier access to tobacco following policy implementation. Inmates tend to continue smoking after prisons adopt comprehensive smoke-free policies or tobacco-free policies, with 76% of male inmates reporting smoking one month after a comprehensive smoke-free policy (indoors and out) was implemented (Cropsey & Kristeller, 2005b). Inmates in a prison that had adopted a complete tobacco-free prison policy reported that 42% continued to smoke compared to 64% in a prison that had an indoor-only tobacco-free restriction (Proescholdbell, et al., 2008).

The security status of the prisons may affect the use of tobacco and the enforcement of the policy. Access to tobacco is greatest in minimum security status prisons according to inmates and officers (Lankenau, 2001). There are fewer restraints such as barbed wire fences, guard towers and many are more farm-like which gives inmates the opportunity to obtain tobacco from outside sources or while they are on work-release in the community. The two tobacco-free prisons in this study were BCC which is a 500 acre minimum security prison with no fences and KCIW which houses medium and minimum security inmates. The two tobacco-free prisons (BCC and KCIW) also differ from the two smoke-free (EKCC and LSCC) prisons by having a more rapid turnover. BCC is the facility that inmates move to as a step-down from higher security levels in the year prior to discharge so most are housed there for less than one year. Women tend to have shorter sentences than men. The influx of new inmates may affect the medication refill rate as inmates move to tobacco-free prisons from other prisons and, as a matter of course, get their chronic medications refilled. Inmates who move to these prisons also may have been smoking and continue to have respiratory symptoms after entry to a tobacco-free prison.

Enforcement of the smoke-free and tobacco-free policies may have affected the findings of this study. Implementation effectiveness can affect the current smoking rate and SHS exposure (Lee, et al., 2009) which could affect respiratory health indicators.

Enforcement may have been stronger immediately after the policy went into effect and waned over time given that the use of short-term inhalers decreased significantly in the few months afterwards and within a year or so was back to the previous level. Approximately two years after BCC and KCIW became tobacco-free prisons, a study measuring $PM_{2.5}$ levels in two dormitories in each of the four prisons used in this study was conducted (Unpublished, McGuire & Connell, 2010). At BCC (tobacco-free) which is all minimum security, the maximum $PM_{2.5}$ was 11.2 $\mu g/m^3$ in one dormitory and 30.4 $\mu g/m^3$ in a second. At KCIW (tobacco-free) the maximum level in two dormitories was 4.1 $\mu g/m^3$ and 15.0 $\mu g/m^3$. At the two smoke-free prisons (EKCC and LSCC), the highest level in a medium security dormitory at each prison was 37.5 and 37.1 $\mu g/m^3$ but was 16.5 and 17.4 $\mu g/m^3$ in a minimum security dormitory at the same prisons indicating that there may be variations in enforcement of the policy within prisons which may affect the respiratory health indicators measured in this study.

The study results indicate that primary care providers such as the physicians and nurse practitioners need to continue to counsel their patients on tobacco cessation regardless of the tobacco policy of the prison. In prisons with indoor smoke-free policies, providers should also encourage current smoking inmates not to smoke indoors to reduce the exposure to non-smoking inmates. In prisons with tobacco-free policies, providers should not assume that inmates are not smoking once the policy is implemented.

The main policy implication is that the success of a tobacco-free policy in reducing the use of tobacco depends on the consistent enforcement of the policy in dormitories and outside. Most states report that tobacco becomes the most common form of contraband after a tobacco-free policy is implemented which to many administrators is better than smuggling heroin (NCCHC, 2004). This presents challenges to correctional officers who have many other forms of contraband to deal with including cell phones, knives (shivs), and illicit drugs. A replication of this study in a tobacco-free medium security prison in which tobacco is harder to smuggle would help to determine the effect of the looser structure of a minimum security prison on the effect of the policy.

Limitations

The primary limitation in this study was the lack of longitudinal inmate movement data which are available in the Kentucky Offender Management System (KOMS). Longitudinal person-level data that tracks the location of the inmates each month would allow for calculation of the rate of medication use per inmate with asthma and/or COPD, as opposed to the rate of medication use per capita in each prison. The inmate movement is the critical piece of missing data since it was not possible to determine if an inmate did not refill a medication, whether the inmate had better asthma/COPD control, or whether he or she had been moved to another prison or was discharged. The rate of turnover in the prisons was not available to control for the influx and outflow of inmates. These data may be available from the KY DOC but is more likely to be aggregated quarterly or yearly rather than daily. Also, in this study, since the data were obtained from the pharmaceutical vendor, demographics such as race/ethnicity, co-morbidities, or other medication use was not entered into the model. Smoking status of the inmates was also not known.

A second limitation is that enforcement was not assessed and air quality was not measured before and after the tobacco-free policy to document compliance with the policy. The study using $PM_{2.5}$ in the four prisons was done two years after the tobacco-free policy was implemented, and pre-policy air quality data are unknown. The best way to gauge enforcement would be to measure $PM_{2.5}$ before and at varying time periods after to assess policy compliance over time.

The third main limitation was that the tobacco-free policy was implemented in the two prisons with more rapid turnover rates and many if not all, minimum security inmates (BCC and KCIW) than the smoke-free prisons which were 95% medium security (EKCC and LSCC). Kentucky State Reformatory (KSR) is a tobacco-free, medium security prison and the medical facility for the state and has a more stable population with fewer turnovers due to housing inmates who are more ill. However, medication data were not available prior to the prison becoming tobacco-free because Diamond pharmaceuticals did not have the contract with the KY DOC prior to the tobacco-free policy implementation at KSR.

Future research is suggested using a prospective study of inmates with a diagnosis of asthma and/or COPD in Kentucky prisons with varying levels of tobacco-free policy. These inmates could be assessed for biomarkers of SHS exposure, demographic data and FEV_1 measurements, salivary cotinine levels, personal smoking history and movements between prisons to control for person-level data and the influx of inmates into and out of prisons with different tobacco policies. EHR records of provider prescriptions could be documented as a control variable. These data could be entered in a generalized linear regression model to determine the effect of the tobacco policy on biological markers of smoke exposure and lung function.

The optimal time to conduct a policy analysis study on health outcomes is when an entire state Department of Corrections adopts a tobacco-free policy such as in 2010 when Nevada, Virginia, North Carolina and Georgia become tobacco-free in all prisons simultaneously. In this setting all inmates receive the same intervention (i.e., tobacco-free policy) so that the only inmate movement data needed would be the dates of admission and discharge into and out of the prison system. Month by month tracking would not be necessary since every prison would have the same policy.

Conclusion

The hypothesis that there would be a reduction in inhaler and oral medication use after the implementation of a tobacco-free policy in Kentucky state prisons was partially supported. There was an immediate reduction in use of short-term inhalers following the tobacco-free date in both of the intervention prisons but the rate gradually increased to baseline within 12 to 15 months. The turnover of inmates in the two prisons with a tobacco-free policy is postulated as the most likely reason for this gradual increase in short-term inhaler use but movement data were not available from the pharmaceutical vendor. The logistical issues of tracking thousands of inmates over time intervals from one movement to the other precludes the use of KOMS data unless it were for a smaller sample.

Given the improvements in respiratory health indicators in the non-incarcerated population secondary to smoke-free laws in public places and workplaces and the short-term benefit of the tobacco-free policy in this study, comprehensive tobacco-free prison

policies may improve the respiratory health of inmates. Enforcement of tobacco-free policies is the key to implementation effectiveness especially in minimum security prisons where tobacco may be more readily accessible.

Table 3.1 Characteristics of accessible population of prisons by policy status

Prison	Average Inmate Population	Gender	Security Status	Policy Status
Blackburn Correctional Complex (BCC)	594	Male	Minimum	Tobacco-free prison policy Sept 17, 2007
Kentucky Correctional Institution for Women (KCIW)	682	Female	Minimum/Medium/ Maximum/Death Row	Tobacco-free, prison policy July 1, 2007
Eastern Kentucky Correctional Complex (EKCC)	1689	Male	Medium (1639 inmates) Minimum (50 inmates)	Smoke-free inside only
Little Sandy Correctional Complex (LSCC)	992	Male	Medium (892 inmates) Minimum(100 inmates)	Smoke-free inside only

Table 3.2 Study variables

Variable Name	Coding	Type of Data
Facility Name	Name of prison (BCC, KCIW, EKCC, LSCC)	Nominal
Tobacco policy	'0' for smoke-free (indoors) '1' for tobacco-free	Nominal
Month Time	Number of months during the study period starting with July 2006 as '1' to '33' for BCC in March 2009	Continuous
Age at Fill	Age calculated as the age at the time of refill	Continuous
Inmate Count	Monthly inmate count in each prison from KOMS	Continuous
Short Acting Inhaler Use	Short-acting inhalers (Albuterol, Ipratropium bromide)	Nominal
Long Acting Inhaler Use	Long-acting inhalers (Q-var, Advair, Azmacort, Spiriva)	Nominal
Oral Medication Use	Oral (Theophylline, Terbutaline, Singulair, Accolate)	Nominal

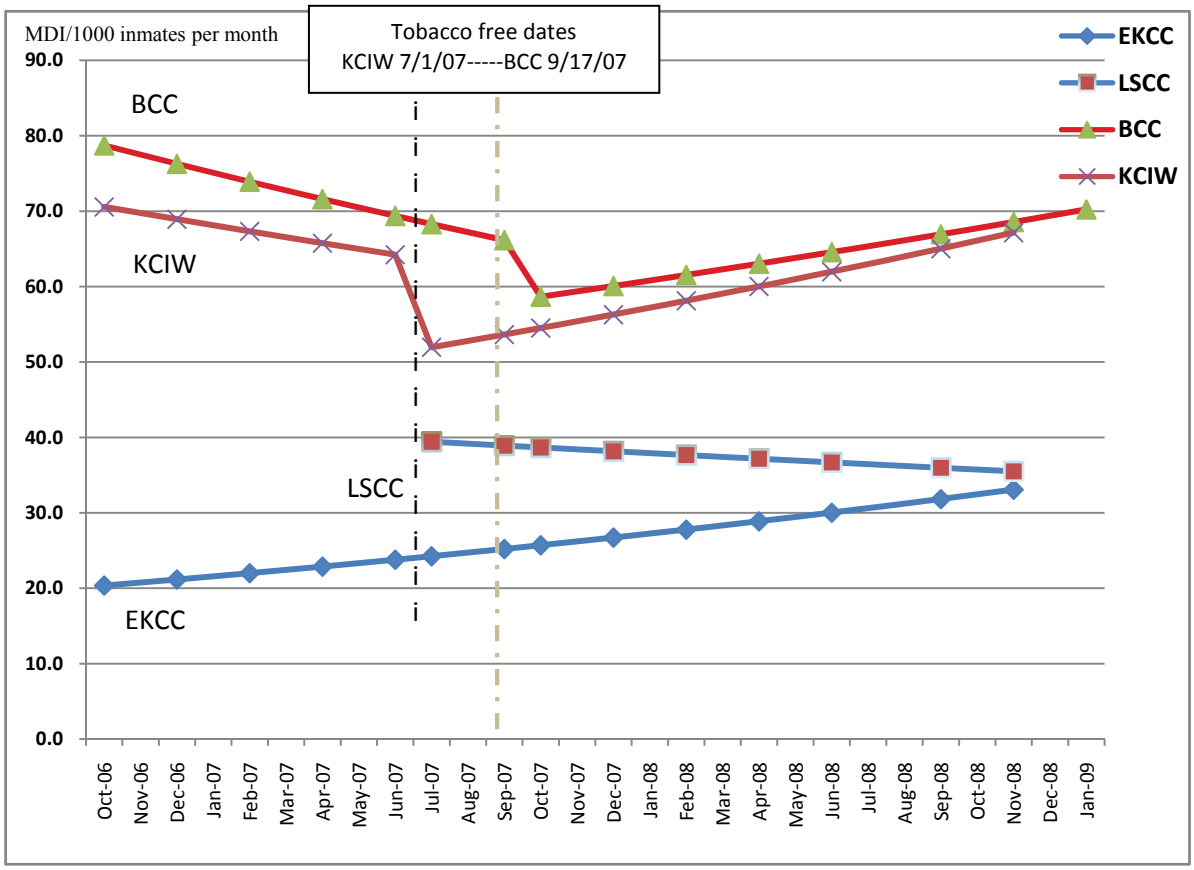
Table 3.3 Study period dates in each prison

Prison	Study start date	Tobacco-free date	Study end date	Number of months in study
Blackburn Correctional Complex (BCC)	July 1, 2006	Sept 17, 2007	March 31, 2009	33
Kentucky Correctional Institution for Women (KCIW)	July 1, 2006	July 1, 2007	December 31, 2009	30
Eastern Kentucky Correctional Complex (EKCC)	July 1, 2006	NA	December 31, 2009	30
Little Sandy Correctional Complex (LSCC)	July 1, 2007	NA	December 31, 2009	13

Table 3.4 Demographic data by inmate and medications

Demographic data	Total	Tobacco-free prisons		Smoke-free (indoor) prisons	
		BCC	KCIW	EKCC	LSCC
Total population		594	682	1689	992
Total sample of inmates	1109	281	461	240	127
Age Range	19-75	20-75	19-64	20-75	19-75
Age Mean	41.7	45.2	39.2	40.7	41.7
Gender	M/F	Male	Female	Male	Male
Total medications	6374	1898	1622	1905	949
Short-acting inhalers	4587	1437	1220	1313	617
Long-acting inhalers	1289	380	305	333	271
Oral medications	498	81	97	259	61

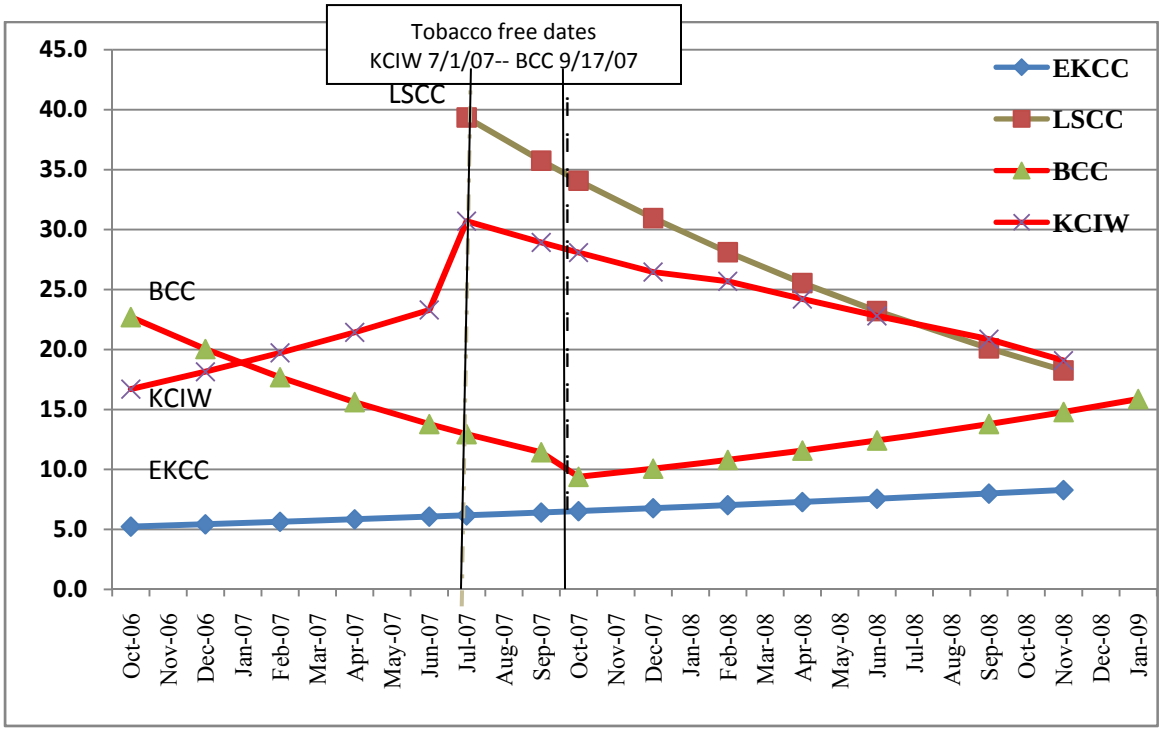
Figure 3.1 Short-acting inhalers (MDIs per 1000 inmates per month)



Tobacco-free prisons: BCC and KCIW

Smoke-free prisons: EKCC and LSCC

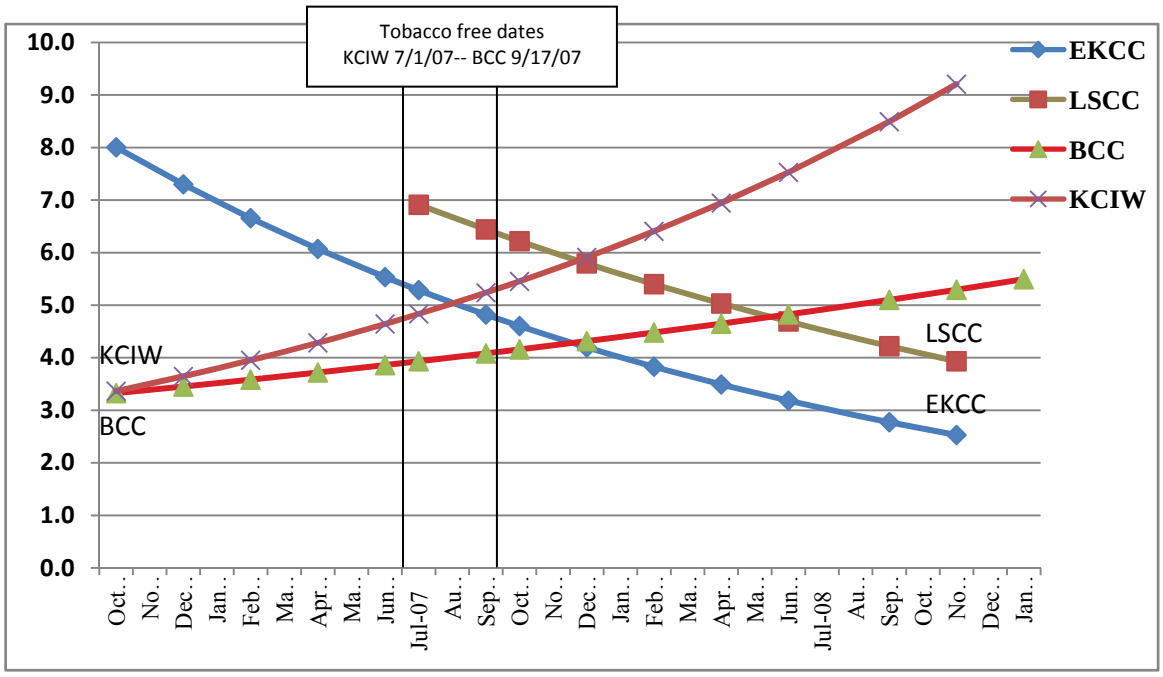
Figure 3.2 Long-acting inhalers (MDIs per 1000 inmates per month)



Tobacco-free prisons: BCC and KCIW

Smoke-free prisons: EKCC and LSCC

Figure 3.3 Oral medication use (Theophylline, Terbutaline, Singulair, Accolate)



Tobacco-free prisons: BCC and KCIW

Smoke-free prisons: EKCC and LSCC

CHAPTER 4: TOBACCO-FREE PRISON POLICY AND ACUTE MYOCARDIAL INFARCTION AMONG INMATES

Synopsis

Purpose: The purpose of this study was to determine the effect of a tobacco-free policy on the hazard of acute myocardial infarctions (AMI) in inmates compared to inmates in prisons that had indoor smoke-free policies. Smoke-free in the KY DOC means that there is no smoking indoors but outdoor smoking is allowed. Tobacco-free means that no tobacco of any kind is allowed on the grounds of the prison.

Hypothesis: It was hypothesized that there would be a lower hazard for having an AMI in the tobacco-free prisons than the smoke-free (indoors) prisons, where 70% of the inmates could continue to smoke outside.

Method: The study design was a retrospective survival analysis on the time to first AMI using censored intervals with tobacco policy status (tobacco-free or smoke-free) of the prison as the primary predictor variable.

Sample: A list of all inmates (N = 87) who had a hospital discharge diagnosis of AMI between January 1, 2005 through December 31, 2009 in six state prisons in Kentucky was obtained from the health care management company for the KY DOC.

Results: The hazard ratio for an AMI for the time inmates were housed in a prison with an indoor smoke-free policy was 2.87 compared to the time spent in a tobacco-free environment after controlling for facility, past smoking status, co-morbidities, race and age.

Conclusions: There is an increased hazard for having an AMI while living in a prison with an indoor smoke-free policy where smoking is allowed outdoors which may be a result of current smoking by approximately 70% of inmates and subsequent outdoor secondhand smoke (SHS) exposure for non-smoking inmates. There is a clear policy implication for prisons to adopt tobacco-free policies instead of indoor smoke-free policies to improve the health of inmates.

TOBACCO-FREE PRISON POLICY AND ACUTE MYOCARDIAL INFARCTIONS AMONG INMATES

Introduction

Cigarette smoking is the leading cause of death in the United States, causing 21% of all deaths. Secondhand smoke (SHS) is estimated to cause between 57,800 to 97,700 AMIs annually and between 33,500 and 56,900 deaths from coronary heart disease per year (Lightwood, et al., 2009; Peto, et al., 2006). SHS has been estimated to cause 80% to 90% as much damage as smoking (Barnoya & Glantz, 2005). Secondhand smoke is defined by the American Cancer Society (ACS) as a combination of sidestream smoke which is the smoke from the end of a lit cigarette, cigar or pipe, and mainstream smoke which is the smoke exhaled by the smoker (ACS, 2010). The 2006 Surgeon General's report on "The health consequences of involuntary exposure to tobacco smoke" reviewed the scientific evidence to date and concluded that there is no risk-free level of exposure to SHS and that separate smoking areas within a building cannot eliminate SHS (USDHHS, 2006).

Outdoor SHS also produces measurable levels of nicotine in non-smokers. In a study of 10 non-smokers who spent an average of 25 days at outdoor bars and restaurants that allowed smoking in Athens, Georgia, salivary cotinine, a nicotine metabolite, increased by up to 162% from baseline after outdoor SHS exposure (Hall, et al., 2009). Outside nightclubs in Athens, Greece, the average outdoor level of fine particulate matter ($PM_{2.5}$) from the burning end of a cigarette was 32.2µg/m^3, exceeding the standard maximum level set by the Environmental Protection Agency (EPA) of 15 µg/m^3 for annual exposure and is close to the 24-hour standard of 35 µg/m^3 (EPA, 2009).

The overall relative risk for coronary heart disease for people who smoke is 1.78 and 1.31 for people exposed to SHS (Barnoya & Glantz, 2005). However there is a dose-dependent effect from increasing cigarette exposure as reported in a large international study, the INTERHEART study which was designed to examine cardiovascular risk factors for acute myocardial infarction (AMI) including the effects of smoking and secondhand smoke on the risk for AMI (Teo, et al., 2006). The study enrolled 15,152

cases of first AMI matched by age and sex with 14,820 controls in 52 countries. The odds ratio (OR) for AMI increased by 1.056 for every additional cigarette smoked per day so that a person who smoked 40 cigarettes per day had an OR of 9.16. There was an increased risk of AMI with increasing hours of SHS. The OR for having an AMI was 1.24 with 1 to 7 hours per week of SHS which increased to 1.62 for people living with a spouse who smoked or who were exposed over 21 hours per week.

Smoke-free legislation in communities, states, and nations, has resulted in reductions in the incidence of acute myocardial infarctions (AMI) as concluded by the Institute of Medicine (IOM) (IOM, 2009). The 2009 IOM report summarized the data on the incidence of AMI following smoke-free policies in 11 national and international locales and found that there is sufficient evidence to infer a causal relationship between SHS and coronary heart disease and that smoke-free policies reduce the risk for AMI.

The first report on the incidence of AMI following enactment of a smoke-free ordinance was from Helena, Montana in 2002. Over the next six months there was a 40% reduction in AMIs (Sargent, et al., 2004). A time-series study using the 18 month period before and after an ordinance was implemented in Pueblo, Colorado found a 27 percent reduction in AMI hospitalizations in the City of Pueblo and no decrease in the adjacent county where public smoking was allowed (Bartecchi, et al., 2006). New York State passed a comprehensive smoke-free policy in 2003. In the following year there were 3813 fewer hospital admissions (8% reduction) for AMI than expected after adjusting for seasonal and secular trends (Juster, et al., 2007).

Reductions in AMI have also been reported at the national level after countries have enacted smoke-free policies in indoor public places. The hospitalization rate for AMIs in a region of Italy decreased by 11% among people less than age 60 after a prohibition on indoor smoking in public places in 2005 (Barone-Adesi, et al., 2006). In the 10 months after smoking was prohibited in public places in Scotland, there was a 17% reduction in the incidence of hospitalizations for AMI compared to a 4% reduction in England which did not have a smoke-free policy (Pell, et al., 2008). Two meta-analyses on studies on AMI incidence following smoke-free policies found that there was a 17% reduction in the rate of hospitalizations for AMI worldwide where smoke-free policies were enacted (Lightwood & Glantz, 2009; Meyers, et al., 2009). The research is clear that

smoke-free legislation reduces AMIs but there is no research on the effects of comprehensive smoke-free (indoors and out) or tobacco-free prison policies on AMIs among inmate populations.

Tobacco use and policy in United States prisons

In the United States, prison inmates as a sub-population have three times higher rates of current cigarette smoking than the non-incarcerated population, with current smoker rates reported from 42% to 91% with an average of 70 to 74% (Cropsey, et al., 2006; Durrah, 2005). Tobacco related disease is common in inmates. The leading cause of death in inmates is cardiovascular disease, as it is in the general population, accounting for 27% of the deaths in state prisons between 2001 and 2004 (Mumola, 2007).

The cost of health care from tobacco-related diseases is a primary reason that correctional departments have adopted increasingly restrictive tobacco policies. The Kentucky Department of Corrections (KY DOC) reported that the highest medical cost by category was for the treatment of diseases of the circulatory system: $3.4 million in the 10 months from July 1, 2008 to April 30, 2009 (Upton & Spaulding, 2009). The United States Supreme Court determined that deliberate indifference to inmates' serious medical needs constituted an Eighth Amendment violation ("Estelle v. Gamble," 1976), so that inmates must receive health care which cost $3.3 billion in the 50 state prison systems in 2001, representing 12% of the total operating cost (Stephan, 2004).

Smoke-free and tobacco-free policies are becoming more prevalent in correctional systems. By 2004 the majority of state correctional departments and the Federal Bureau of Prisons had adopted indoor smoke-free policies which allow outdoor smoking only or limited indoor smoking in designated areas (Zoroya, 2004). Due to the health effects of cigarette smoking and SHS on health and the cost of providing health care to inmates, in the past five years more State Departments of Corrections have adopted tobacco-free policies prohibiting all tobacco products on the prison campus for staff, visitors, or inmates. With a tobacco-free policy, tobacco is considered contraband in the same manner as illicit drugs, weapons or cell phones, and may carry a misdemeanor charge in some states and a felony charge in others such as New York and Texas (Byrne, 2006; Wilcox, 2007a). Tobacco, however, continues to make its way into prisons and a survey

by the National Correctional Commission on Health Care (NCCHC) (NCCHC, 2004) reported that, following a complete tobacco-free policy, tobacco usually overtakes heroin as the primary smuggled drug.

Air quality studies in prisons have shown that there can be significant reductions in SHS following tobacco-free policies but enforcement of the policy is a critical factor in reducing tobacco use. In North Carolina there was a 98% decrease in SHS as measured by $PM_{2.5}$ in a dormitory where the level was 305 $\mu g/m^3$ before a tobacco-free policy and 6.5$\mu g/m^3$ after the policy was implemented (Proescholdbell, et al., 2008). However, enforcement of the policy may vary even within prisons. In three Kentucky prisons in which indoor smoking was prohibited, the highest level of $PM_{2.5}$ in three medium security dormitories was more than double that of minimum security dormitories in the same prisons (McGuire & Connell, 2010).

Health outcome studies on the effects of smoke-free or tobacco-free prison policies have not been reported in the literature. The purpose of this study was to determine the effect of a comprehensive tobacco-free policy on the hazard ratio for AMI in prisons with smoke-free (indoors) policies compared to prisons that had tobacco-free policies. Tobacco-free in the KY DOC means that no tobacco of any kind is allowed on the grounds of the prison. Smoke-free in the KY DOC indicates that there is no smoking indoors but outdoor smoking is allowed. It was hypothesized that there would be a lower hazard for having an AMI in the tobacco-free prisons than the smoke-free (indoors) prisons. Approval was obtained from the University of Kentucky Institutional Review Board and the Commissioner for the KY DOC.

Methods

The study design was a retrospective survival analysis on the time to first AMI using censored intervals with tobacco policy status (tobacco-free or smoke-free) of the prison as the primary predictor variable. Data were collected from three sources: CorrectCare, the KY DOC and the electronic health record (EHR). CorrectCare provided a list of all inmates from the six study prison sites who had a hospitalization with a discharge diagnosis of AMI from the time when CorrectCare commenced its contract

with the KY DOC starting on January 1, 2005 through December 31, 2009. Inmates who did not have an AMI during this 5-year period were not included in the study sample.

Setting

In 2003 the KY DOC formed a public/private partnership called the Kentucky Corrections Health Services Network (KCHSN) in order to manage the health care of inmates in the state prisons and contain costs while at the same time improving quality of care. The three KCHSN partners are the KY DOC, the University of Kentucky, and CorrectCare Integrated Health, Inc, a for-profit health management company. KCHSN implemented a comprehensive electronic health record (EHR) that allows access to the medical status, history, and medication record of each inmate. Secondary care data refers to any health care that was received by the inmate while away from the prison and is tracked by CorrectCare. This includes the cost and related data for hospitalizations and specialty consults.

There are 16 State prisons in Kentucky, three of which are privately managed. The overarching policy for the KY DOC is an indoor smoke-free policy in which indoor smoking is prohibited and outdoor smoking is allowed. Of the 13 state-managed prisons, four have adopted a tobacco-free policy in which no staff or inmate may have tobacco of any type on the prison campus. There is also a fifth tobacco-free prison in Kentucky which housed female inmates but it is one of the privately managed prisons and has a separate medical company managing the health care of the inmates.

Six Kentucky prisons were chosen as study sites, three of which had tobacco-free policies and three that had smoke-free (indoors) policies. Kentucky Correctional Institution for Women (KCIW), Blackburn Correctional Complex (BCC) and Kentucky State Reformatory (KSR) implemented tobacco-free policies between 2006 and 2007 (see Table 4.1). The two other tobacco-free prisons in Kentucky were not appropriate for the study due to one being the assessment center for the KY DOC where inmates stayed for less than a month on average and the other being a privately managed prison with a different health care management company. The three tobacco-free prisons used in the study were fairly unique within the state system, preventing matching prisons by gender or security status. KCIW is the only female prison that is managed by the KY DOC. BCC is the only minimum security prison which houses more than 300 inmates so there was

not a match of equivalent size by security status. KSR is the largest prison in the state and is comparable in size and security status to EKCC, since both are medium security prisons with over 1600 inmates. KSR is unique in that it houses inmates who have more complex medical needs and includes a 58 bed nursing care facility. Three prisons with indoor smoke-free policies (outdoor smoking allowed) were chosen randomly from the remaining KY DOC prisons since matching was not possible (see Table 4.1). These three were Eastern Kentucky Correctional Complex (EKCC), Little Sandy Correctional Complex (LSCC) and Luther Luckett Correctional Complex (LLCC). Table 4.1 shows the population and smoking status of each prison. Each of the medium security prisons houses a few minimum security inmates who live "outside the fence" and do maintenance work on the property.

To provide information on where the inmates had been housed for at least six years prior to their first AMI, Kentucky Offender Management System (KOMS) data of inmate movements from January 1, 1999 through December 31, 2009 was provided by the KY DOC for each of the inmates who had AMIs. KOMS is a database that contains demographic data, sentencing information and movement of inmates from prison to prison or whenever they leave the prison (i.e., for medical appointments, hospitalizations or court appearances).

Sample

There were 87 inmates from the six prisons during the period from January 1, 2005 through December 31, 2009 who had a hospital discharge diagnosis of AMI (see Table 4.2). The racial distribution was similar to the Kentucky offender population with 64.5% Caucasian, 27.5% African American and 8% unknown. In 2009, the KY DOC had a racial distribution of 64% Caucasian, 34% African American and 2% other. Of the 87 inmates who had an AMI, all but one was male. The age range for the sample was 24 to 84 years of age with a mean of 56.4 years (SD = 11.32).

The majority of inmates had at least one co-morbidity of diabetes, hypertension and/or hyperlipidemia. Seventy-five inmates (86.2%) had hypertension and 71 (81.6%) at least two co-morbidities. Only five inmates had no diagnosis of hypertension, hyperlipidemia or diabetes. Data were unavailable for four inmates because the EHR was

implemented incrementally starting at KSR in June 2005 and the AMI occurred prior to that time.

KSR is the primary medical facility for the KY DOC and 50.6 of the AMIs occurred while inmates were living at KSR (n = 44). There were 19 AMIs in the 16 months prior to the tobacco-free date and 25 in the 43 months after the policy was implemented. EKCC is the second largest prison next to KSR. Inmates who are minimum security with medical conditions are typically housed at BCC. There were 18 AMIs at EKCC, 7 at LSCC and 9 at BCC. Six AMIs happened at BCC prior to the tobacco-free date and three occurred after. Two inmates had AMIs while incarcerated in a jail and a halfway house. The inmates who had AMIs in the jail and halfway houses are state inmates but were housed outside of the 13 KY DOC prisons since approximately 7,000 of the 20,000 KY inmates are housed outside of the state prisons.

The longest stay in one facility was 3,449 days. The majority of inmates moved from prison to prison multiple times with only 29 (33%) moving less than once a year. The greatest number of moves for one inmate was seven times in one year and the most total movements was 24 for one inmate over a 7 year period. The mean number of prison moves was 1.1 per year for the total sample. There were four inmates who stayed in one prison for the length of their incarceration during the study period.

Measures

Time to the first AMI was the primary outcome measure. Since this was a survival analysis, subsequent AMIs were not included in the analysis to avoid duplication of time intervals. AMI was defined as a hospital discharge diagnosis of ICD-9 codes 410.0 to 410.99. Demographic data such as age, race/ethnicity, co-morbidities, past and current smoking history were derived from the EHR. Age for each time interval was calculated as the average age over that time period (‘age during’). Racial data were derived from the EHR and were not available for all inmates. Co-morbidities of diabetes, hypertension and hyperlipidemia were elicited from the problem list in the EHR.

A binary variable was created identifying the tobacco policy of the prison during a particular time interval. The values of the binary indicator variable for smoking policy were ‘1’ (indoor smoke-free policies in which smoking was allowed outdoors) and ‘0’ (tobacco-free prisons prohibiting all tobacco products on the grounds of the prison).

Facility data were recorded as KSR, EKCC, LSCC, BCC and Location Other. Location Other included one AMI at KCIW and eight AMIs that occurred at other facilities. CorrectCare recorded the prison to which the inmate was discharged on the billing data and eight of the inmates were discharged from hospital to KSR since it is the medical facility but had their AMI in other prisons. KOMS inmate movement data were used to determine where the inmates were residing at the time of their first AMI.

Past smoking was recorded as any report of smoking in the chart from the intake history, the problem list or the clinical notes. The EHR had documentation that 61 (70.1%) inmates were past smokers, four (4.6%) had never smoked, and 22 (25.3%) had no smoking history information. Current smoking indicates that at the last entry noted in the chart, the inmate continued to report that he was smoking. However, after inmates moved to a tobacco-free prison in which tobacco was completely prohibited, the providers generally did not ask about smoking history. At the last entry documented in the EHR there were 49 (56.3%) current smokers and 15 (17.2%) non-smokers, with no information on 23 (26.4%) but the quit dates for the non-smokers were not documented in relation to the AMI occurrence so current smoking history was not used in the analysis.

Statistical Analysis

Cox regression, a type of survival analysis using a proportional hazards model (Garson, 2010), was used to analyze the time to first AMI. This regression analysis is appropriate for determining the effects of one or more predictor variables on an outcome that is censored (i.e., it measures time to an event that may not have yet happened for all observations). Those observations for which the event has not yet occurred are treated as censored, while those with an event are not censored. In this study, the dependent variable was time to an inmate's first AMI. Each observation or time interval was entered as a censored or not censored interval based on whether the AMI occurred during that time period. The tobacco policy at each time period was the primary predictor variable. The hazard ratio is the main statistical output and indicates the likelihood of an event occurring in a given time period which has associated variables (i.e., tobacco policy status) compared to another time period that does not have these variables (Garson, 2010). The hazard ratio is a summary of the probability of events per unit time. If there are many unit-times, there is a greater probability of an event occurring.

Each time interval had a tobacco-related policy covariate associated with it; this variable was a binary variable that indicated whether the facility was smoke-free or tobacco-free. Time intervals were the number of days the particular inmate spent at a given facility before being moved to another location. KOMS data listed every movement after 1/1/1999. In some cases in which an inmate had been committed prior to 1999, the first movement from a particular prison was at some future date, indicating that the inmate had been housed in that prison since 1/1/1999. The duration of time between 1/1/1999 and the time of the first movement was calculated. Likewise, the last documented movement may have been years prior to the end of the study period. In these cases, the date of the last movement until the end of the study period on 12/31/2009 was calculated as a time interval since this indicated that the person had stayed at that same prison until 12/31/2009. Each time interval was recorded as days which could last for less than one day if the person went out and back in a day or potentially up to 4,015 days if the person stayed in one facility for the entire 11 years.

Some of the time intervals extended over the time when the prisons became tobacco-free. To account for this situation, the total time period was divided into two time periods: one before the tobacco-free policy and one time-period after the tobacco-free policy. Table 4.3 provides an example of one inmate's movements between facilities over the study period. The inmate in the example moved to four different prisons between 1/23/2005 and 12/31/2009, the end of the study period. Between 5/12/2005 and 2/14/2008, the inmate resided in KCR which became tobacco-free on 5/1/2006. This time interval between 5/12/2005 and 2/14/2008 was analyzed as two time periods for this inmate, namely before and after the tobacco-free date. For prisons that had not yet become tobacco-free by the conclusion of the study period (12/31/2009), the tobacco-free date was listed as 1/1/3000 so that any time intervals prior to this date were identified with a value of 1 for the binary smoking policy variable (i.e., which indicated smoking is allowed outdoors). For example, the inmate in Table 4.3 had an AMI on 2/14/2008. Thus for each time interval before this date, the time interval was censored (since the AMI had not yet occurred) and the time interval when the inmate was hospitalized for the AMI was not censored. The date of the first AMI was the stop date for calculating censored

intervals since the survival analysis is designed to determine the time to an event. Therefore, the next line of movement after the AMI date was deleted.

Race, past smoking status, average age during each time period and co-morbidities of diabetes, hypertension and/or hyperlipidemia were entered as covariates. Facility data were entered with five levels including KSR, EKCC, LSCC, BCC and Location Other. Two-way interactions were added for policy-smoke by age-during, policy smoke by facility, policy smoke by past smoker, and policy smoke by race. The model was weighted by the length of time in days that the person was incarcerated between 1/1/1999 and 12/31/2009.

Results

Proportional hazards model

The initial proportional hazards model that included the facility tobacco policy indicator variable, location, age during each interval, past smoker and race had a good fit with a likelihood ratio that was significant (χ^2 =.21.95, *df*=10, *p* =.02). The predictor variable was the tobacco policy of the facility, i.e., smoke-free (indoors) or tobacco-free. The hazard ratio for having an AMI in prisons with an indoor smoke-free policy where outdoor smoking was allowed compared to tobacco-free prisons was 3.34. When inmates' co-morbidities were added to the model including diabetes, hypertension and hyperlipidemia, the final model had a better fit with a significant likelihood ratio (χ^2 = 36.17, d*f*= 14, *p* = .001) (see Table 4.4). in the final model, the hazard ratio for having an AMI while housed in a smoke-free prison compared with tobacco-free facilities was 2.87 (*p* = .03).

Having been a past smoker had a hazard ratio of 1.28 compared to being a non-smoker which was not significant (χ^2 = 4.62, d*f*=2, *p* = .10) but was 2.12 for inmates whose smoking history was unknown compared to past smokers (χ^2 = 4.05, *df*=1, *p* =.04). Location was significant for BCC (*p* = .02) and KSR (*p* = .004) which had hazard ratios of 3.56 and 4.72, respectively, compared to Location Other. Race and age during each interval were not significant predictors of time-to-AMI. None of the two-way interaction terms were significant including policy smoke*age-during, policy smoke*past smoker, policy smoke*facility, or policy smoke*race.

The prisons with the highest hazard ratio were two of the tobacco-free prisons: KSR which had a hazard ratio of 4.72 and BCC which had hazard ratio of 3.56 compared to the group of nine prisons in which there was one AMI each. These results were expected since these two prisons are the medical facilities for medium inmates (KSR) and minimum inmates (BCC). Inmates with diabetes had an increased hazard for AMI of 1.14 compared to inmates who did not have diabetes ($\chi^2 = 12.31$, $df=2$, $p = .002$). The co-morbidities of hypertension and hyperlipidemia were not significant. After controlling for the past smoking history of the inmates, co-morbidities and the prison location, there was 2.87 times the hazard for AMI in prisons with indoor smoke-free policies compared to prisons with tobacco-free policies.

Discussion

This is the first study to demonstrate a significant increase in the probability of an inmate having an AMI while living in a prison that has an indoor smoke-free policy where outdoor smoking is allowed than in a tobacco-free prison, after controlling for location, and inmates' past smoking, age, race and co-morbidities. The hazard ratio indicates that for any given period of time the probability of an inmate having an AMI goes up 2.87 times in prisons with an indoor smoke-free policy compared to prisons that do not allow tobacco products on the grounds. After controlling for the two medically intensive prisons (BCC and KSR) which are also prisons that adopted tobacco-free policies, there was still an effect of the tobacco policy on the hazard for having an AMI.

The results of this study suggest that a tobacco-free policy may be an effective way to improve the health of inmates by reducing the hazard of having an AMI. This may be due to reductions in the proportion of current smoking and in SHS exposure by non-smokers. Indoor smoke-free policies do not limit current smoking except that they have to wait until the yard opens to smoke. The tobacco-free policy is more likely to reduce the rate of current smoking and the number of cigarettes smoked since possessing any tobacco product is a disciplinary violation. In Kentucky prisons, this is a Category III violation (on a scale from I to VII) (KYDOC, 2010).

Having a known past smoking history was not associated with an increased hazard of AMI but an unknown smoking history was associated with more than twice the

hazard (hazard ratio of 2.12, $p = .04$). Of the 61 (70.1%) inmates who were known past smokers, nine reported quitting at some point, three had currently unknown smoking history and 49 were current smokers at the last documentation in the chart. There were 22 (25.3%) inmates whose smoking history was unknown. Based on the increased hazard ratio for unknown smoking status, it is probable that these inmates were smokers. Conversely, the fact that nine past smokers quit smoking, probably resulted in there being a non-significant hazard for past smoking status. There were only four (4.6%) inmates who had never smoked and who remained non-smokers.

Current smoking status was not entered in the model because it was not possible to determine the quit date in relation to the AMI. Some inmates had documentation years after their AMI that they quit when they moved to a tobacco-free prison and a few had cardiology reports that they quit after having their first AMI. The prison primary care providers tended to stop asking about smoking history once the prisons became tobacco-free except in one case where the provider noted that the inmate smelled of smoke and the inmate confirmed that he had smoked. These data point to the need for providers to continually reinforce the need for inmates to quit smoking and to encourage smoking inmates to quit regardless of the prison's tobacco policy. Brief 5-minute interventions by providers have been reported by smokers to assist in quitting smoking (Fiore, et al., 2008).

It is unknown if the inmates return to smoking when they move from a tobacco-free prison to a prison with an indoor smoke-free policy that allows outdoor smoking. Female inmates in the Indiana Department of Corrections were assessed on stage of change to quit smoking before and after the implementation of a comprehensive smoke-free policy in which no lighted tobacco product was allowed in the prisons or in enclosed outdoor areas (Cropsey & Kristeller, 2003). Four days after the prison became tobacco-free, those who had not considered quitting were more likely to report that they would resume smoking on release from prison than those who were contemplating quitting smoking ($F = 27.2$, $p < .001$). This persisted one month after the policy was implemented ($F = 21.8$, $p < .001$). In another Indiana DOC study, 188 male inmates were surveyed before and after the comprehensive smoke-free policy was introduced (Cropsey & Kristeller, 2005a). One month after smoking was prohibited, 76% of those who were

smoking at the time of the policy implementation continued to smoke and 24% had quit. Having greater withdrawal symptoms was correlated with continuing to smoke ($F = 7.61$, $p < .01$). Lankenau (2001) reported that after prisons implemented tobacco-free policies or very restrictive smoke-free policies in which no indoor or outdoor smoking was allowed, inmates who continued to smoke reported smoking fewer cigarettes per day.

This study tracked inmates' movements from prison to prison over the course of 11 years. The majority of inmates moved from prison to prison multiple times with only 29 (33%) moving less than once a year with the majority of these residing at KSR due to medical needs. On average inmates moved 1.1 times per year but up to seven times in a year. In a qualitative study of 40 Australian male and female inmates on the role of tobacco in prison, the movement from prison to prison or to a new unit was reported by inmates as particularly stressful and more likely to prompt them to smoke (Richmond, et al., 2009). Given that inmates move multiple times from prison to prison, there is a greater chance that they may relapse if moved from a tobacco-free prison to a smoke-free prison.

Since there are variations in the enforcement of tobacco policies within and among prisons, there might be even greater reductions in the hazard for AMI if tobacco-free policies are enforced consistently. Four of the six prisons in this study were tested for $PM_{2.5}$ in Fall 2009 including two tobacco-free prisons (BCC and KCIW) and two smoke-free prisons (EKCC and LSCC) (McGuire and Connell, unpublished, 2010). The smoke-free (indoors) prisons (EKCC and LSCC) had low levels of $PM_{2.5}$ (mean 8.1 $\mu g/m^3$) in the communal living areas of the medium security dormitories at these prisons until the inmates' cell doors were opened when the level increased to 37.3 $\mu g/m^3$ indicating that inmates were smoking in their cells during the night. The two smoke-free (indoors) prisons (EKCC and LSCC) (see Table 4. 1) are predominantly medium security prisons with one minimum dormitory outside the fence. The minimum dormitories at EKCC and LSCC had less than half the level of $PM_{2.5}$ than the medium dormitories "behind the fence". An inmate in a medium security prison has little to lose by smoking so may be more likely to smoke in his or her cell when there is an indoor smoke-free policy in place whereas an inmate in a minimum security dormitory in a predominantly medium security

prison might have to return to medium security with many more restrictions if there is a disciplinary violation.

Variations between dormitories may also indicate differing levels of enforcement of the policy within the same prison. At BCC, which is a minimum security, tobacco-free prison, the highest level of $PM_{2.5}$ was 30.4 $\mu g/m^3$ in one dormitory and 11.2 $\mu g/m^3$ in another. The $PM_{2.5}$ of 30.4 $\mu g/m^3$ was measured at 6 AM in a dormitory lobby which had a central officer's station. The SHS level could have been from officers smoking on night shift or officers who allowed inmates to smoke. Inmates in other minimum security prisons have reported that bringing tobacco into a tobacco-free prison is easier with lower security levels (Lankenau, 2001). Correctional officers may be lax in writing up violations which require a lot of paperwork. The friction resulting from enforcing a no-smoking policy in cells may be viewed as not worth the cost. The attitude of the corrections' officers toward smoke-free or tobacco-free policies may affect the enforcement of these policies. In a survey of 321 Vermont DOC employees, those who smoked were much less receptive to comprehensive indoor and outdoor smoke-free policies for inmates and/or employees compared to officers who had quit smoking or never smoked (p <.001) (Carpenter, Hughes, Solomon, & Powell, 2001).

Limitations

The primary limitation of the study was that data from all of the prisons in Kentucky were not obtained which would have provided a cross-sectional view of the AMIs over the entire KY DOC population for five years. Originally, the aim was to compare three prisons with tobacco-free policies to three with smoke-free policies. However, the hospital billing data from CorrectCare was recorded with the prison that the inmate was discharged to and not admitted to the hospital from, resulting in 13 locations in which AMIs occurred. In the future if this study is replicated, all of the AMIs within the study time period in all of the prisons need to be included.

A limitation that is inherent in prison studies and needs to be accounted for in future research is that almost all inmates move multiple times over the course of their incarceration. The multiple movements from smoke-free (indoors) to tobacco-free prisons or from jail, halfway house or parole back to prison create challenges in evaluating the

effects of a tobacco-free policy on the risk for an AMI over time. If inmates stayed in one prison for an extended period of time before and after a tobacco-free policy was implemented or if all of the prisons adopted a tobacco-free policy on the same date, a time-series analysis examining the difference in AMI rates pre- and post-policy could be conducted. However, in reviewing the inmate movements over the previous 11 years of these 87 inmates who had AMIs, inmates resided in all of the DOC's 13 prisons plus the three private prisons. They also spent time out of prison on parole, in jail or in halfway houses. Counting the 13 DOC prisons, the three private prisons, jails, halfway houses and parole there were 19 possible locations in which this sample of inmates resided over the course of the study period. Since moving between prisons has been identified as a stressor and a trigger for smoking relapse, future research could add a "movement variable" to account for the number of moves for each inmate.

While the analysis strategy used in this study was able to account for multiple movements retrospectively, a case-control study of the potential health benefits of tobacco-free prisons could prospectively enroll a representative random sample of smoking and non-smoking inmates and follow them through their incarceration in prisons with varying tobacco policies for an equal period of years to determine the risks for AMI. It would be optimal to assess salivary cotinine or exhaled carbon monoxide as an accurate indicator of current tobacco use during multiple time points in the study which has been validated in other prison studies to confirm abstinence (Cropsey, et al., 2006; Kauffman, Ferketich, Murray, Bellair, & Wewers, 2010). Air quality testing in multiple dormitories could be done simultaneously to monitor the enforcement of the policy in each prison. In states in which a tobacco-free policy is implemented in all state prisons simultaneously, a time-series analysis strategy could be used to determine the rate of AMIs in the years before and after the policy was implemented. In this analysis, cases of AMI would be the unit of analysis.

Another limitation of the study was having only one female inmate with an AMI which makes the study not generalizable to women. Women in the prison system tend to be younger than men and have shorter sentences, which may account for the relative absence of AMI events in females, in addition to the fact that women typically tend to have cardiac events at an older age.

Policy Implications

The policy implication is clear: tobacco-free policies in prisons decrease the hazard for having an AMI. Indoor smoke-free policies place few restrictions on tobacco access or on current smokers, even if the policy is enforced, since smoking is still allowed outdoors and non-smokers remain exposed to SHS outdoors. In cells with doors (as opposed to open dormitories with multiple bunks) it is more difficult to monitor and enforce an indoor smoke-free policy where smoking is not visible to the correctional officers and non-smokers may be exposed to SHS in their cellblocks. Tobacco-free policies are more likely to reduce the rate of current smoking and reduce the number of cigarettes smoked by those who take the risk to receive contraband, thereby decreasing SHS by smokers and non-smokers alike. Strict enforcement of a tobacco-free policy is affected by the security status and the physical layout of the prison (Lankenau, 2001) and the attitude of the administration and staff (Carpenter, et al., 2001),.

Conclusions

This is the first study to examine the effects of a tobacco-free policy compared to an indoor smoke-free policy on cardiovascular health. The results demonstrate that for time spent in a smoke-free prison there is a 2.87 increased hazard for having an AMI compared to time spent in a tobacco-free prison in which all tobacco products are prohibited in the entire prison for staff, inmates, and visitors. Inmates in tobacco-free prisons may still be able to smuggle tobacco into prison but they risk having disciplinary violations which is a misdemeanor in some states and a felony in others so are more likely to at least reduce cigarette consumption even if they do not completely quit smoking.

There are currently 7.3 million people in America who are under some form of correctional supervision including jails, state and federal prisons, probation and parole (Glaze & Bonzcar, 2009). This is a large sub-population which has high rates of tobacco-use and consequently high rates of tobacco-related disease. Tobacco-free policies in prisons may reduce cardiovascular morbidity and mortality. Given the health and cost benefits of tobacco-free prisons, there is a national trend in correctional systems toward

adopting tobacco-free policies. The results of this study may accelerate the likelihood that prisons will adopt tobacco-free policies rather than less restrictive indoor smoke-free policies.

Table 4.1 Prisons with tobacco-free and smoke-free policies

Prison	Average Population	Gender	Security Status	Smoking Status
Blackburn Correctional Complex (BCC)	594	Male	Minimum	Tobacco-free on Sept 17, 2007
Kentucky Correctional Institution for Women (KCIW)	682	Female	Minimum/Medium/ Maximum/Death Row	Tobacco-free on July 1, 2007
Kentucky State Reformatory (KSR)	2005	Male	Medium (1987 inmates) Minimum (22 inmates)	Tobacco-free on May 1, 2006
Eastern Kentucky Correctional Complex (EKCC)	1689	Male	Medium (1639 inmates) Minimum (50 inmates)	Smoke-free— Outdoor smoke allowed
Little Sandy Correctional Complex (LSCC)	992	Male	Medium (892 inmates) Minimum(100 inmates)	Smoke-free— Outdoor smoke allowed
Luther Luckett Correctional Complex (LLCC)	1073	Male	Medium (1029) Minimum (44)	Smoke-free— Outdoor smoke allowed

Table 4.2 Demographic characteristics of the sample of inmates with AMI ($N = 87$)

Variable		*n*	Percent
Race	Black	24	27.5%
	White	56	64.5%
	Unknown	7	8.0%
Gender	Male	86	98.9%
	Female	1	1.1%
Past smoker	Yes	61	70.1%
	No	4	4.6%
	Unknown	22	25.3%
Current smoker at last entry in chart	Yes	49	56.3%
	No	15	17.2%
	Unknown	23	26.5%
Co-morbidities	Diabetes	36	41.4%
	Hypertension	75	86.2%
	Hyperlipidemia	64	73.6%
	One co-morbidity	7	13.8%
	Two or more	71	81.6%
Prison at which AMI occurred*	KSR	44	50.6%
	EKCC	18	20.7%
	LSCC	7	8.0%
	BCC	9	10.3%
	Other	9	10.3%

*KSR-Kentucky State Reformatory, EKCC-Eastern Kentucky Correctional Complex, LSCC-Little Sandy Correctional Complex, BCC-Blackburn Correctional Complex, "Other" includes: FCDC-Frankfort Career Development Center, GRCC-Green River Correctional Complex, KCIW-Kentucky Correctional Institution for Women, KSP-Kentucky State Penitentiary, LAC-Lee Adjustment Center, LLCC-Luther Luckett Correctional Complex, MAC-Marion Adjustment Center

Table 4.3 KOMS data of one inmate's movement and censored intervals with the prisons' tobacco policy

From	To	Prison	Prison Tobacco Policy	Censored Interval
1/25/2005	3/8/2005	Jail	Smoke-free	Yes
3/8/2005	4/24/2005	RCC	Smoke-free	Yes
4/24/2005	5/12/2005	EKCC	Smoke-free	Yes
5/12/2005	*2/14/2008*	*KSR*	*Tobacco-free policy was implemented on 5/1/06 so this time period was divided into two intervals with tobacco policy as the predictor variable as indicated below*	
5/12/2005	4/30/2006	KSR	Smoke-free	Yes
5/1/2006	2/14/2008	KSR	Tobacco-free on 5/1/2006	Yes
2/14/2008	2/15/2008	KSR	Tobacco-free	No AMI Occurred on 2/14/08
2/15/2008	12/31/2009	KSR	Tobacco-free	Time interval deleted since post-AMI

Table 4.4 Hazard ratios for predictors of time to first AMI ($N = 87$)

Variable		χ^2	P value	Hazard ratio
Indoor smoke-free policy (outdoor smoking allowed)		4.57	.03	2.87
Age during the intervals		2.51	.11	1.00
Race				
	Caucasian	0.78	.68	1.17
	African American	0.33	.56	0.86
Location				
	BCC	4.96	.03	3.56
	KSR	8.23	.004	4.72
	EKCC	1.95	.16	1.89
	LSCC	1.41	.24	1.91
Inmate smoking history				
	Past smoker—yes	4.62	.10	1.28
	Past smoker—unknown	4.05	.04	2.12
Co-morbidities				
	Diabetes	12.31	.002	1.14
	Hypertension	0.99	.32	0.66
	Hyperlipidemia	.92	.34	1.38

CHAPTER 5: CONCLUSIONS

Summary of Findings

This dissertation was comprised of a literature review and two research studies. The literature review discussed the evolution of tobacco-free prison policies, the motivators for implementing increasingly restrictive policies and the unintended consequences of tobacco-free policies in prisons. Policy outcome studies with the non-incarcerated population were reviewed as the background for the hypothesized effects of tobacco-free prisons on respiratory and cardiovascular outcomes. The first study compared the effects of two different types of tobacco policies on respiratory health. Two prisons had indoor smoke-free policies in which smoking was allowed outdoors. The other two prisons had tobacco-free policies which prohibited all tobacco products on the grounds of the prison for staff, inmates and visitors. The second study evaluated the effects of the time an inmate spent in prisons with an indoor smoke-free policy compared to prisons with a tobacco-free policy on the hazard for having an AMI.

The literature review of smoke-free and tobacco-free policies revealed that there is a continuum of tobacco-related policies among and within states. Most states now have indoor smoke-free policies in which smoking is prohibited indoors with outdoor designated smoking areas for staff and inmates. Comprehensive smoke-free policies cover indoor and outdoor areas but tobacco is not entirely prohibited from the prison grounds. The most restrictive policy is a tobacco-free policy in which no tobacco products are allowed on the prison grounds for staff, inmates, and visitors.

The primary unintended consequence of tobacco-free policy implementation in prisons is the smuggling of tobacco into prisons which creates a lucrative black market for the inmate dealers. Correctional officers sometimes participate in smuggling tobacco into prisons, lured by the significant profit which undermines security in the prison. Tobacco historically is the main form of informal currency for inmates in prisons which make its eradication more challenging.

There are no reports of studies on health outcomes of smoke-free or tobacco-free policies in prisons. In community-based studies of municipalities, states, and countries,

there is a large body of evidence indicating that the risk for AMI decreases significantly in the year following passage of smoke-free legislation in public places with the risk decreasing even more after three years. Respiratory improvements following smoke-free laws have also been seen with improvements in respiratory symptoms and in severe asthma exacerbations.

There are studies in prisons that report a reduction in cigarette smoking following comprehensive smoke-free and tobacco-free policies, but a surprising proportion continue to smoke. Secondhand smoke (SHS) as measured by particulate matter 2.5 ($PM_{2.5}$) has been shown to decrease following the adoption of a tobacco-free policy. However, the enforcement of the policy appears to determine the level of secondhand smoke (SHS) exposure.

The first study in this dissertation was a time-series analysis that examined the use of inhalers and oral medications by inmates with asthma and/or COPD. Two prisons had smoke-free (indoors) policies and two had tobacco-free policies. Immediately following implementation of the tobacco-free policy there was a reduction in short-acting inhalers such as albuterol. However, the use of these medications gradually increased over the next year back to the frequency of use prior to policy implementation. Confounders in this study were the rapid turnover of inmates in the tobacco-free prisons and the security status of these prisons with many inmates living in minimum security. Inmates in minimum security prisons have greater access to the outside world and consequently to cigarettes which are often brought into the prison. Future research on the effects of tobacco-free policies on respiratory health needs to examine person-level data such as smoking history, physiologic measurements of respiratory function and SHS exposure and inmate movement data to track admissions and discharges from each prison.

The second study was a survival analysis to determine the hazard for having an AMI given differing time intervals in prisons with smoke-free (indoors) and tobacco-free policies. The results of this study demonstrated that there was a 2.87 times increased hazard of an inmate having a first AMI in a prison that had an indoor smoke-free policy compared to a tobacco-free policy. Person-level data including inmates' co-morbidities, age, race, past smoking history and movement between prisons, jails, halfway houses and parole were control variables.

Diabetes was the only co-morbidity associated with an increased hazard ratio of 1.14 compared to inmates without the diagnosis. Hypertension, hyperlipidemia, age and race were not significant. Having documentation of being a past-smoker was not associated but having no documentation in the chart of smoking history had a 2.12 hazard ratio of AMI which may be an indication of current smoking. Two of the tobacco-free prisons had 3 to 4 times the hazard for AMI compared to the other prisons but these were the minimum and medium medical facilities for the state and house the sickest inmates. After controlling for the past smoking history of the inmates, their medical conditions and the prison location, there was still 2.87 times the hazard for AMI in prisons with indoor smoke-free policies compared to tobacco-free prisons.

Limitations of this study were that inmates' smoking history was not readily available in the electronic health record (EHR) prevented determining if inmates were current smokers at the time of their first AMI. The second main limitation was that the billing data were recorded by the prison the inmate was discharged to and not the prison in which the AMI occurred which resulted in 13 prisons in which the AMI occurred rather than the original six. The tobacco policies of all the study prisons were included in the model. If this study were to be replicated, all of the AMIs from the KY DOC prisons during the study period would be included to give a cross-sectional view of the entire state.

These two dissertation studies are the first to report on health outcomes secondary to tobacco-free prison policies. The AMI study was also the first to incorporate the multiple movements of an inmate population among prisons within one state. The movement of inmates between prisons is a major challenge in prison policy outcome research. In the respiratory study, the results may have been affected by inmates' movement among prisons but this was not tested since the data were derived from the pharmaceutical company for the state. It was not feasible to track over 1,100 inmates' movement over three years. In the AMI study with a smaller samples size ($N = 87$), the frequency of inmate movements was calculated by specific time intervals and included in the model with a predictor variable indicating the tobacco policy of the prison at a point in time. Most inmates moved from one prison to another an average of once per year but some moved multiple times in one year.

Research Implications

Findings from these studies support the need for further research that examines the effects of the continuum of smoke-free to tobacco-free prison policies on health outcomes on both inmates and correctional staff. In states such as Kentucky that have different strengths and scopes of tobacco policies it is more difficult to determine the effect of the policy on a particular health outcome. If these studies were to be replicated, all state prisons over the same time period would need to be included and all inmates' movements tracked over an extended time period before and after policy implementation. Future research would also include a movement variable to account for the number of movements by each inmate during the study period. The best time to evaluate the effect of a tobacco-free policy is when an entire state increases the strength and scope of the existing tobacco policy such as in Nevada, North Carolina, Virginia and Georgia which are all becoming tobacco-free in 2010. States such as Kentucky where tobacco policies vary prison by prison make it harder to evaluate the effect of the policy since inmates move frequently from one prison to another.

There are three main methods for evaluating the effect of tobacco-related policies on the health of inmates. One is a population-based analysis of a particular health outcome such as the cases of AMI in the year before and after the implementation of a tobacco-free policy in all prisons across the state. This would be more challenging if the policy was not implemented simultaneously on the same date in all prisons. This method would be similar to studies in the non-incarcerated population in Helena, Montana and Piedmont, Italy in which the age-adjusted incidence rate in the pre-policy period was compared to that of the post-policy period (Barone-Adesi, et al., 2006; Sargent, et al., 2004).

The second method would be a prospective, longitudinal study with a pre-post design but with a smaller convenience sample that includes person-level data such as physiologic measures such as cotinine levels and pulmonary function tests, co-morbidities, smoking history, length of incarceration and sentencing data, and movement among, and in and out of prisons. These would be measured preferably for at least a year prior to the tobacco-free date and then at intervals in the post-policy implementation period. The health outcome could be the number of cases (e.g., AMI) or a physiologic

marker (e.g., FEV_1) which could be entered into a regression to determine the likelihood of the particular health outcome while controlling for facility and person-level variables.

A third way of analyzing the effect of tobacco policies on health outcomes in prisons would be a cost-analysis on AMIs for a period of time. Again, simultaneous adoption of a tobacco-free policy in all state prisons would be the best scenario for this analysis. Cost-analysis requires a complex mixed-model design that includes random and fixed effects such as facility, rate of admissions and discharges to the state, inflationary costs, and fixed costs such as for staff and overhead.

Practice Implications

The main factor that facilitated the two health outcome studies of the tobacco policies in Kentucky was the partnership between the KY DOC and the University of Kentucky: Kentucky Corrections Health Services Network (KCHSN). KCHSN streamlined and centralized the health care of the inmates in Kentucky by hiring a health care management company and a single pharmaceutical company. The health care management company provided the data for the AMI events, and the pharmaceutical company provided the data on medications by disease type. Both of these companies have a sophisticated, electronic database which can track data by time, inmate, and ICD-9 code. The electronic health record facilitated chart review since every inmate in the state has a health chart. Prior to this, each prison contracted with individual and primarily local vendors and paper charts were used, both of which precluded systematic policy analysis research. There are few State Departments of Corrections that have a university partnership but this is recommended to increase the quantity and quality of health-related research on the incarcerated population since at any given time there are over 7 million people under correctional supervision including 2.3 million people in prison and approximately 5 million on parole and probation (Glaze & Bonzcar, 2009).

The most important practice implication of the studies reported here is that primary care providers need to regularly assess and document details of inmates' smoking history. This allows for tracking of the quit date in relation to health outcomes. Providers need to encourage inmates to consider permanent smoking cessation regardless of the tobacco policy of the particular prison since the literature indicates that inmates

continue to find ways to smoke even in tobacco-free prisons and they tend to resume smoking after discharge from a tobacco-free prison (Thibodeau, Jorenby, Seal, Kim, & Sosman, 2010). Ninety-five percent of inmates will eventually be discharged and many return to smoking upon return to their home communities (Sabol, et al., 2009; Thibodeau, et al., 2010). Incarceration may be a time when inmates can achieve prolonged abstinence from tobacco.

Tobacco dependence treatment needs to be offered to inmates regardless of the tobacco policy of the prison since approximately 70% of inmates are current smokers on entry to prison. Tobacco cessation classes have been offered to inmates with varying degrees of success. A tobacco cessation program, using a mood management training behavioral intervention once a week for 10 weeks combined with nicotine replacement, was provided to a purposive sample of 250 female current smoking inmates (Cropsey et al., 2008). Of the 116 who completed the intervention, quit rates were 18% at the end of the program, 17% at three months and 14% at six months which is consistent with quit rates in community cessation programs. In Australia, in a prison with 330 male inmates, 30 signed up for a smoking cessation intervention which included two brief cognitive behavioral therapy sessions, nicotine replacement gum, bupropion and self-help resources. At six months, eight (26%) were abstinent which was confirmed by exhaled carbon monoxide measurements.

Despite promising results of tobacco treatment in prisons, a survey of 100 correctional administrators reported that tobacco cessation programming is not a high priority in correctional facilities (NCCHC, 2004). Eighty percent reported that they have no tobacco cessation programs in prisons regardless of the status of the tobacco policy of the environment. It is recommended that prison health care providers such as physicians, nurse practitioners and nurses offer tobacco dependence treatment as they would for any other chronic, relapsing health condition (Fiore, et al., 2008).

Policy Implications

The results of the AMI study reporting a hazard ratio of 2.87 for having an AMI in a smoke-free prison compared to completely tobacco-free prisons has significant policy implications for State Departments of Corrections that are considering becoming

tobacco-free (vs. smoke-free) and for prisons within Kentucky that have not yet become tobacco-free. Since current smoking prevalence data were not available, it is not clear whether the reduction in hazard at tobacco-free prisons was related to reductions in personal smoking, SHS exposure or a combination of the two. Regardless, the policy was associated with reductions in the hazard of AMI despite expected differences in levels of enforcement in the prisons and after controlling for unique characteristics of the prisons. The result of this study will be shared with the Medical Director for the KY DOC and the Commissioner of the KY DOC as well as with individual wardens of Kentucky prisons who may consider strengthening the existing indoor smoke-free policies to tobacco-free prison policies.

Conclusion

This dissertation is the first study to examine health outcomes following adoption of a tobacco-free policy in prisons. The first study which examined medications for asthma and/or COPD as a proxy marker of respiratory health did not yield conclusive results on the effect of the policy. There was an immediate reduction in short-acting inhaler use for respiratory symptoms but this effect was not sustained over the following 18 months. However, the study with AMIs as the dependent censoring variable in a survival analysis which included person-level data, determined that there was a hazard ratio for having an AMI of 2.87 in prisons with an indoor smoke-free policy compared to prisons with a tobacco-free policy, in which no tobacco is allowed on the grounds of the prison. These results are consistent with policy outcome studies in the non-incarcerated population that show reductions in the risk for AMI after passage of smoke-free legislation. There are no equivalent, free-world studies of tobacco-free policies since non-incarcerated current smokers are at liberty to smoke when away from the location covered by the law without fear of disciplinary action while inmates risk disciplinary violations by possessing or using tobacco in tobacco-free prisons.

Tobacco in prisons has an added dimension in that inmates consider it as informal currency. This increases its demand and value as smuggled contraband after prisons become tobacco-free. In prisons with comprehensive tobacco-free policies, the rate of current smoking decreases as the policy becomes more restrictive and as the security

status of the prison increases. Tobacco typically overtakes heroin as the number one contraband item following a tobacco-free policy (Garland, 2006) but as one Kentucky warden who implemented a tobacco-free policy in her prison said, “I would rather chase tobacco than drugs any day. It’s fiscally and ethically the right thing to do” (personal correspondence, Warden Crews, June 22, 2010).

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VITA

Alison Ruth Connell

Date of Birth: 09/16/1959 Birthplace: London, England

Education

Institution	Degree	Date Conferred	Field of Study
University of Kentucky	PhD	Expected August 2010	Nursing
University of Kentucky	MSN	1987, December	Family nurse practitioner
University of Nebraska	BSN	1982, December	Nursing
University of Nebraska	AD	1981, May	Nursing

Licensure
KY RN
KY ARNP

Certification
ANCC Family Nurse Practitioner
Current UPIN/NPI

Professional Experience

Dates	Institution and Location	Position
May, 2010 – present	Kentucky Corrections Health Services Network (KCHSN), Lexington, KY	Project Director
August, 2006–May, 2010	KCHSN, Lexington, KY 40503	Research Assistant
January, 2008-May, 2010	Kentucky Medical Research Center (KMRC), Lexington, KY 40504	Sub-investigator
January, 2007-May, 2007	RICH Heart team, University of Kentucky, Lexington, KY	Research Assistant
January, 2005-July, 2005	Bluegrass Mental Health Mental Retardation Board, Lexington, KY	Consultant: Fetal alcohol syndrome
May, 1991-Sept, 2006, Sept-Dec 07, Oct 2009-Mar,2010	Children's Clinic, Irvine, KY 40336	Nurse Practitioner, pediatrics
February, 1987 – March, 1991	John A. Patterson, MD, Irvine, KY 40336	Nurse Practitioner, family practice
October, 1984-December,1986	St. Joseph Hospital, Lexington, KY	Registered nurse, medical ICU
June, 1981-August, 1983	University of Nebraska Medical Center, Omaha, NE	Registered nurse, pediatrics

Awards and Honors

April, 2010	Invited to be member of the Kentucky Fetal Alcohol Spectrum Disorder Advisory Board
August, 2006 - May, 2007	Graduate school academic year scholarship
June -August, 2006	Tuition scholarship-two summer sessions
May, 2003	Selected as part of a multi-disciplinary team to be trained in fetal alcohol syndrome diagnosis at the University of Washington

Research Activities and Research Funding

October, 2009-present	Biobehavioral Cardiovascular Health Promotion Intervention in a State Prison System 1RC2NR011948-01, DHHS, NIH, NINR, Co-investigator, ($1,913,322)
March, 2009	Effect of a tobacco-free prison policy on respiratory and cardiovascular outcomes, Center for Drug and Alcohol Research, University of Kentucky, PI, ($1,300).
May-August, 2009	Medication compliance evaluation in the inmate population, KCHSN, PI.
January, 2008 - May, 2010	Multiple Phase II and Phase III pharmaceutical clinical trials, KMRC, Lexington, Kentucky, Sub-investigator.
November, 2007- May, 2009	Disease management of chronic disease of inmates in the Kentucky Department of Corrections, KCHSN, PI.

Research Presentations

January, 2010	***** Effect of a tobacco-free prison policy on health. Paper presentation. American Correctional Association 2010 Winter Conference, Tampa, FL.
November, 2010	* Effect of a tobacco-free prison policy on respiratory indicators. Paper presentation. American Public Health Association: 137th Annual Meeting. Philadelphia, PA.
June, 2009	Medication administration records: self-administered medications (SAMs) and directly observed therapy (DOT) in the Kentucky Department of Corrections. Paper presentation. Kentucky Department of Corrections, CorrectCare Integrated Health, Diamond Pharmaceutical, and Med-Unison, Lexington, KY
April, 2009	*Evaluation of chronic disease management of Kentucky prison inmates using an electronic health record. Paper presentation. Student Scholarship Showcase, University of Kentucky, College of Nursing.
April, 2009	*Electronic health records: Benefits of an EHR in the chronic care of inmates. Poster presentation. 21st Annual Regional Conference "Toward Excellence in Advanced Practice Nursing", Kentucky Coalition of Nurse Practitioners and Nurse Midwives.

January, 2009	*Electronic health records: How an EHR aids in documentation of provider behavior, patient compliance and physiologic outcomes in the chronic care of inmates. Paper presentation, American Correctional Association 2009 Winter Conference, Kissimmee, Florida.
October, 2008	*Evaluating disease management processes and patient outcomes using electronic health records. Paper presentation, National Conference on Correctional Health Care, Chicago, Illinois
October, 2008	*Inmate health risk assessment: Risk factors for chronic and infectious diseases. Paper presentation, National Conference on Correctional Health Care, Chicago, Illinois.
June, 2008	*Inmate health risk assessment. Poster presentation. Clinical and Translational Science Conference, Lexington, KY.
March, 2008	*Inmate health risk assessment. Poster presentation. Scholarship Showcase, University of Kentucky College of Nursing, Lexington, KY.

Publications

Curd, P., Winter, S., & **Connell, A**. (2007). Participative planning to enhance offender wellness: Preliminary report of a correctional wellness program. *Journal of Correctional Health Care 13*(4).

Connell, A. (1989). Abnormal uterine bleeding. *Nurse Practitioner, 14*(4), 40-57.

Educational Presentations

March, 2008	Problems, policies and politics: Kingdon's framework in the Kentucky legislature. University of Kentucky, College of Nursing, Health Policy Course, Lexington, KY
May, 2006	* Fetal alcohol spectrum disorder in primary care, University of Kentucky College of Medicine, Department of Pediatrics "Contemporary Pediatrics 2006" conference, Lexington, KY
April, 2006	*Fetal alcohol spectrum disorder. 18th Regional Conference Toward Excellence in Advanced Practice Nursing, Covington, KY
March, 2006	Prenatal alcohol exposure: how it affects the juvenile justice population. Kentucky Department of Juvenile Justice conference: "CHANGE: Making a Difference in Juvenile Justice", Louisville, KY
March, 2006	Fetal alcohol spectrum disorder in primary care. University of Kentucky, Lexington, KY, pediatric nurse practitioner students.
October, 2005	*Fetal alcohol syndrome. Pediatric Grand Rounds, University of Kentucky College of Medicine, Dept. of Pediatrics, Lexington, KY
July, 2005	Fetal alcohol spectrum disorder in primary care. Eastern Kentucky University, Richmond, KY, family nurse practitioner students.
May, 2005	*Fetal alcohol syndrome. Family Medicine Review Board, Lexington, KY

May, 2005	Fetal alcohol spectrum disorder in primary care. University of Kentucky, Lexington, KY, pediatric nurse practitioner students.

Professional Memberships

Kentucky Coalition of Nurse Practitioners and Nurse Midwives

Research Society on Alcoholism

American Correctional Association

American Public Health Association

Academic Service

1997 - 2006	Preceptor for nurse practitioner students from University of Kentucky, Eastern Kentucky University, and Spalding University

Community Service

2003-present	Glendover Elementary School and Morton Middle School
1989-present	Annual presenter on medicinal herbs at Archaeology Weekend in the Red River Gorge, U.S. Forest Service.
April, 2005	Presented lecture to the Estill County High School on Fetal Alcohol Syndrome
2002-2005	Organizer and presenter of annual asthma camp, Children's Clinic, Irvine, KY.
1992, 1993	Presented one-day seminars in 1992 and 1993 to Estill County High School 9th grade students, on responsible decision-making, sex education and sexually transmitted diseases.
1992	Co-founder of Red River Wildlife Club in Powell County, KY
1983-1984	Volunteered in India in 2 hospitals as registered nurse